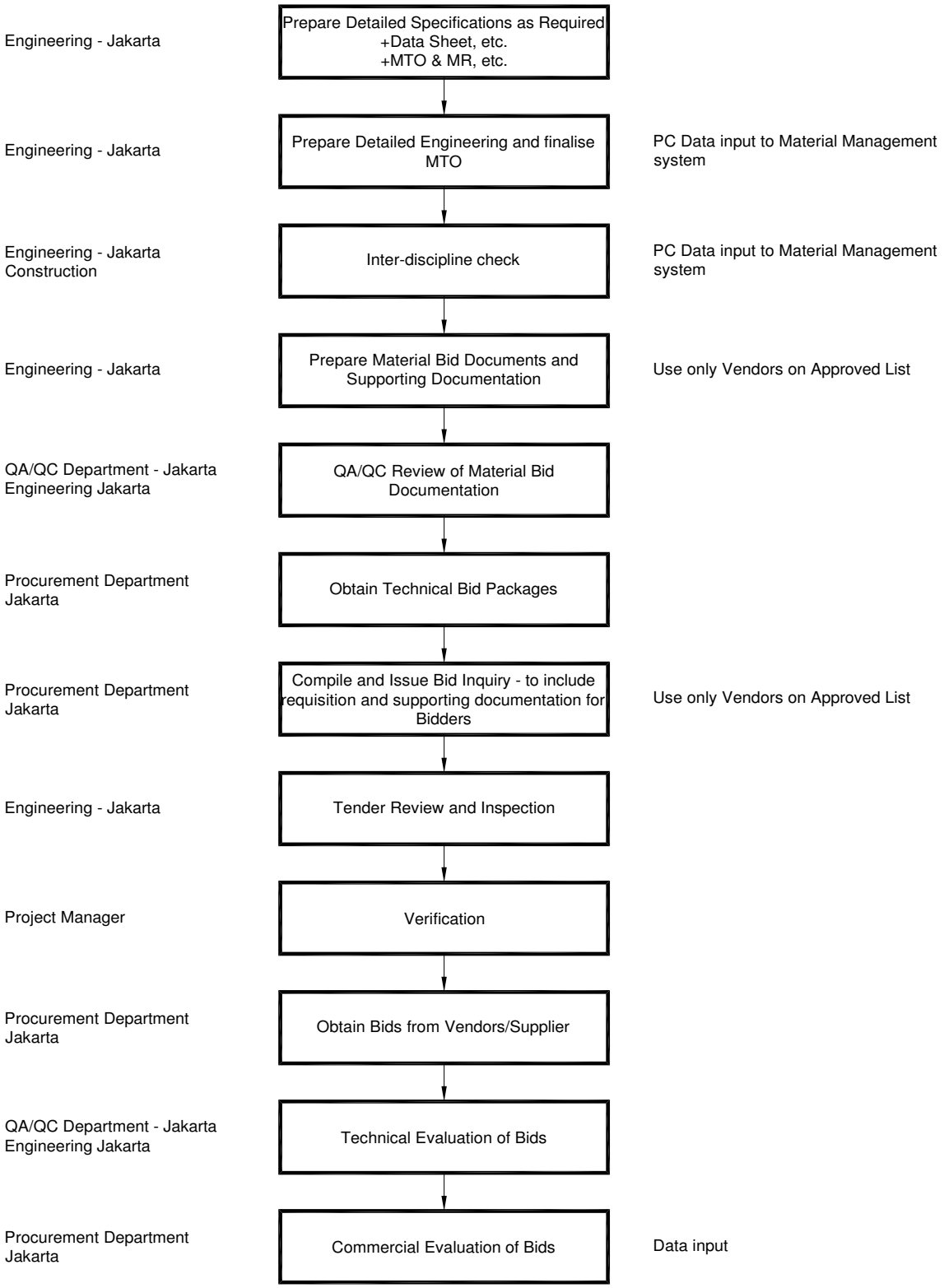
DRAFT Environmental and Social Impact Assessment Report

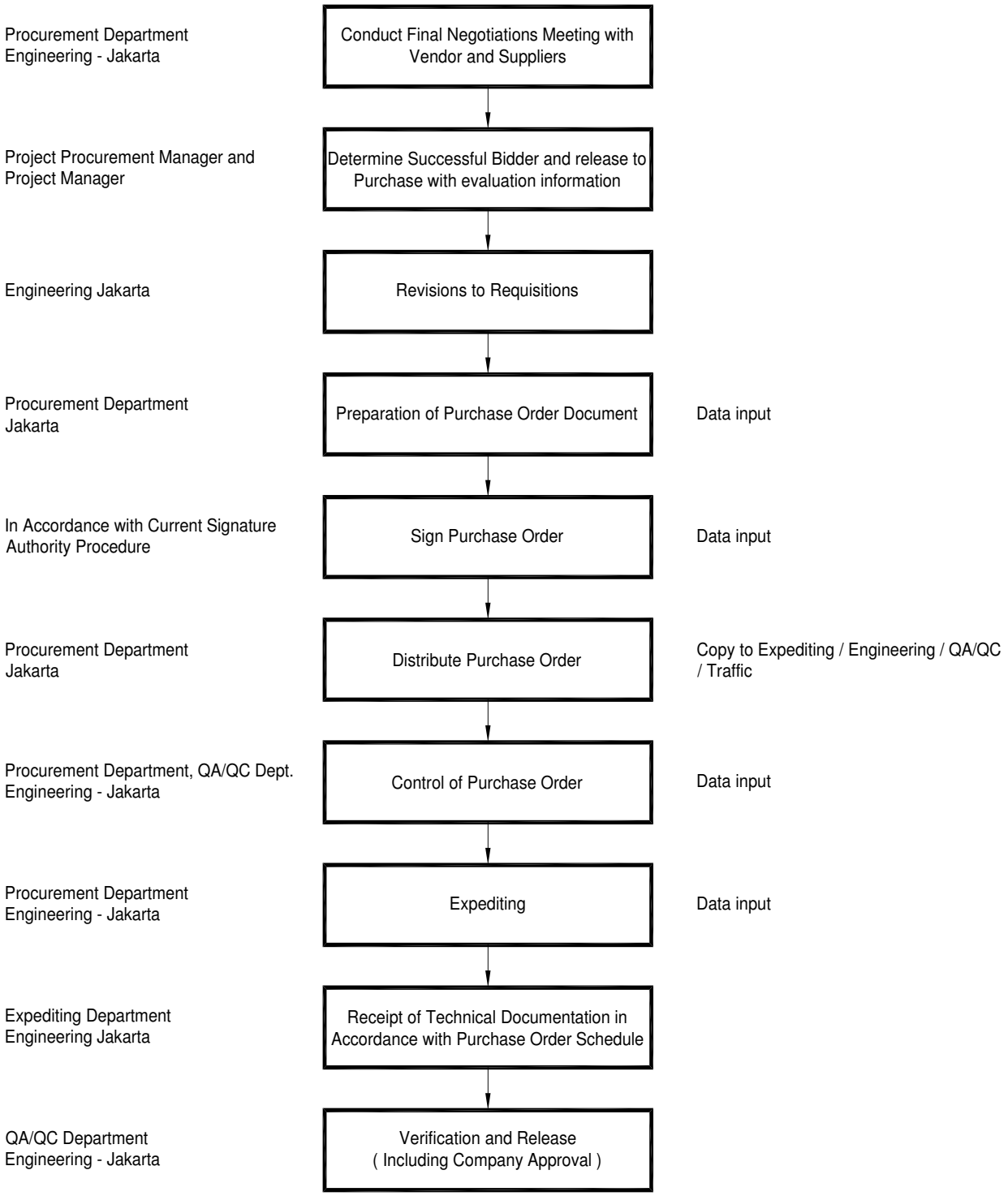
Project Number: 50182-001
May 2018

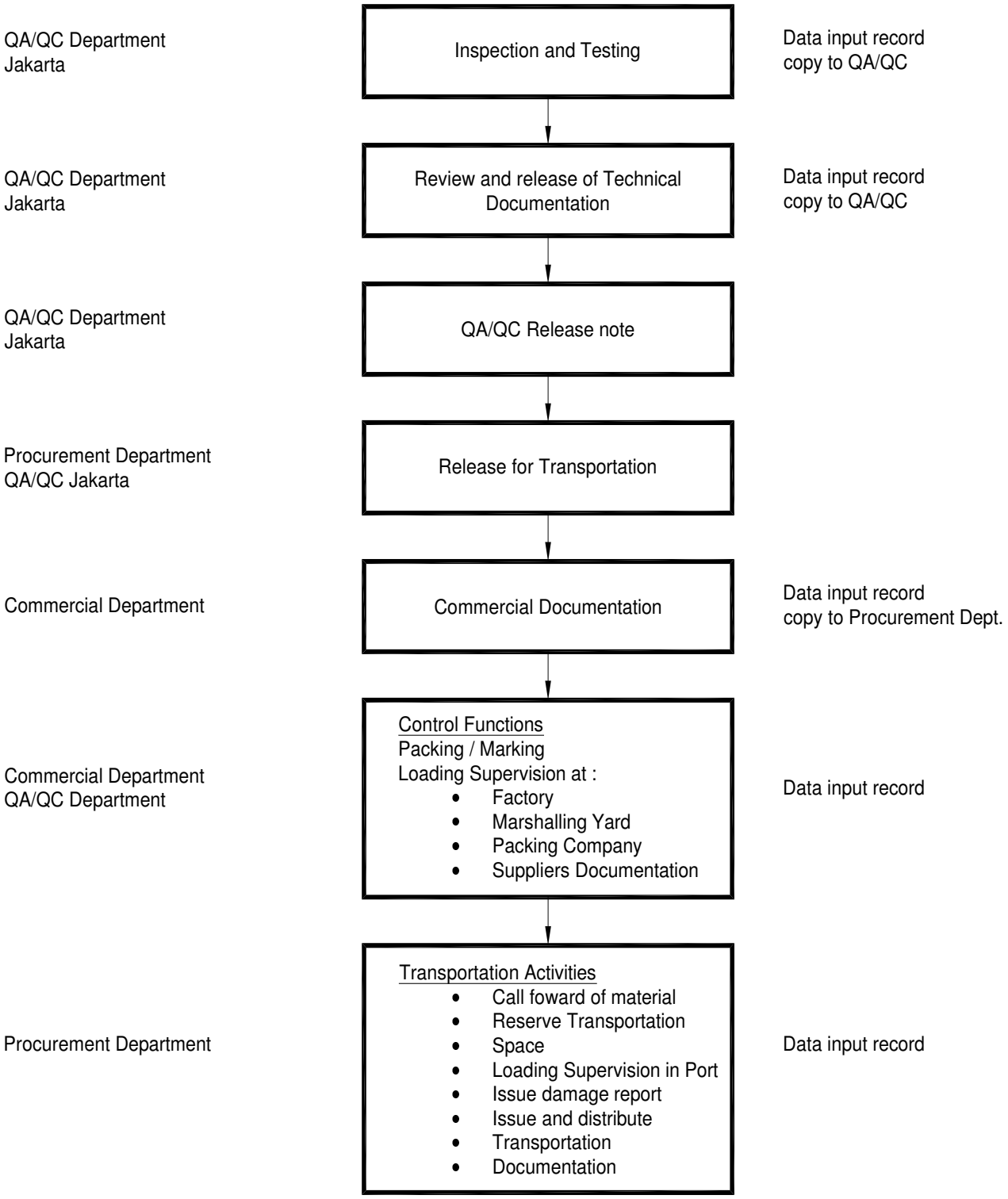
INO: Riau Natural Gas Power Project
ESIA Vol.5C_Technical Appendices

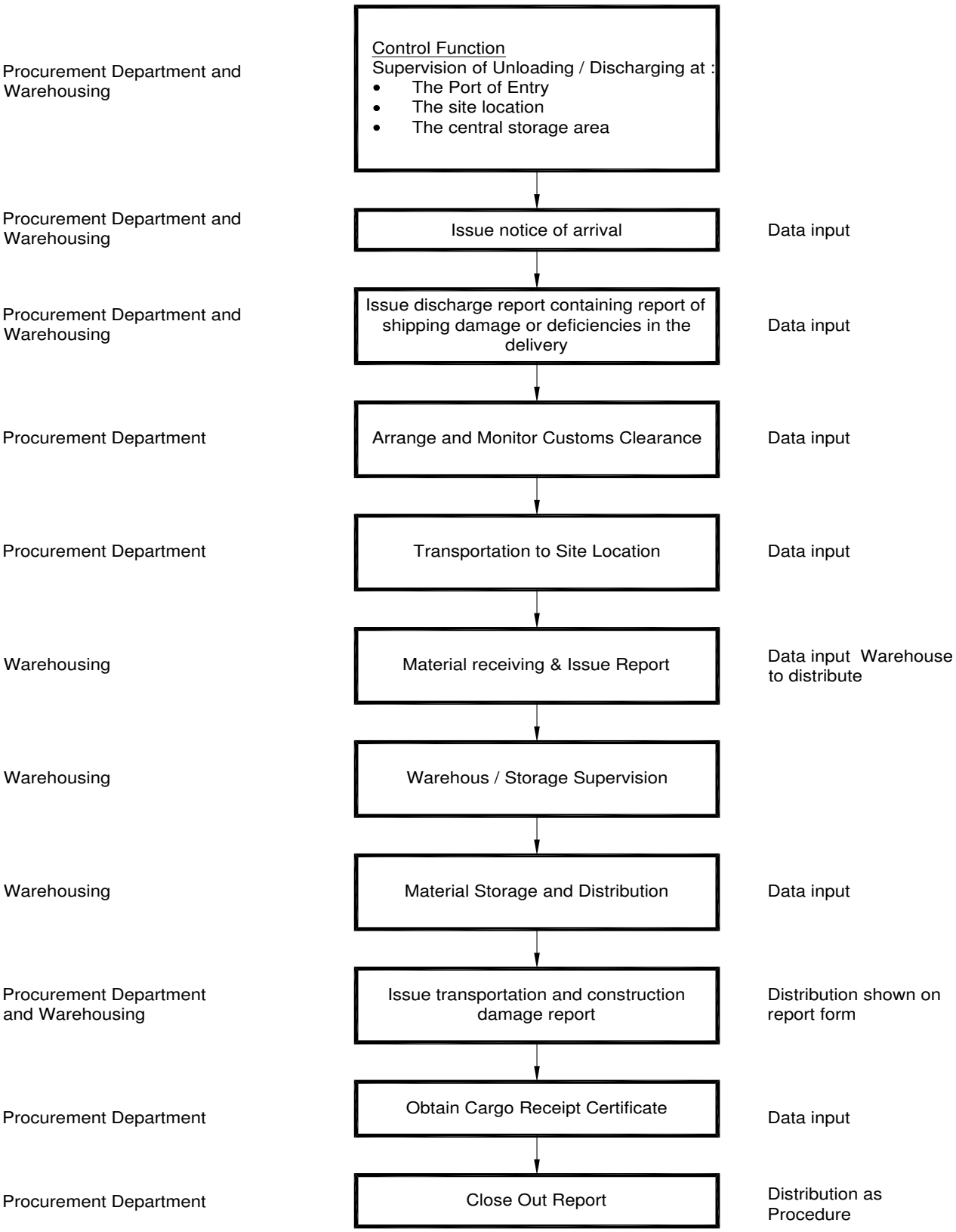
Prepared by ESC for the Asian Development Bank

Attachment – 2: Flow Chart Interfaces between Purchasing and other Department



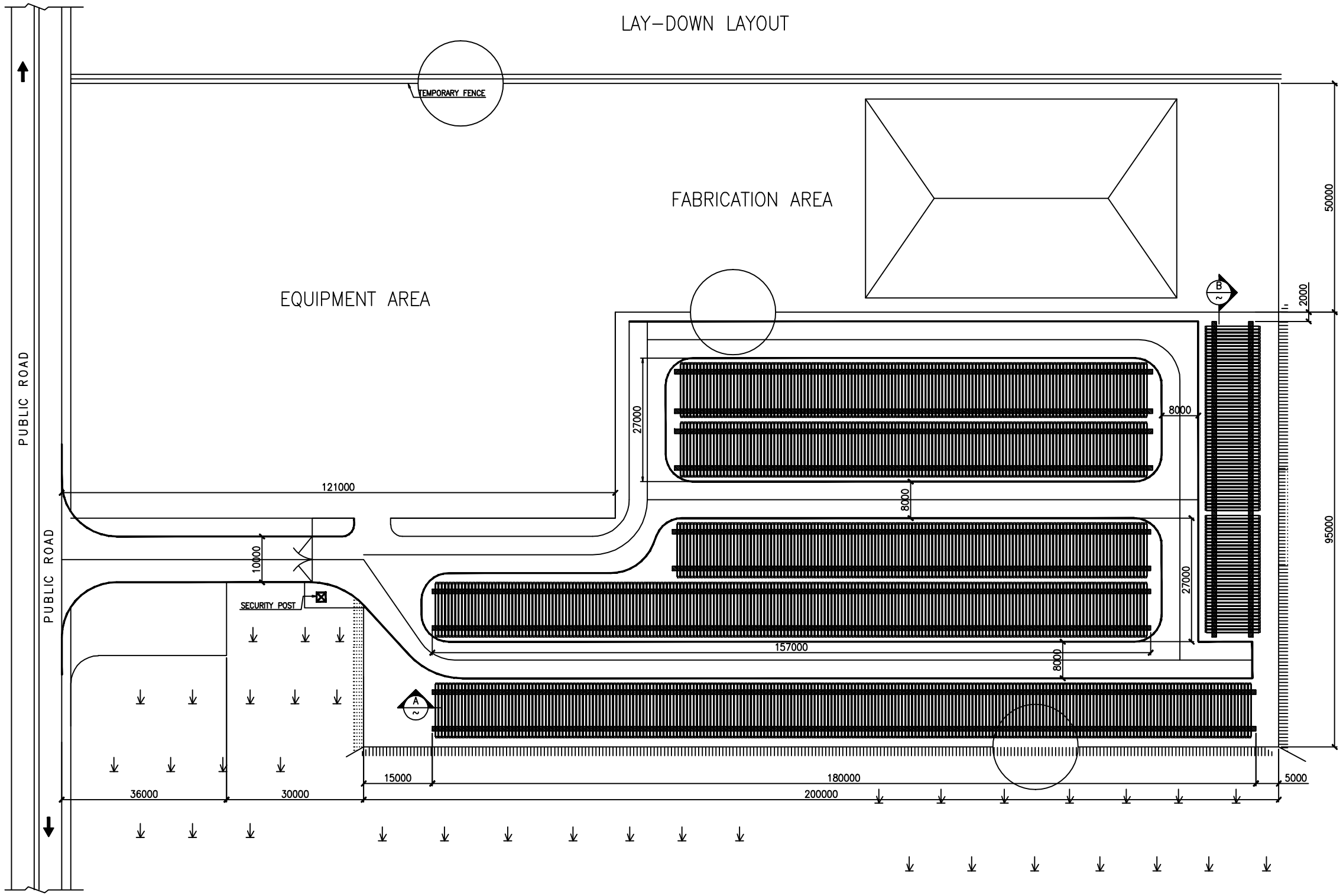

Procurement Department Engineering - Jakarta
Conduct Final Negotiations Meeting with Vendor and Suppliers
Project Procurement Manager and Project Manager
Determine Successful Bidder and release to Purchase with evaluation information
Engineering Jakarta
Revisions to Requisitions
Procurement Department Jakarta
Preparation of Purchase Order Document
Data input
In Accordance with Current Signature Authority Procedure
Sign Purchase Order
Data input
Procurement Department Jakarta
Distribute Purchase Order
Copy to Expediting / Engineering / QA/QC / Traffic
Procurement Department, QA/QC Dept. Engineering - Jakarta
Control of Purchase Order
Data input
Procurement Department Engineering - Jakarta
Expediting
Data input
Expediting Department Engineering Jakarta
Receipt of Technical Documentation in Accordance with Purchase Order Schedule
QA/QC Department Engineering - Jakarta
Verification and Release (Including Company Approval)

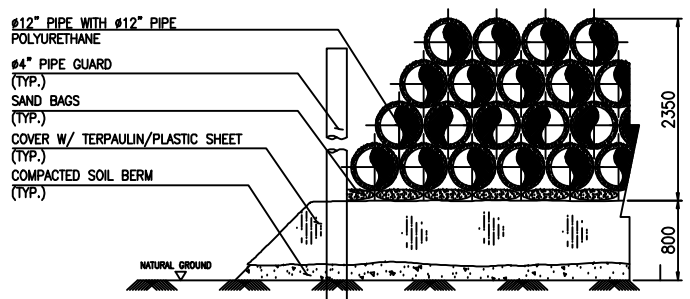

QA/QC Department Jakarta
Inspection and Testing
Data input record copy to QA/QC
QA/QC Department Jakarta
Review and release of Technical Documentation
Data input record copy to QA/QC
QA/QC Department Jakarta
QA/QC Release note
Procurement Department QA/QC Jakarta
Release for Transportation
Commercial Department
Commercial Documentation
Data input record copy to Procurement Dept.
Commercial Department QA/QC Department
Control Functions
Packing / Marking
Loading Supervision at :
Factory
Marshalling Yard
Packing Company
Suppliers Documentation
Data input record
Procurement Department
Transportation Activities
Call foward of material
Reserve Transportation
Space
Loading Supervision in Port
Issue damage report
Issue and distribute
Transportation
Documentation
Data input record


Procurement Department and Warehousing
Control Function
Supervision of Unloading / Discharging at :
• The Port of Entry
• The site location
• The central storage area
Procurement Department and Warehousing
Issue notice of arrival
Data input
Procurement Department and Warehousing
Issue discharge report containing report of shipping damage or deficiencies in the delivery
Data input
Procurement Department
Arrange and Monitor Customs Clearance
Data input
Procurement Department
Transportation to Site Location
Data input
Warehousing
Material receiving & Issue Report
Data input Warehouse to distribute
Warehousing
Warehous / Storage Supervision
Warehousing
Material Storage and Distribution
Data input
Procurement Department and Warehousing
Issue transportation and construction damage report
Distribution shown on report form
Procurement Department
Obtain Cargo Receipt Certificate
Data input
Procurement Department
Close Out Report
Distribution as Procedure

Attachment – 3: Propose Laydown Layout

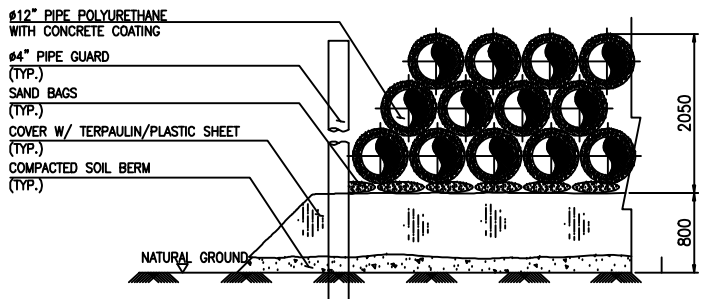
LAY–DOWN LAYOUT





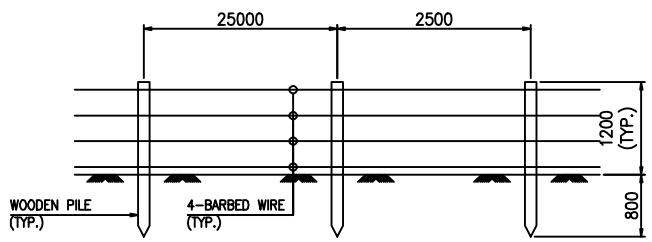
SECTION (TYP.) A

SCALE 1:100



SECTION (TYP.) B

SCALE 1:100



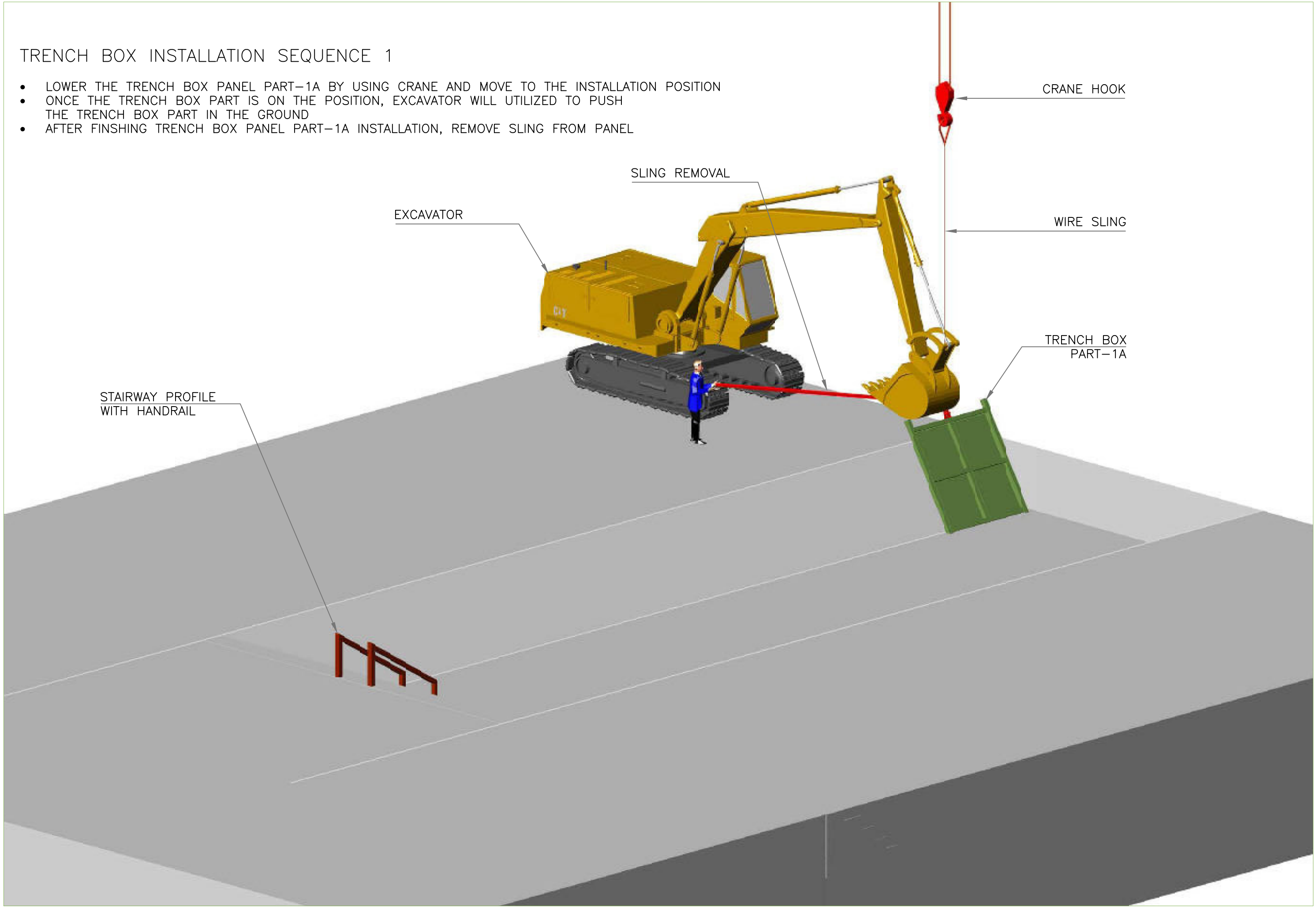
TYPICAL TEMPORARY FENCE

SCALE 1:100

Attachment – 4: Auger Boring Layout

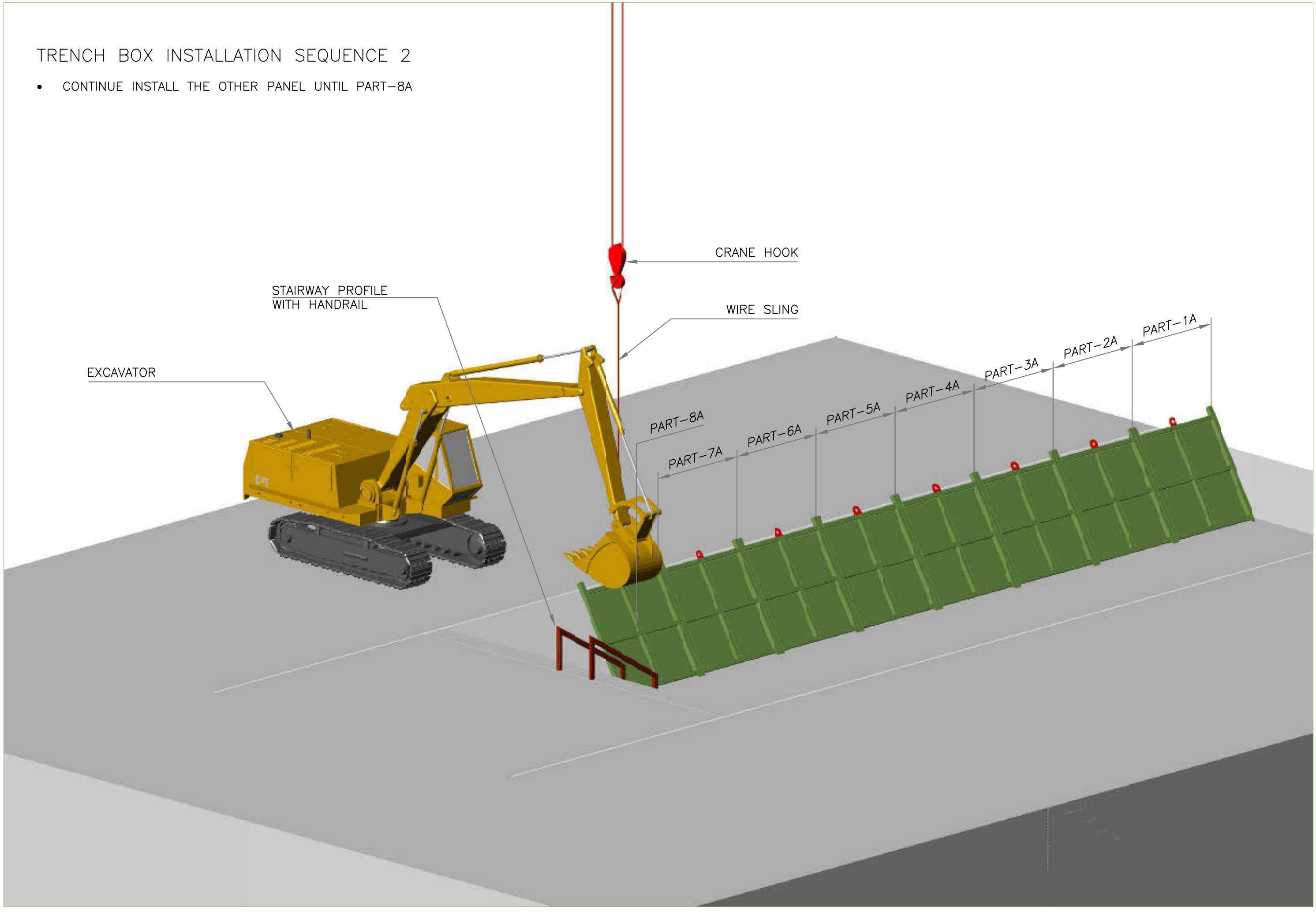
TRENCH BOX INSTALLATION SEQUENCE 1

- LOWER THE TRENCH BOX PANEL PART–1A BY USING CRANE AND MOVE TO THE INSTALLATION POSITION
- ONCE THE TRENCH BOX PART IS ON THE POSITION, EXCAVATOR WILL UTILIZED TO PUSH THE TRENCH BOX PART IN THE GROUND
- AFTER FINSHING TRENCH BOX PANEL PART–1A INSTALLATION, REMOVE SLING FROM PANEL



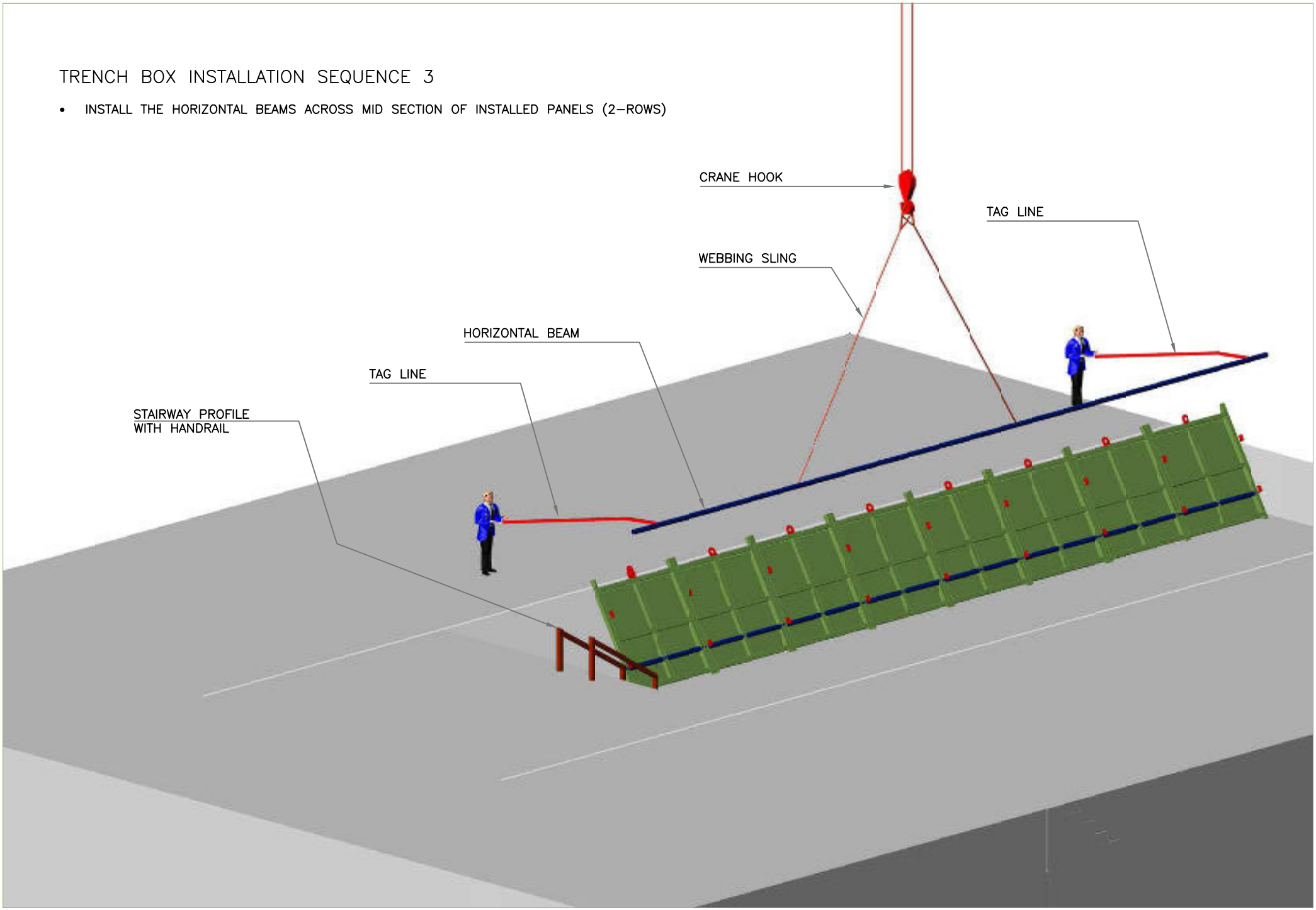
TRENCH BOX INSTALLATION SEQUENCE 2

- CONTINUE INSTALL THE OTHER PANEL UNTIL PART–8A



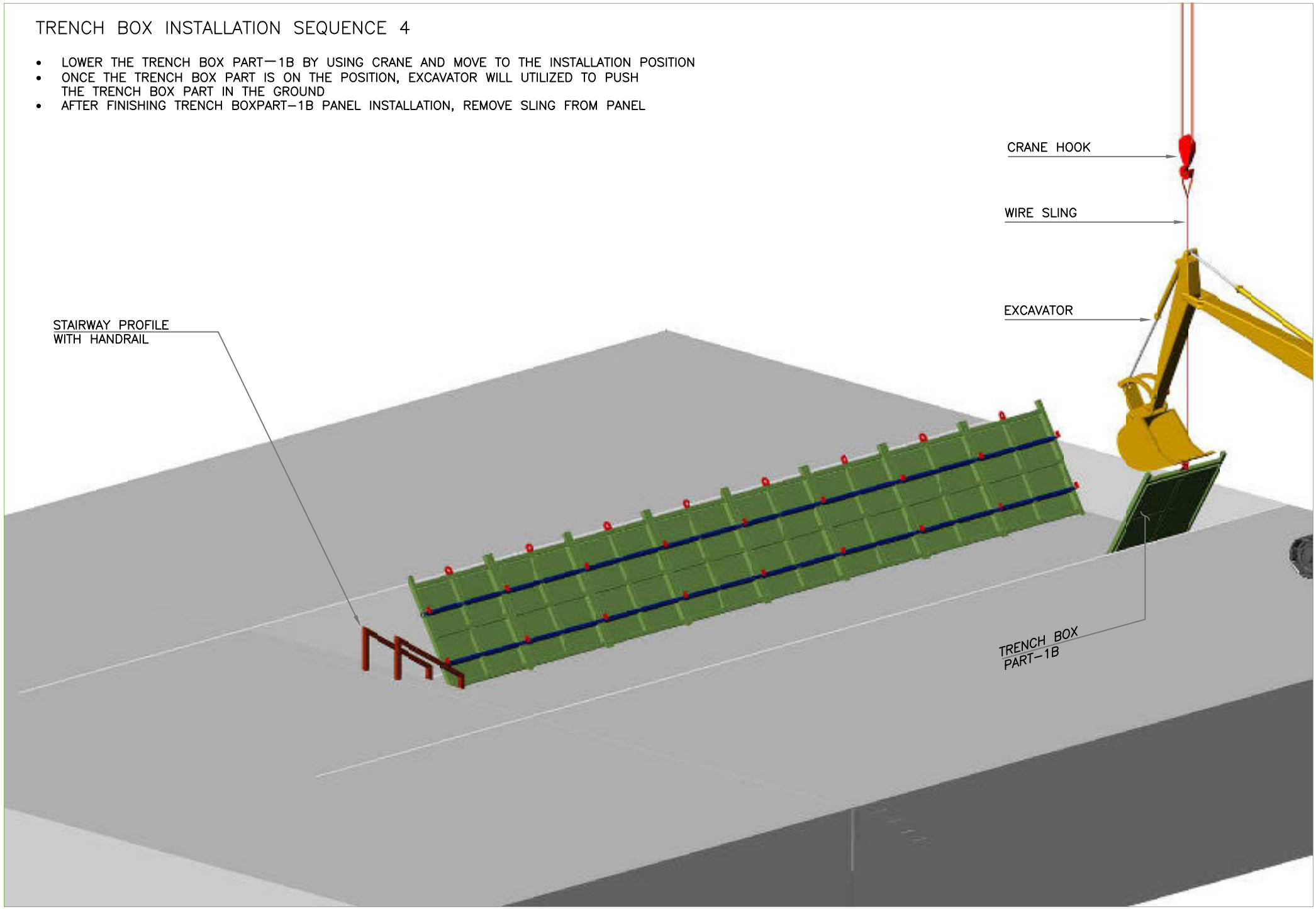
TRENCH BOX INSTALLATION SEQUENCE 3

- INSTALL THE HORIZONTAL BEAMS ACROSS MID SECTION OF INSTALLED PANELS (2–ROWS)



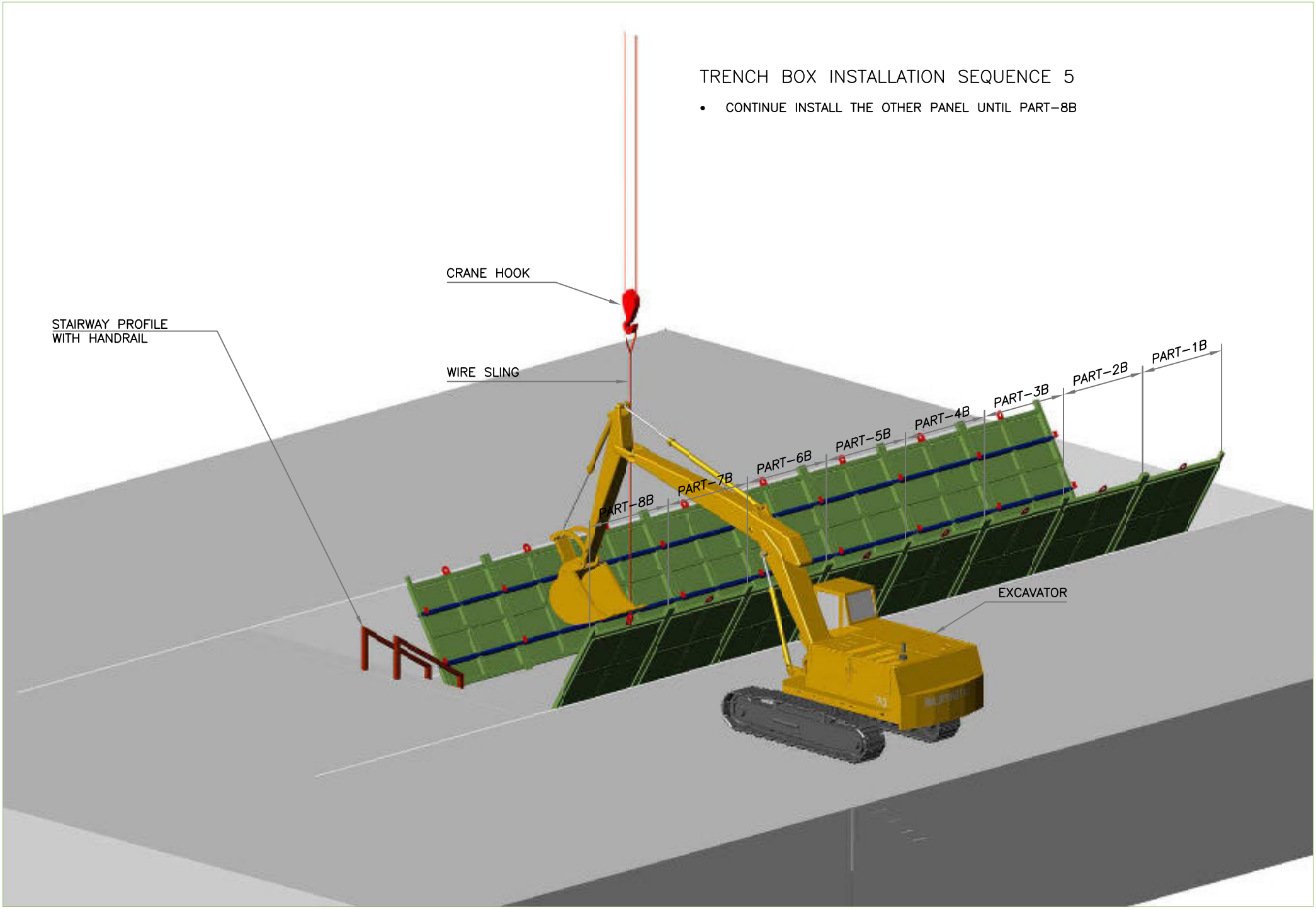
TRENCH BOX INSTALLATION SEQUENCE 4

- LOWER THE TRENCH BOX PART—1B BY USING CRANE AND MOVE TO THE INSTALLATION POSITION
- ONCE THE TRENCH BOX PART IS ON THE POSITION, EXCAVATOR WILL UTILIZED TO PUSH THE TRENCH BOX PART IN THE GROUND
- AFTER FINISHING TRENCH BOXPART—1B PANEL INSTALLATION, REMOVE SLING FROM PANEL



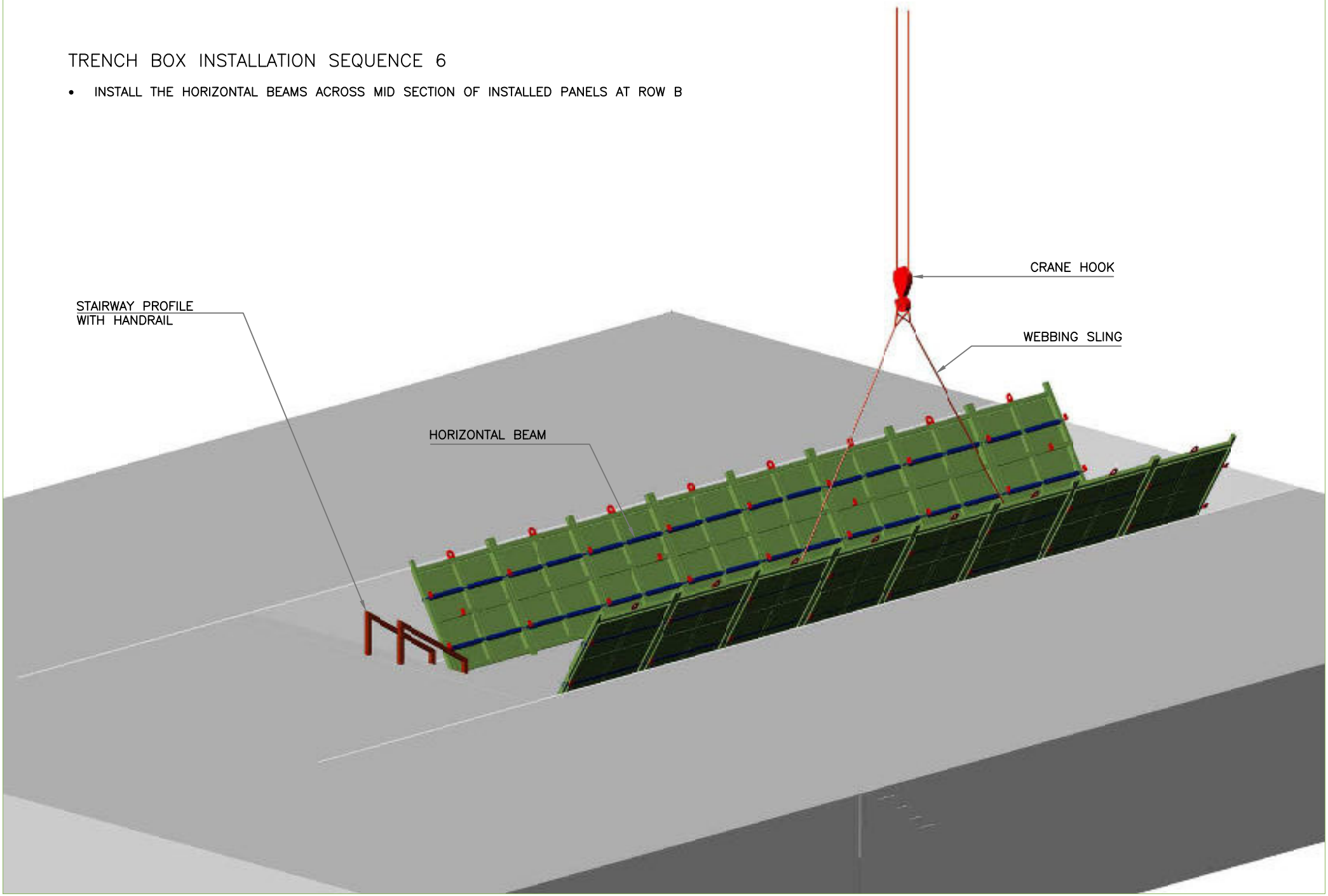
TRENCH BOX INSTALLATION SEQUENCE 5

- CONTINUE INSTALL THE OTHER PANEL UNTIL PART-8B



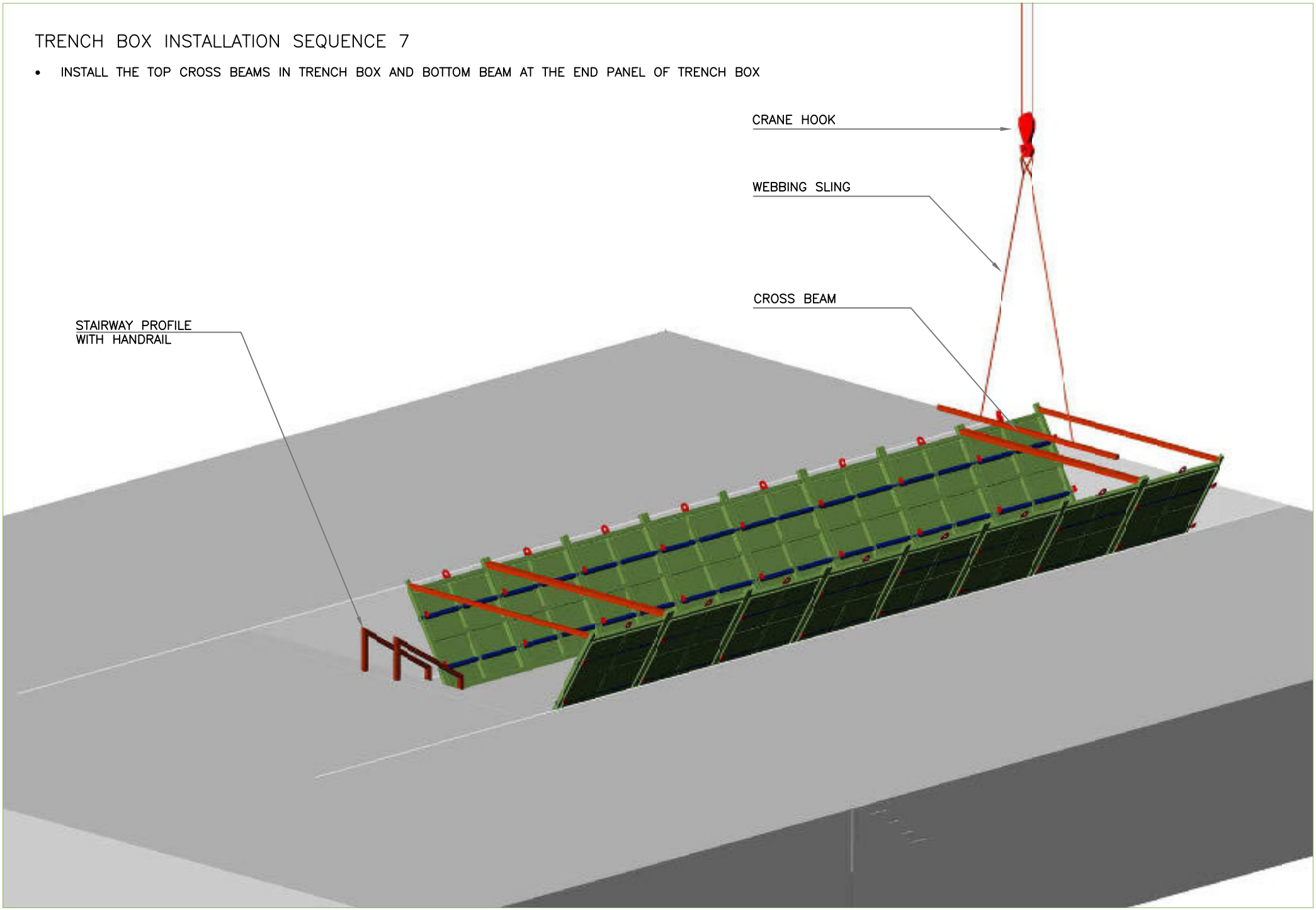
TRENCH BOX INSTALLATION SEQUENCE 6

- INSTALL THE HORIZONTAL BEAMS ACROSS MID SECTION OF INSTALLED PANELS AT ROW B



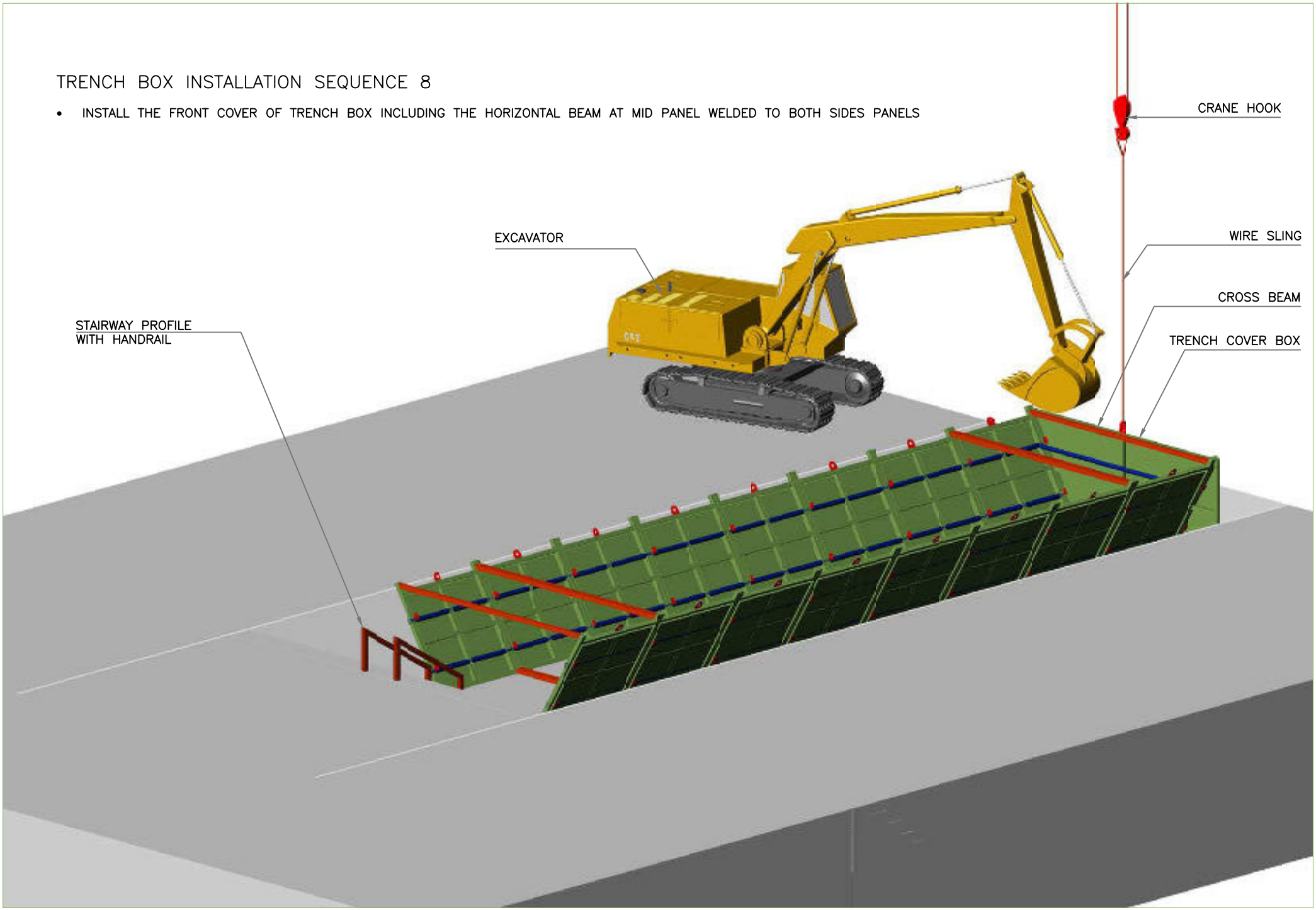
TRENCH BOX INSTALLATION SEQUENCE 7

- INSTALL THE TOP CROSS BEAMS IN TRENCH BOX AND BOTTOM BEAM AT THE END PANEL OF TRENCH BOX

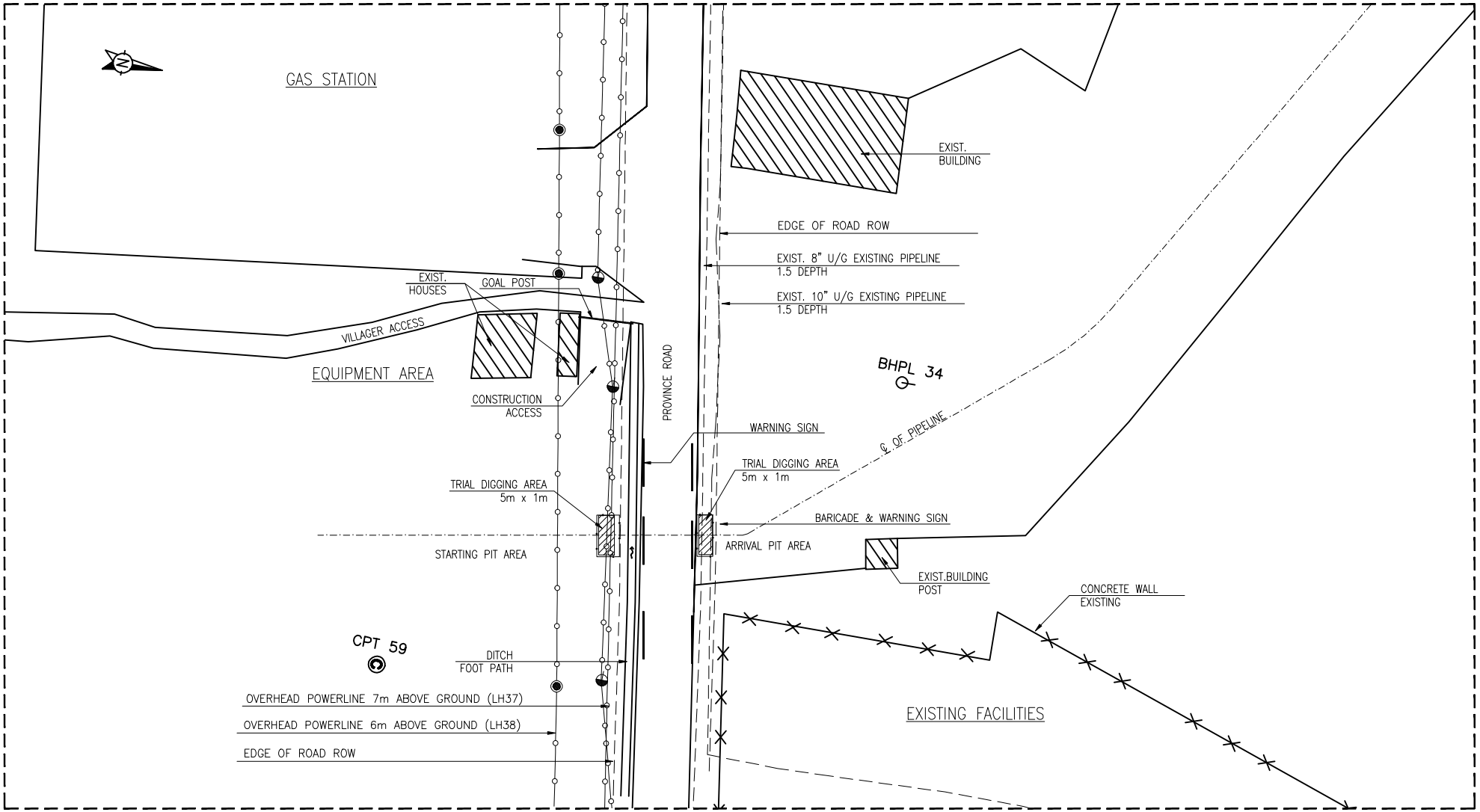


TRENCH BOX INSTALLATION SEQUENCE 8

- INSTALL THE FRONT COVER OF TRENCH BOX INCLUDING THE HORIZONTAL BEAM AT MID PANEL WELDED TO BOTH SIDES PANELS

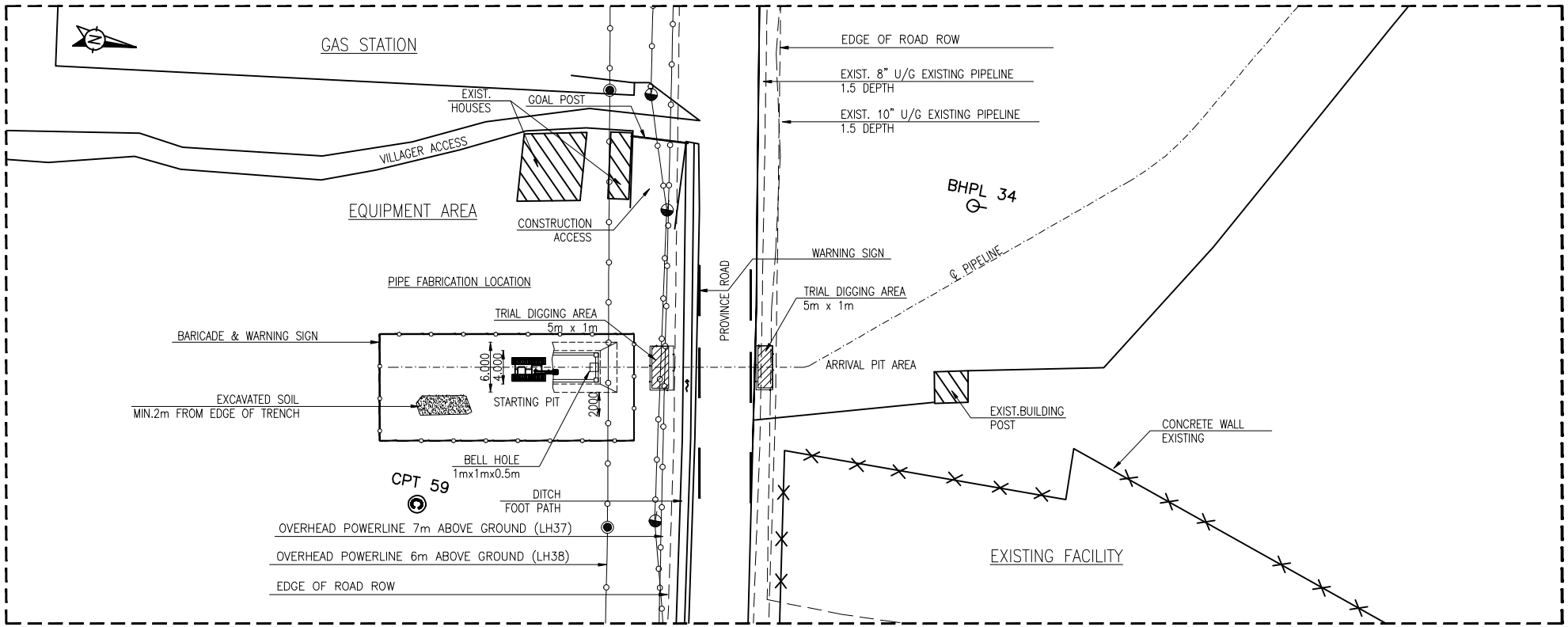


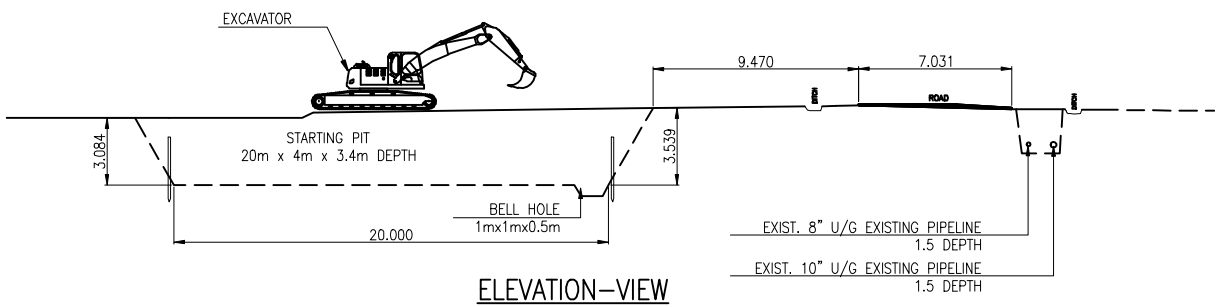
AUGER BORING SEQUENCE 1 OF 21



- Pre Boring meeting shall held with the CLIENT prior to starting work on each bore.
- All the underground pipeline and utilities will be mapped and noted prior to start boring operation. Pipe identification using Pipe/Metal Detector and manual digging shall be performed to ensure the position and depth of the underground pipeline and utilities.
- The Surveyor shall mark the exact boring location on both sides of the road, including any existing underground utilities.

AUGER BORING SEQUENCE 2 OF 21

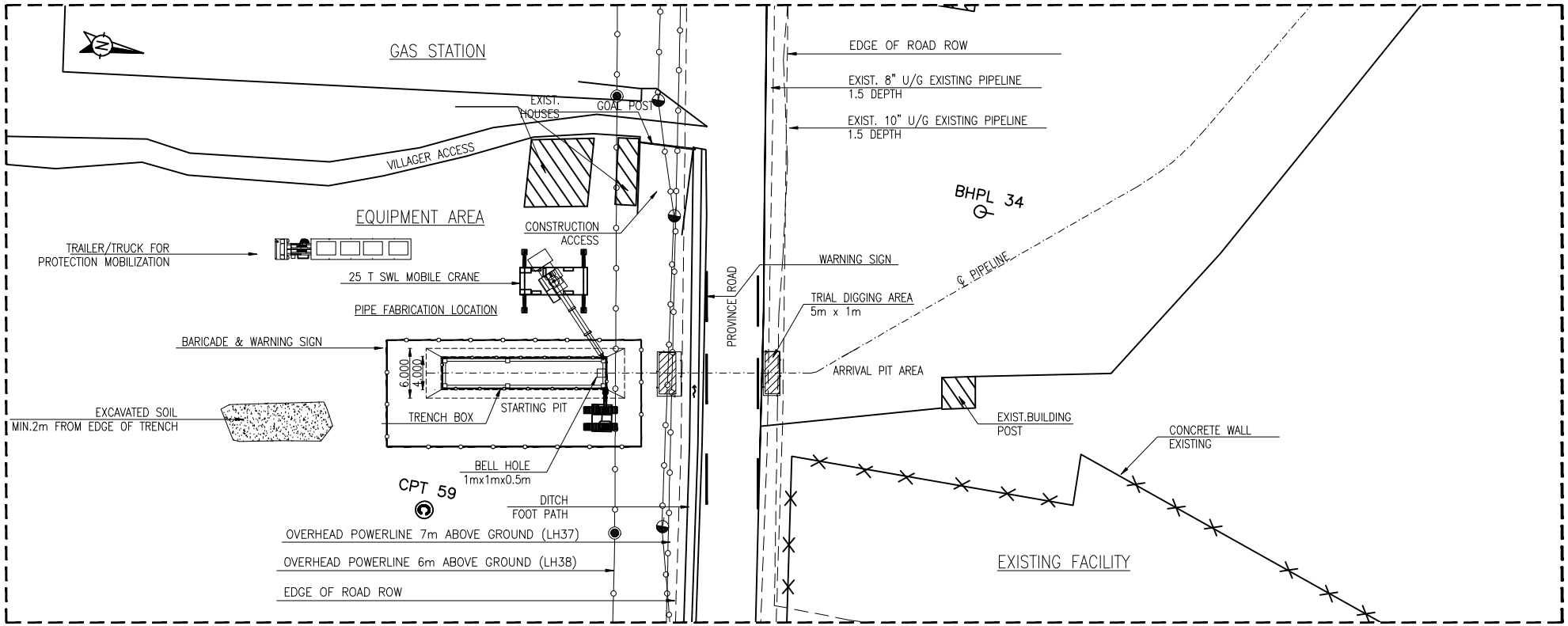


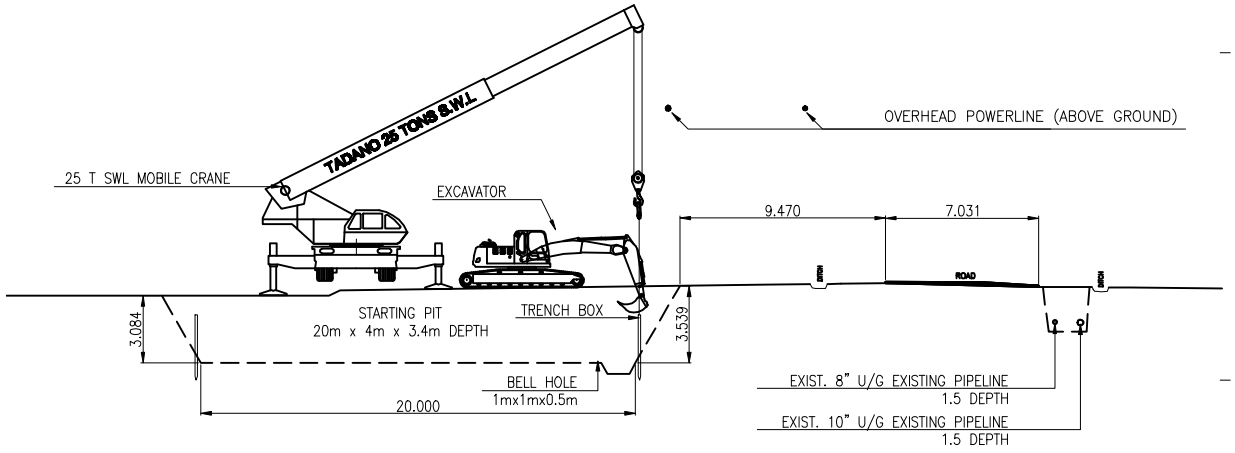


ELEVATION–VIEW

- Install barricade and warning signs around the excavation area.
- Contractor to invite representatives from all affected utilities to observe excavation. Contractor to work with utility companies to relocate existing utilities if necessary.
- To assist with the boring process, two pits will be excavated, one for starting pit and one for arrival pit. The starting pit will be prepared first and the arrival pit will be prepared before the bored pipes reach the exit point

AUGER BORING SEQUENCE 3 OF 21

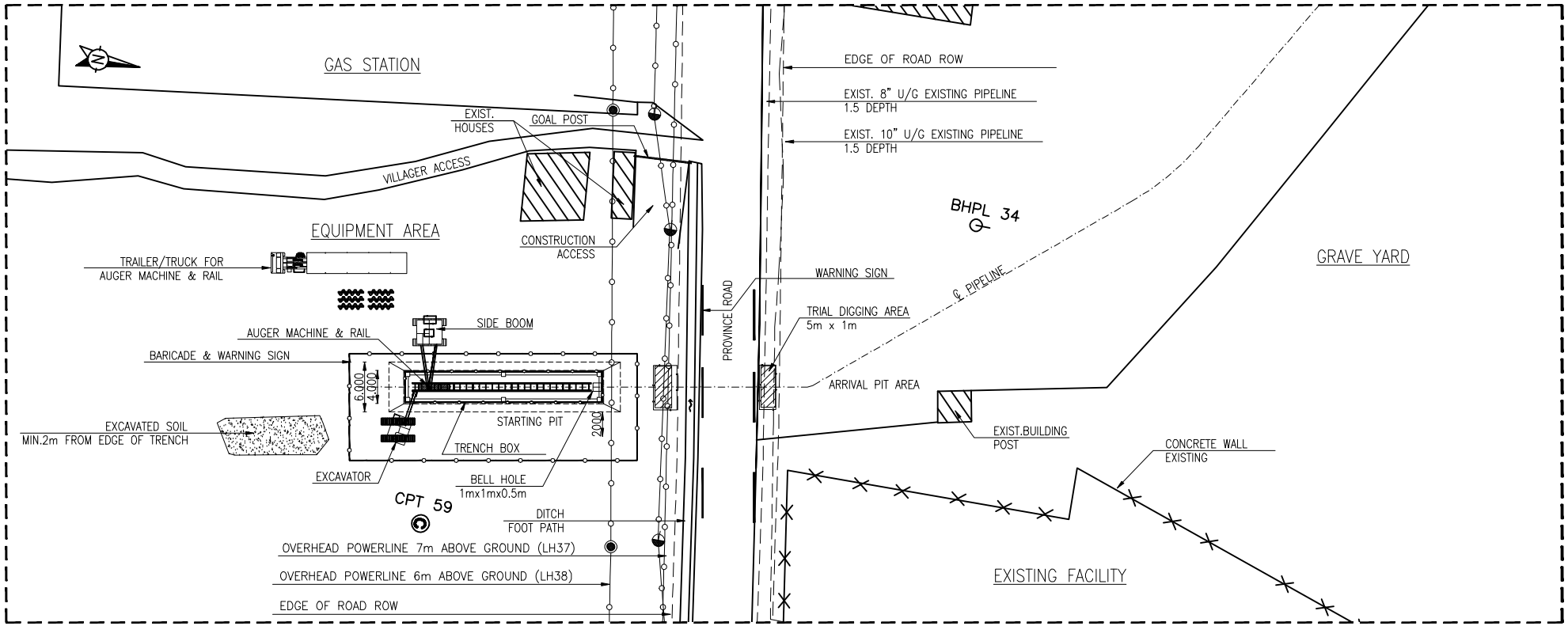


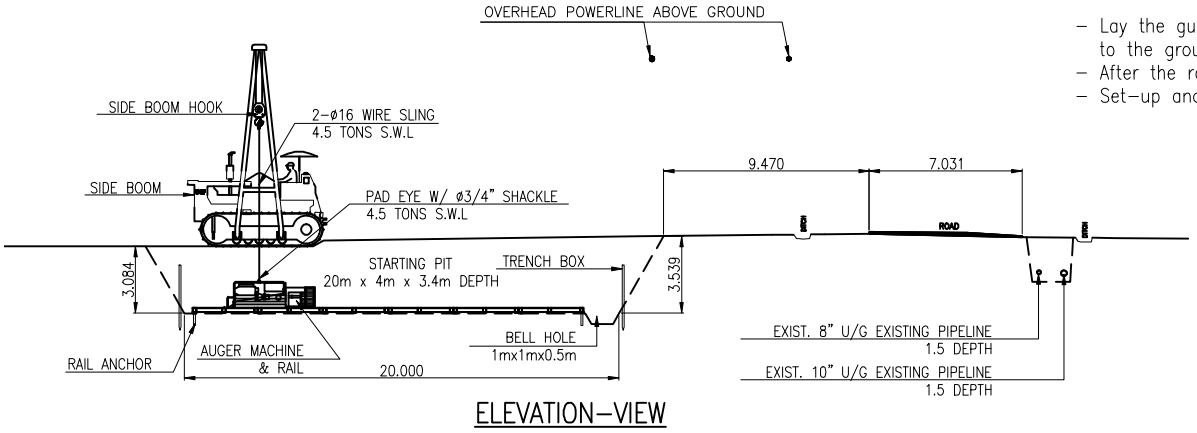


ELEVATION–VIEW

- Workers in the starting pit and arrival pit will be made safe by the installation of trench box, the trench box will be installed as the following sequence:
  1. Lift the trench box one by one in the north side by using crane, and move to the installation position. Once the trench box part is on the position, excavator will utilized to push the trench box into the ground.
  2. Repeat until all of trench box in the west side are installed.
  3. Install the horizontal beam in trench box row–west side.
  4. Lift the trench box one by one in the east side by using crane, and move to the installation position. Once the trench box part is on the position, excavator will utilized to push the trench box into the ground.
  5. Repeat until all of trench box in the east side are installed.
  6. Install the horizontal beam in trench box row–east side.
  7. Install the bottom cross beam in trench box.
  8. Install the front cover box in trench box
- During lifting of the trench box by crane, the crane movements will be closely monitored by the banksman and he's the only one that may direct the crane.

AUGER BORING SEQUENCE 4 OF 21





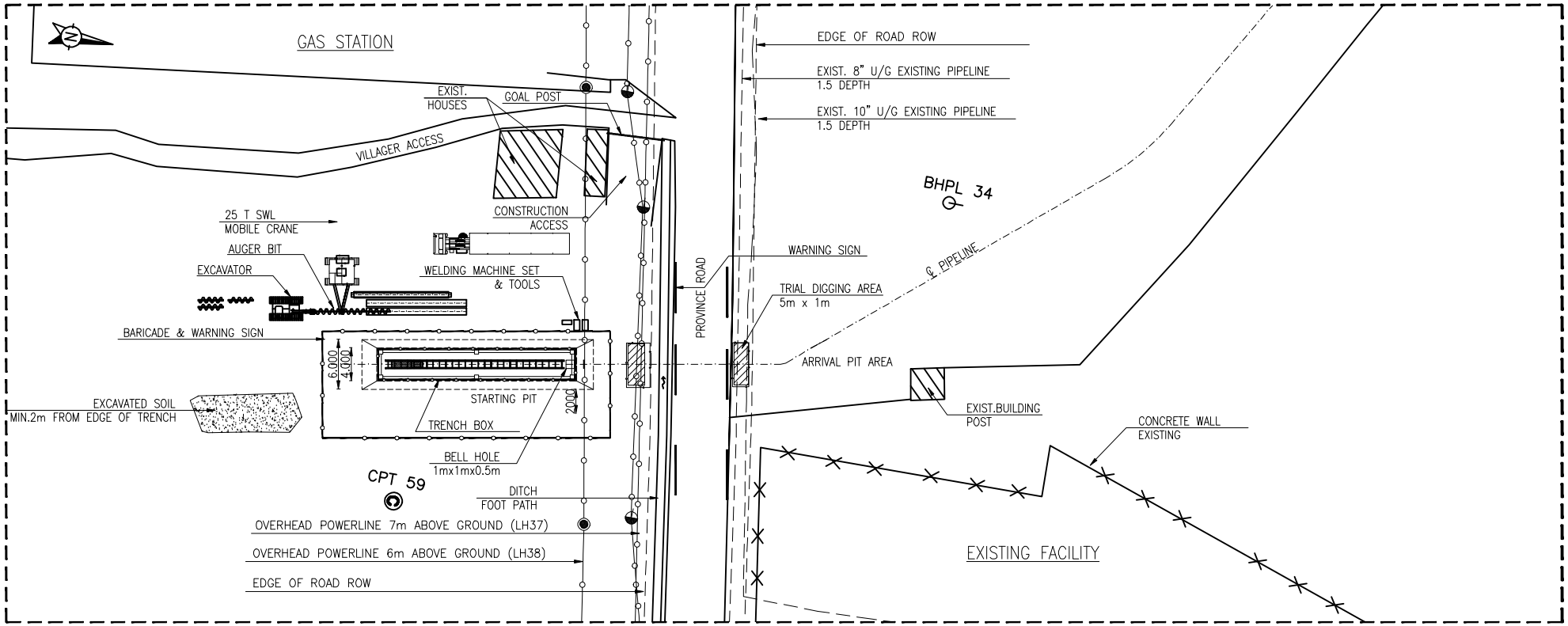
ELEVATION-VIEW

- Lay the guide rail on the bottom of starting pit then install the anchor (piled anchor) to the ground by excavator bucket.
- After the rail has been properly set, the auger boring machine will be lowered into the pit.
- Set-up and level the auger machine. The final positioning will be verified by the surveyor

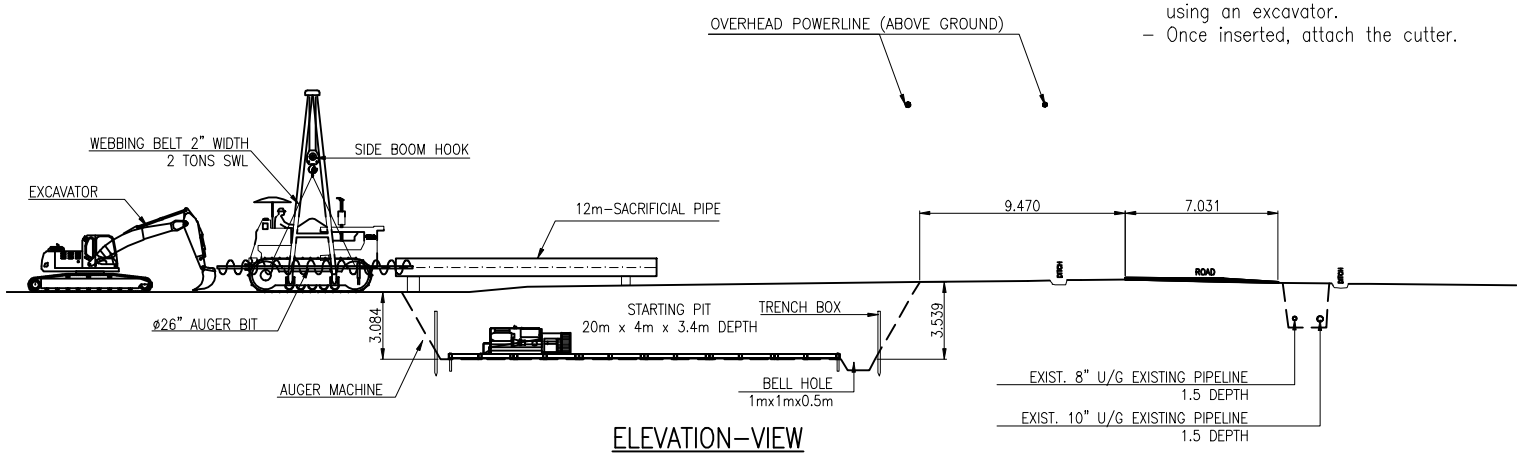
LIFTING CALCULATION

AUGER MACHINE	= 2.5 TONS
CONTINGENCY LOAD	= 0.5 TONS
TOTAL LOAD	= 3 TONS
LIFTING RADIUS	= 6m
SIDE BOOM CAPACITY	= 7 TONS
SAFETY FACTOR	= 2.33

AUGER BORING SEQUENCE 5 OF 21



- Llift the auger bit using a side boom. Then, push inside the sacrificial pipe using an excavator.
- Once inserted, attach the cutter.

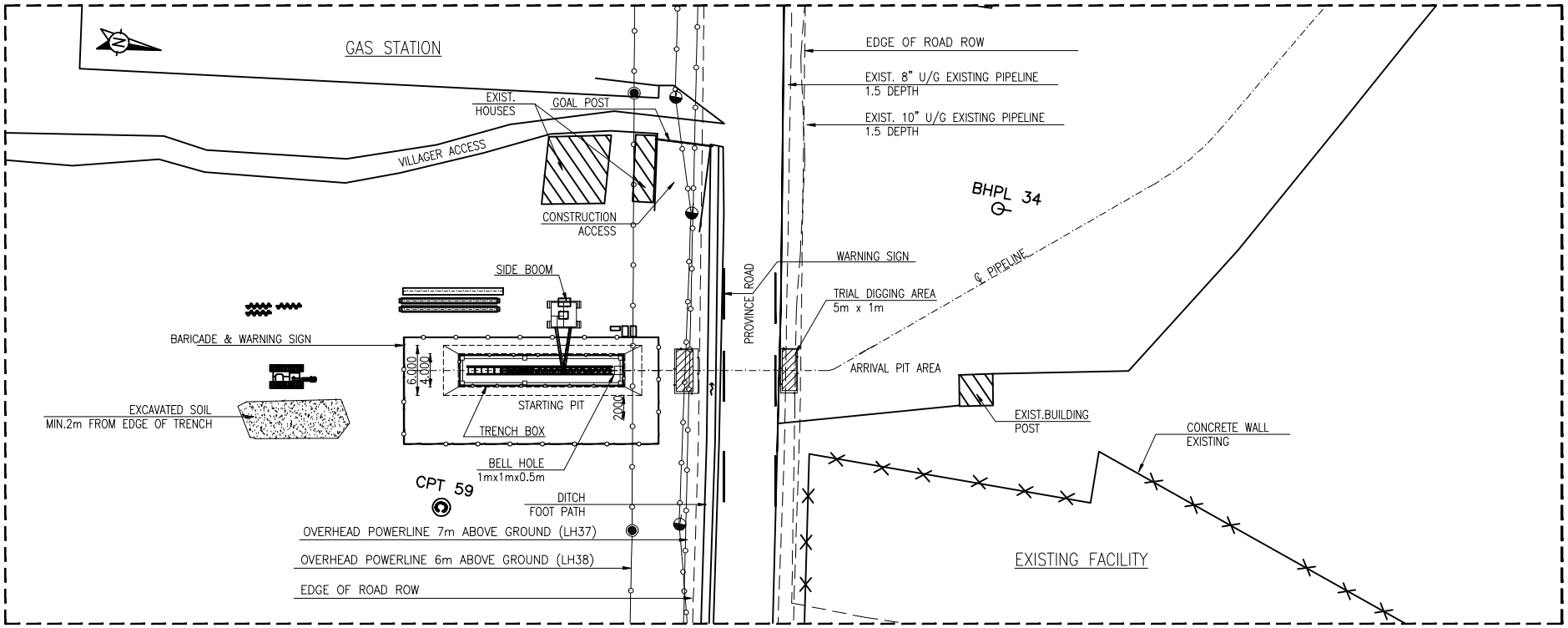


ELEVATION–VIEW

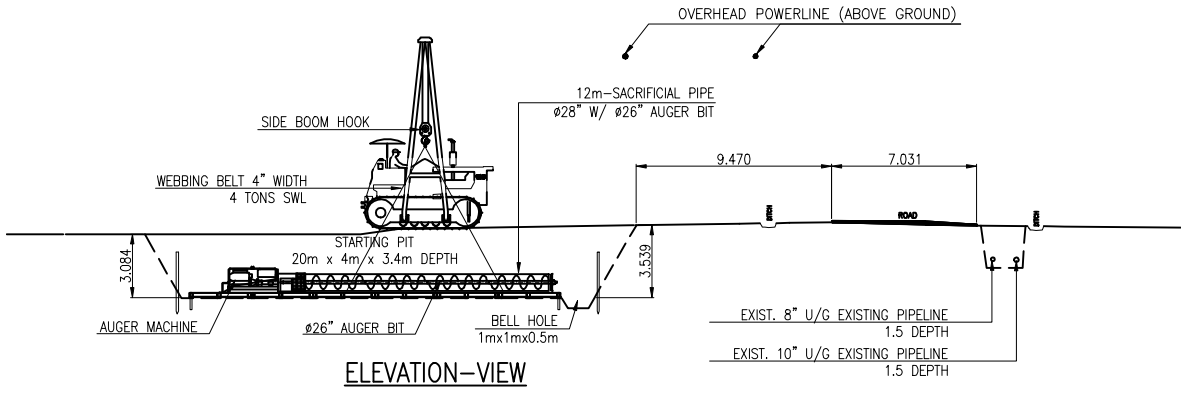
LIFTING CALCULATION

AUGER BIT	= 2 TONS
CONTINGENCY LOAD	= 0.2 TONS
TOTAL LOAD	= 2.2 TONS
LIFTING RADIUS	= 4m
SIDE BOOM CAPACITY	= 10 TONS
SAFETY FACTOR	= 4.55

AUGER BORING SEQUENCE 6 OF 21



– Lower the sacrificial pipe with auger bit into the pit then fit the pipe to the auger machine by connecting the pin connector at the end of the auger bit to the connection point at the Auger machine

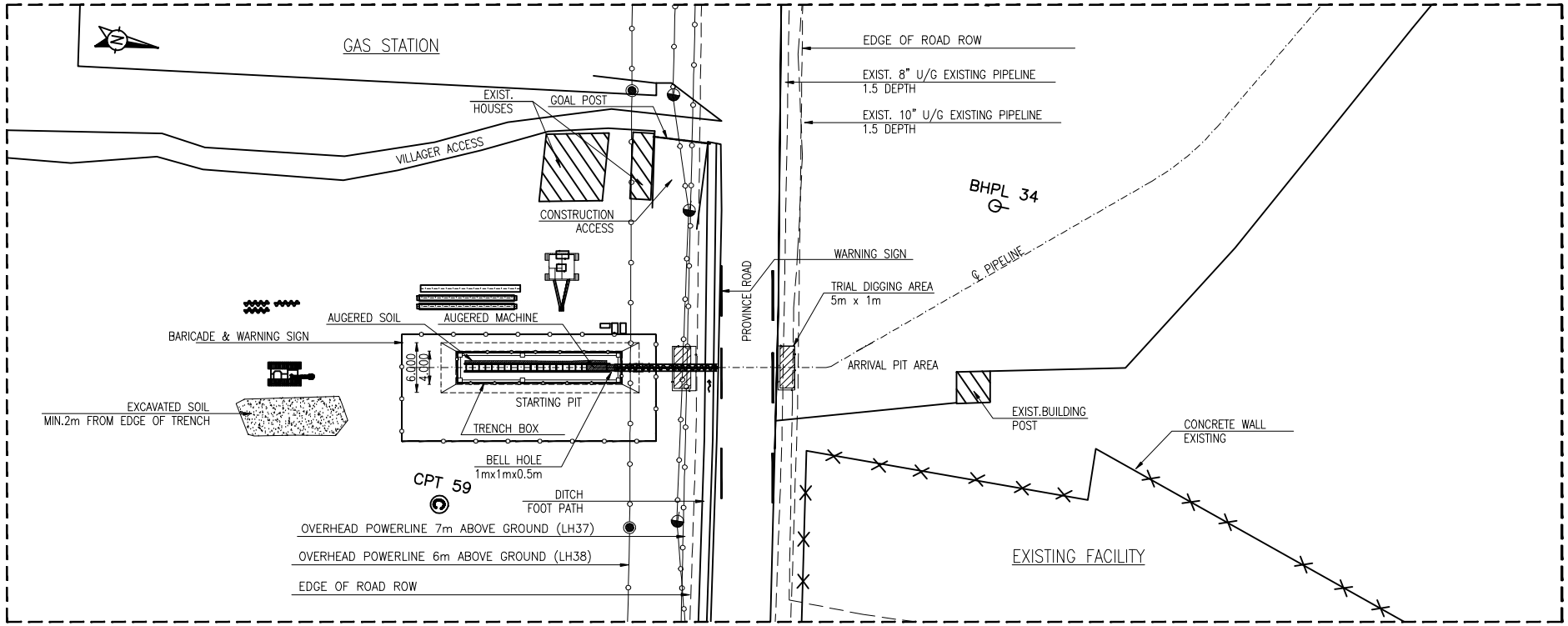


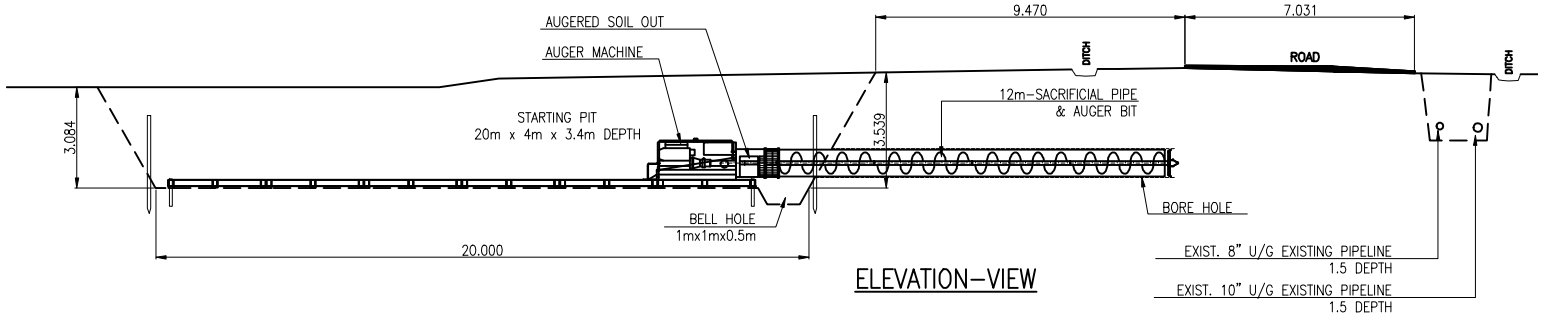
ELEVATION–VIEW

LIFTING CALCULATION

PIPE & BIT LOAD	= 4 TONS
CONTINGENCY LOAD	= 0.5 TONS
TOTAL LOAD	= 4.5 TONS
LIFTING RADIUS	= 6m
SIDE BOOM CAPACITY	= 7 TONS
SAFETY FACTOR	= 1.55

AUGER BORING SEQUENCE 7 OF 21

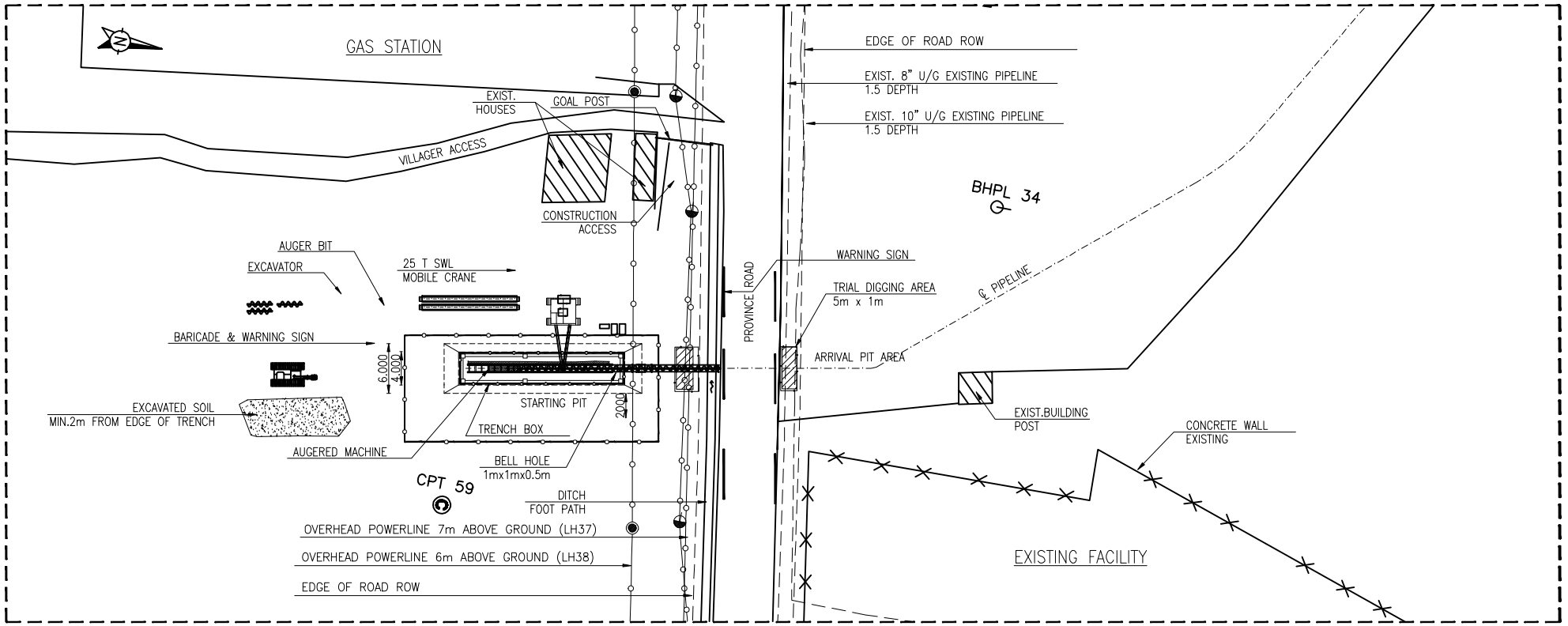




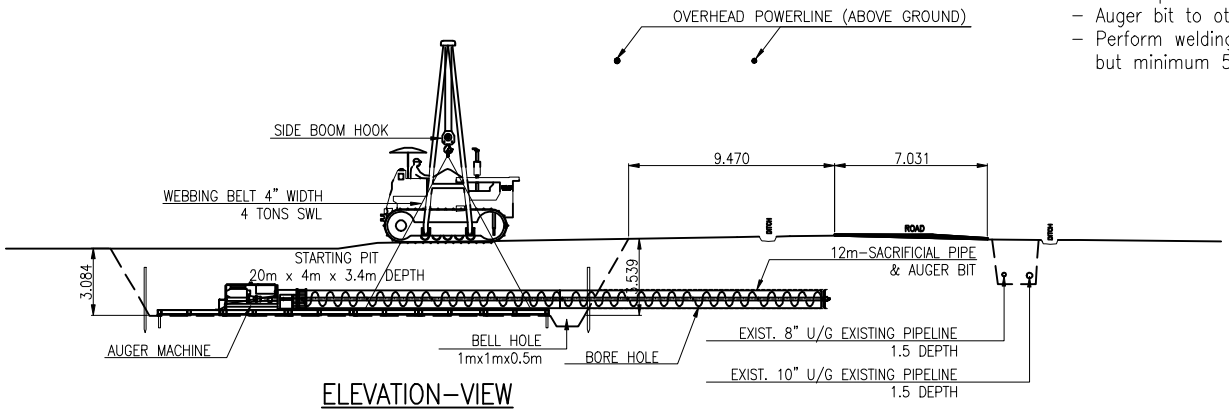
ELEVATION–VIEW

- The sacrificial will be driven (bore and pushed) by using the auger bit fitted with side cutters in the front of the auger bit to create a bore 25 to 40 mm larger than the sacrificial pipe diameter.
- The soil inside the first pipe will removed (drive out) by the auger bit inserted into the pipe. The soil will come out from the auger machine along the side of the rail as the auger machine moves forwards. The extruded soil will be manually removed from the pit.
- Continue the boring operation until the first 12m sacrificial pipe protrudes 1–1.5m from the start side

AUGER BORING SEQUENCE 8 OF 21



- Depending on the length of boring requirement (24m length), insert the next auger bit Into the next sacrificial pipe then lower the second sacrificial pipe and auger bit in the pit on the rails.
- Auger bit to other auger bit clamping will be done, followed by pipe fit up with external clamp.
- Perform welding the first and second sacrificial pipe. The welding will not be full thickness weld, but minimum 50% thickness weld will be performed

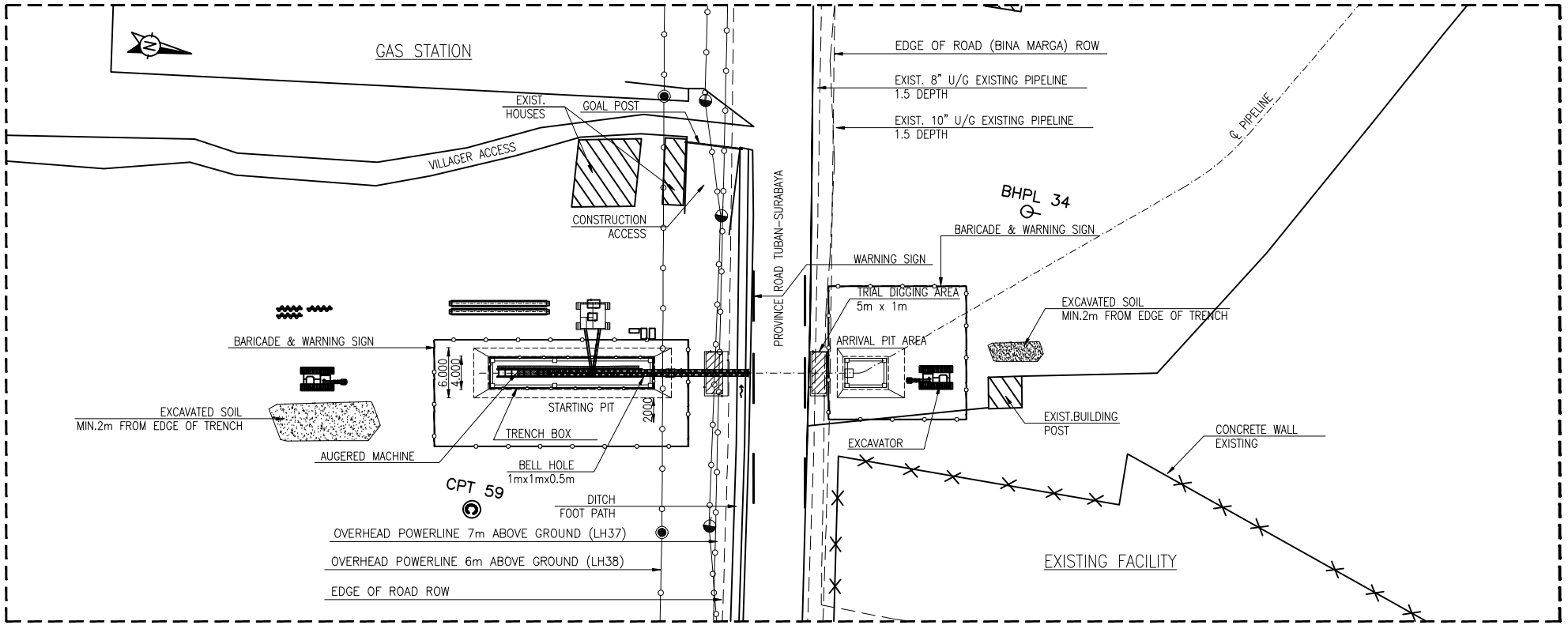


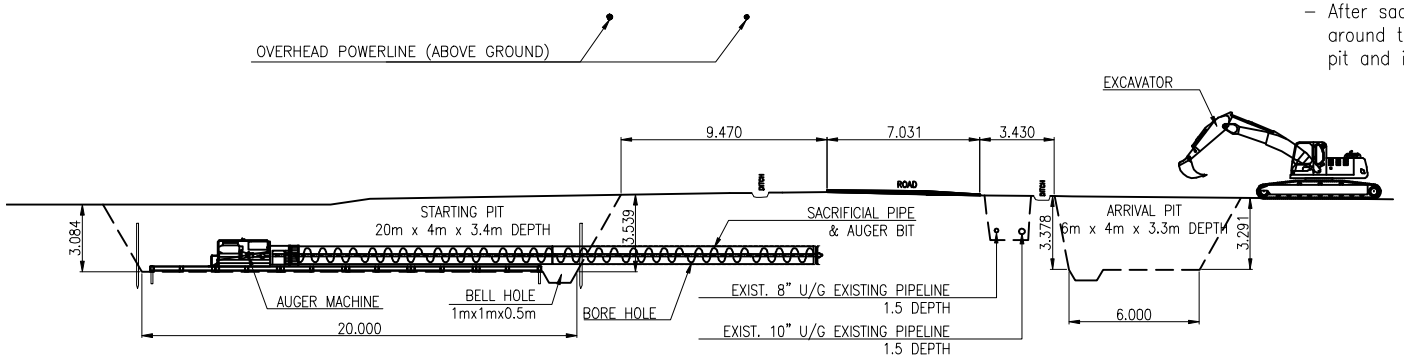
ELEVATION-VIEW

LIFTING CALCULATION

PIPE & BIT LOAD	= 4 TONS
CONTINGENCY LOAD	= 0.5 TONS
TOTAL LOAD	= 4.5 TONS
LIFTING RADIUS	= 6m
SIDE BOOM CAPACITY	= 7 TONS
SAFETY FACTOR	= 1.55

AUGER BORING SEQUENCE 09 OF 21

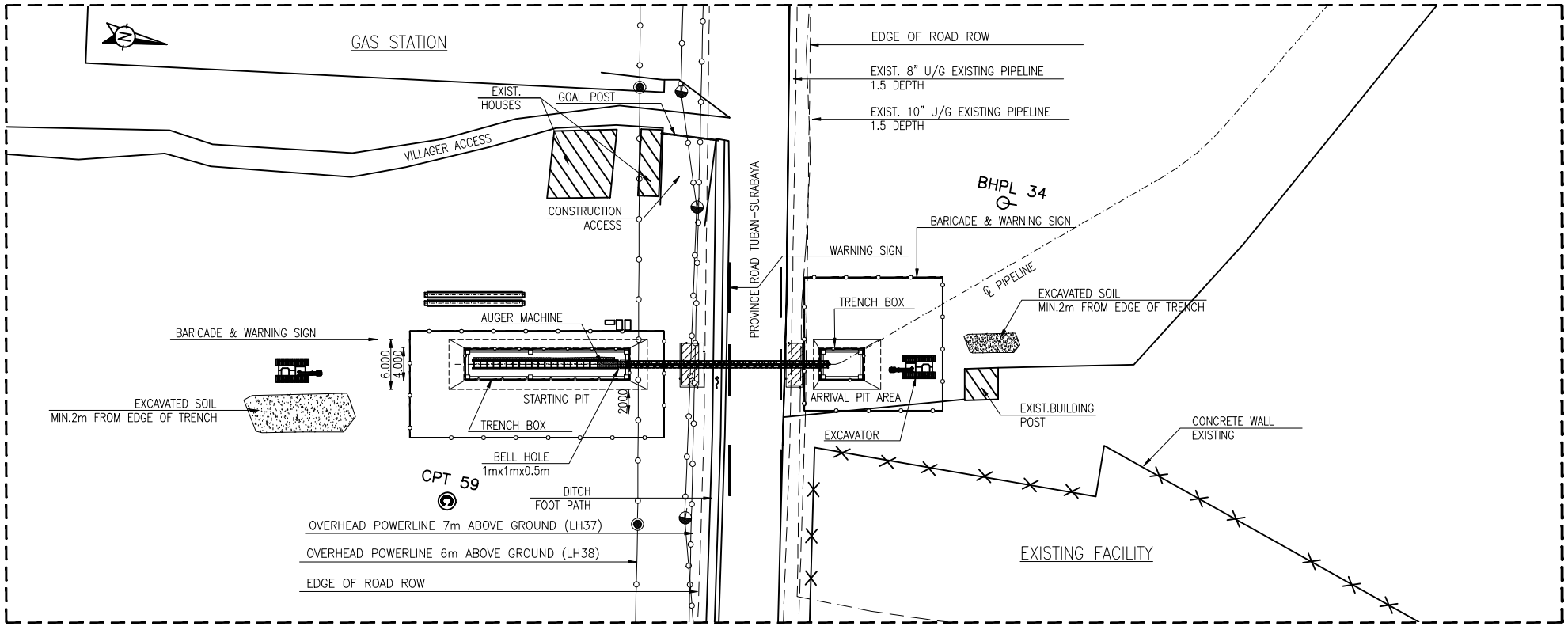




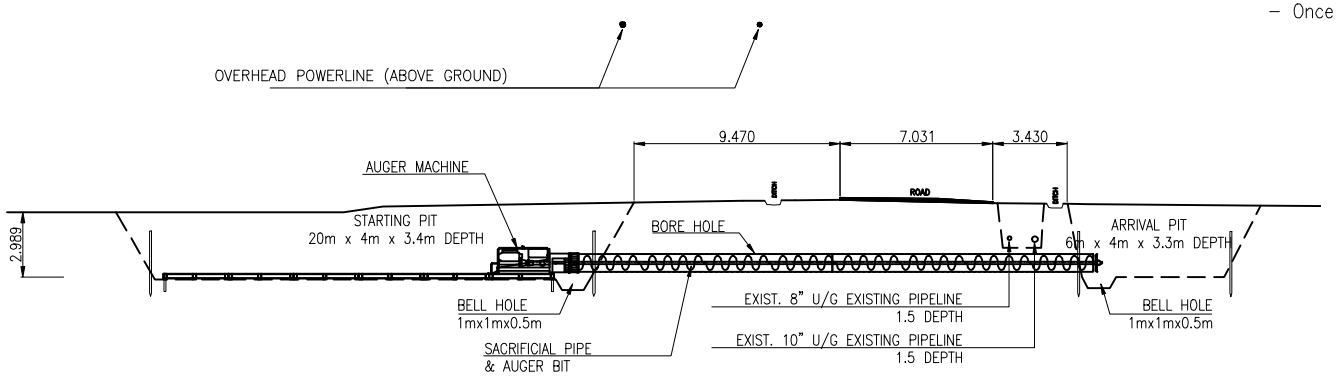
ELEVATION–VIEW

– After sacrificial pipe welding, then install warning signs and barricades around the arrival pit, and then perform excavation for the arrival pit and install trench box after excavation

AUGER BORING SEQUENCE 10 OF 21

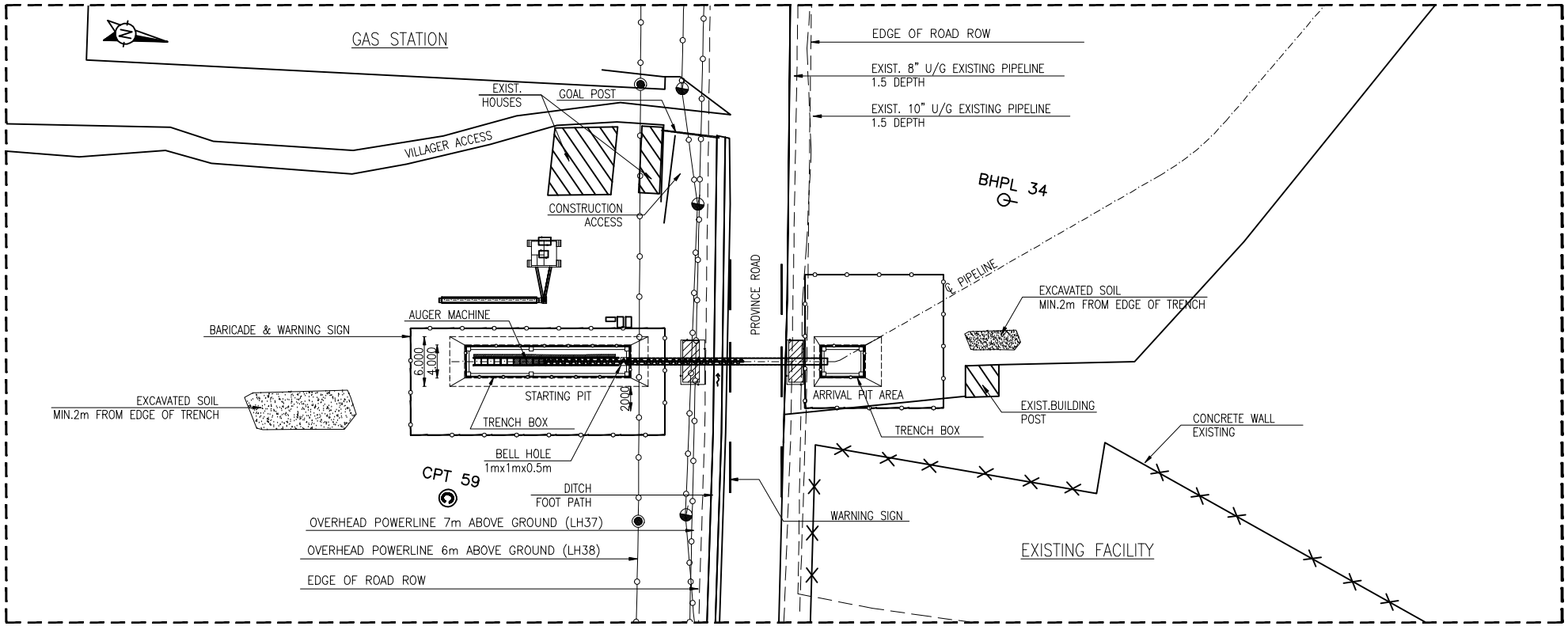


- Boring will continue until the required length has been achieved
- Once the boring operation is completed, the cutter head will be detached

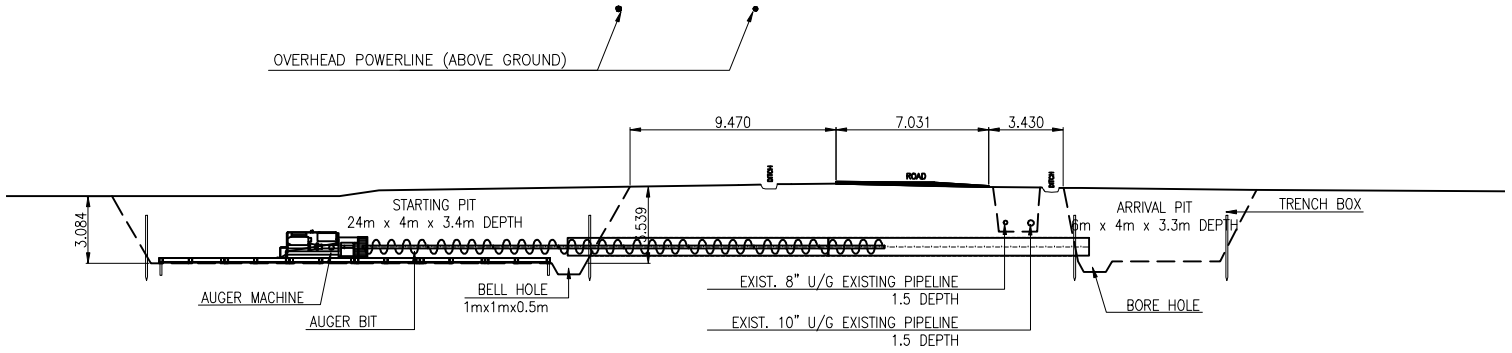


ELEVATION-VIEW

AUGER BORING SEQUENCE 11 OF 21

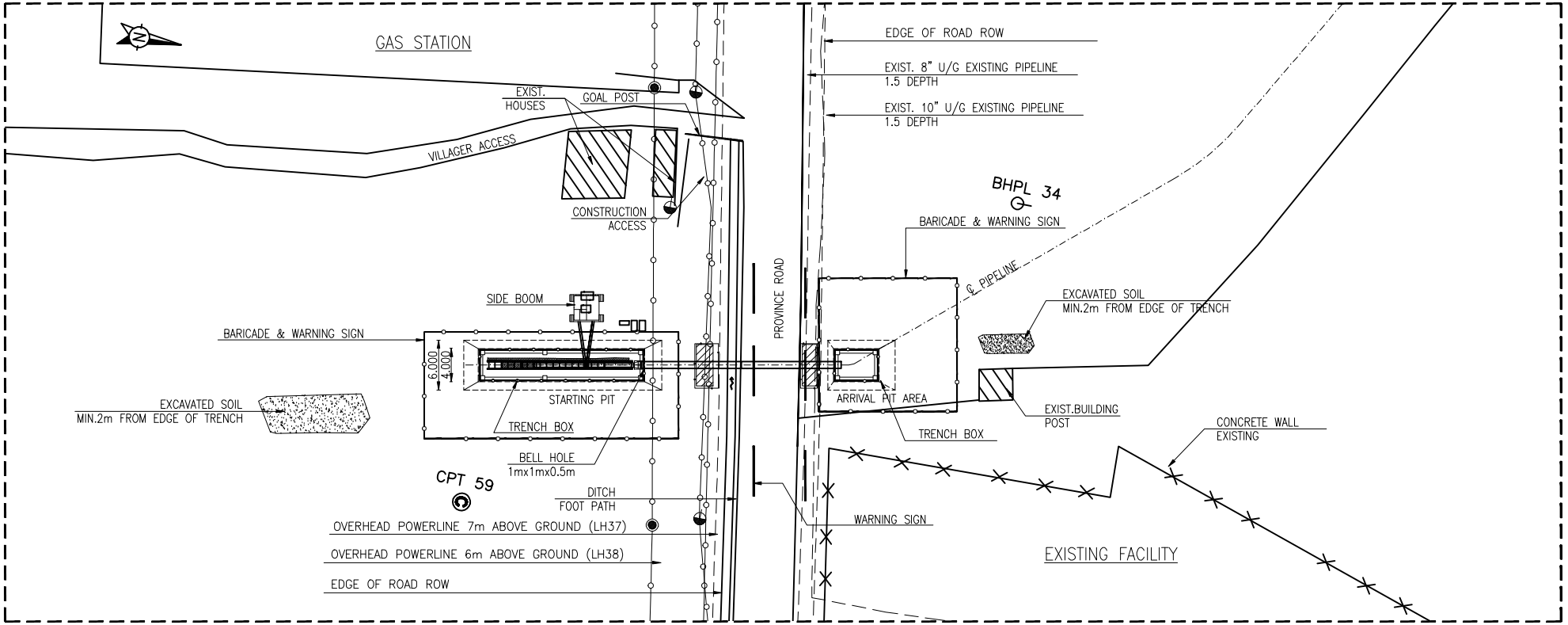


- Pull back the auger bit to the starting pit with the auger machine and remove each section of the auger bit, one by one
- While pull back operation, weld the product pipe (concrete pipe) to the reducer(28" x 20").

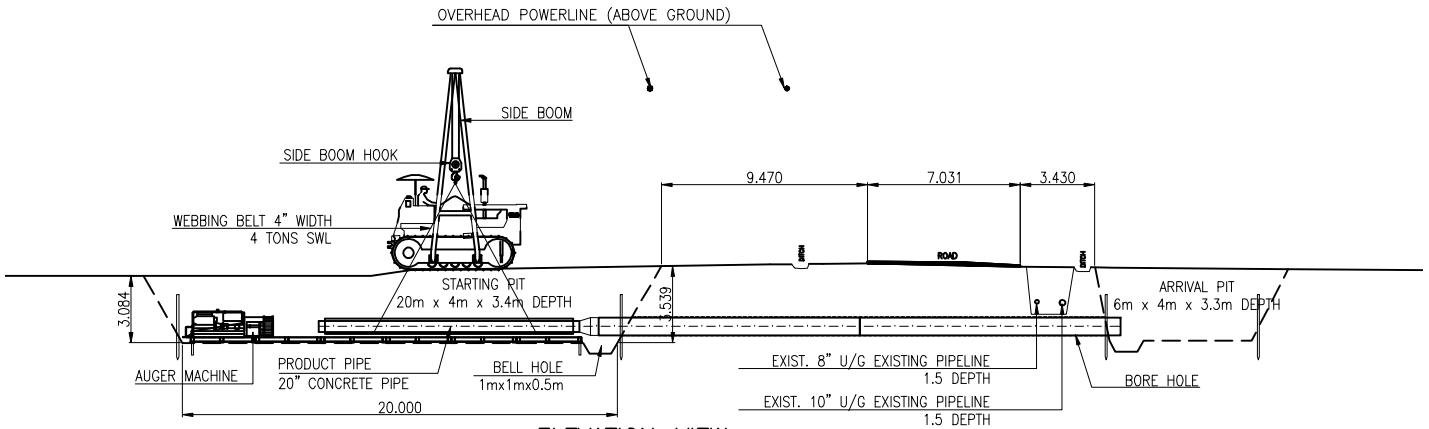


ELEVATION-VIEW

AUGER BORING SEQUENCE 12 OF 21



- Lower the product pipe with end reducer into the trench
- Weld the end of reducer to the bored sacrificial pipe end.

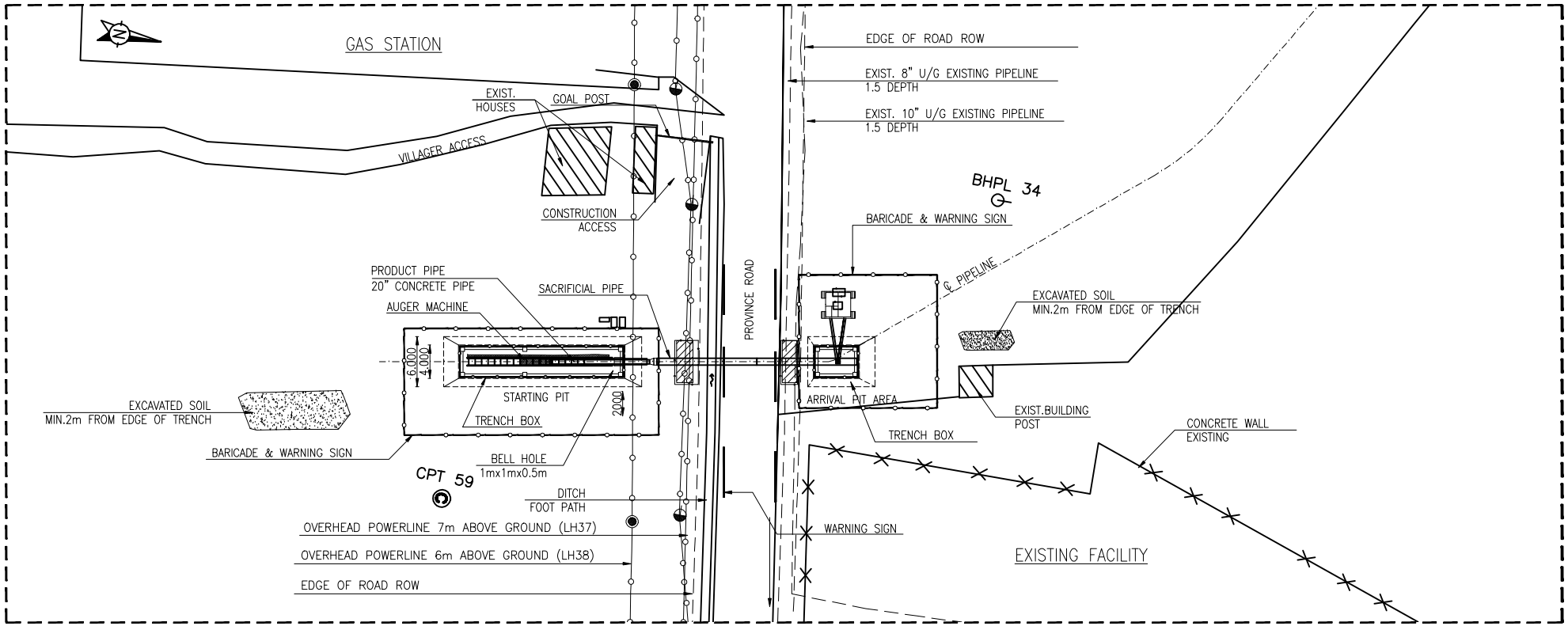


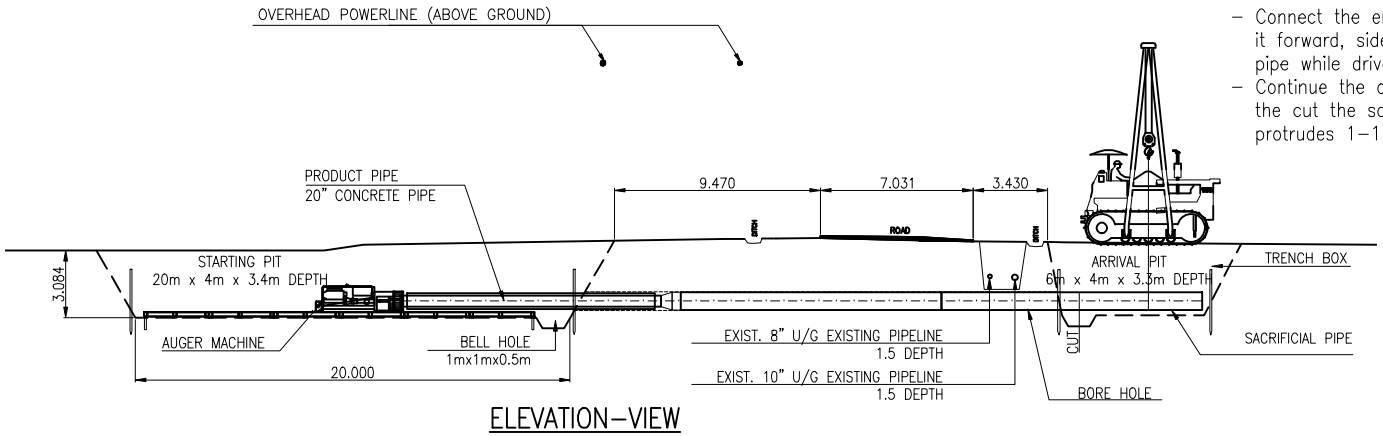
ELEVATION–VIEW

LIFTING CALCULATION

PIPE LOAD	= 5.5 TONS
CONTINGENCY LOAD	= 0.2 TONS
TOTAL LOAD	= 5.7 TONS
LIFTING RADIUS	= 6m
SIDE BOOM CAPACITY	= 7 TONS
SAFETY FACTOR	= 1.23

AUGER BORING SEQUENCE 13 OF 21

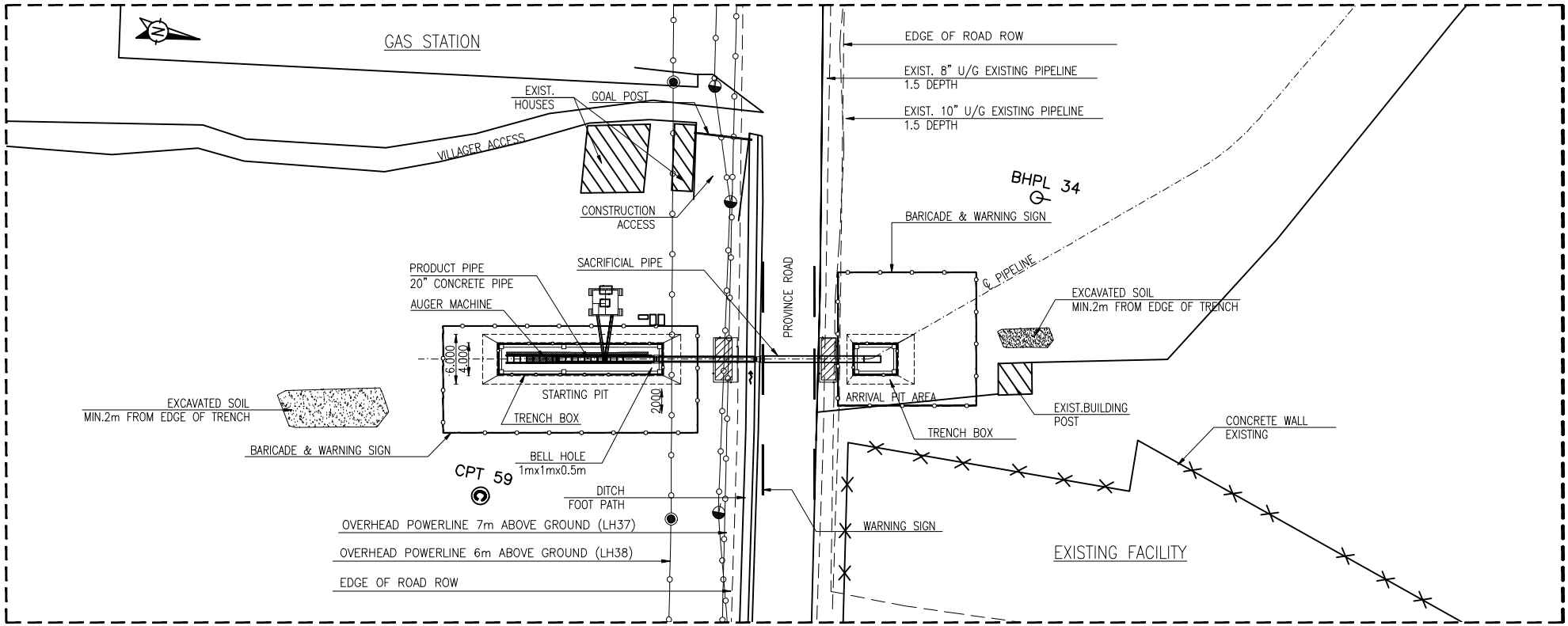


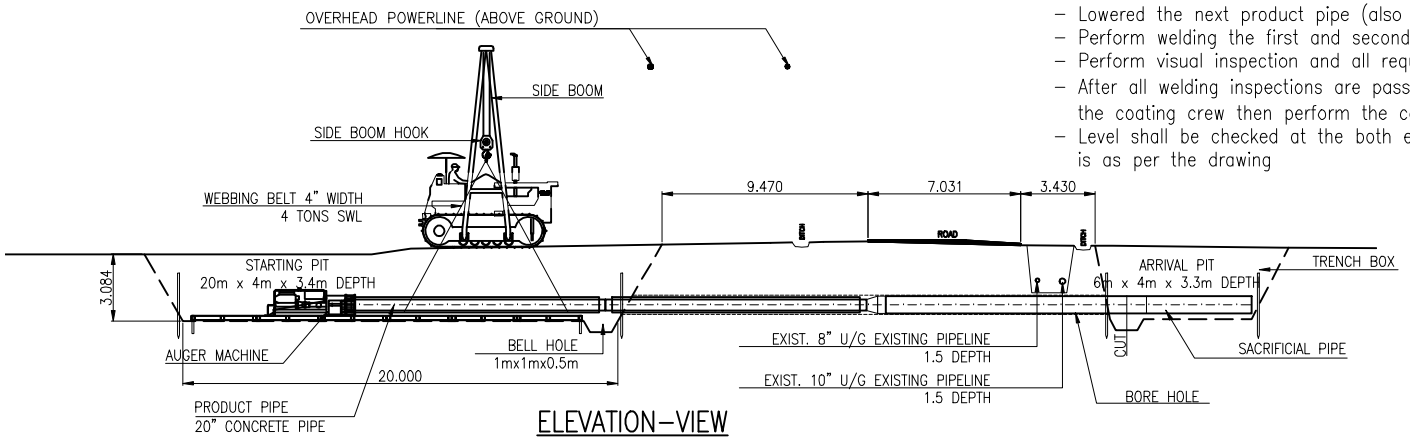


ELEVATION–VIEW

- Connect the end of product pipe to the auger machine then drive (push) it forward, side boom at the arrival pit may be utilized to pull the sacrificial pipe while driven by auger machine.
- Continue the operation until the sacrificial pipe is about 6m out at the arrival pit, the cut the sacrificial pipe and remove. Continue until the product pipe end protrudes 1–1.5m from the start side

AUGER BORING SEQUENCE 14 OF 21





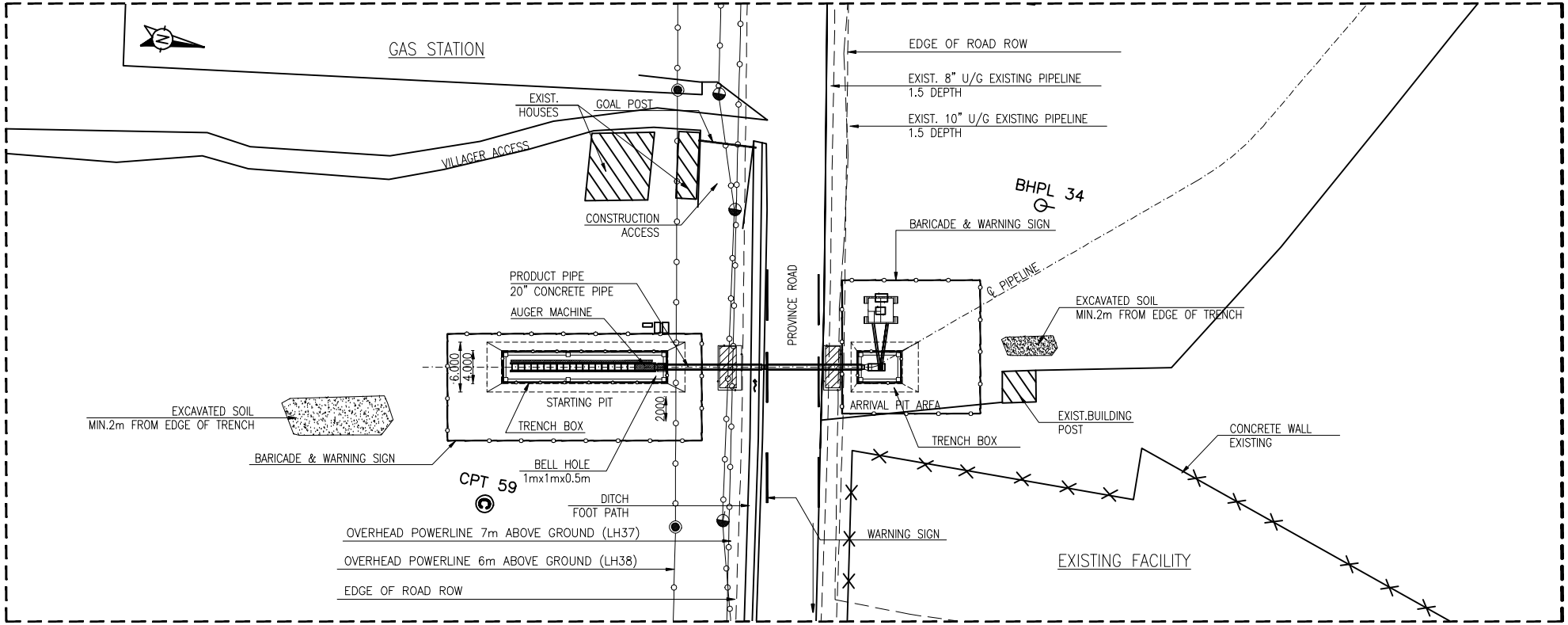
ELEVATION–VIEW

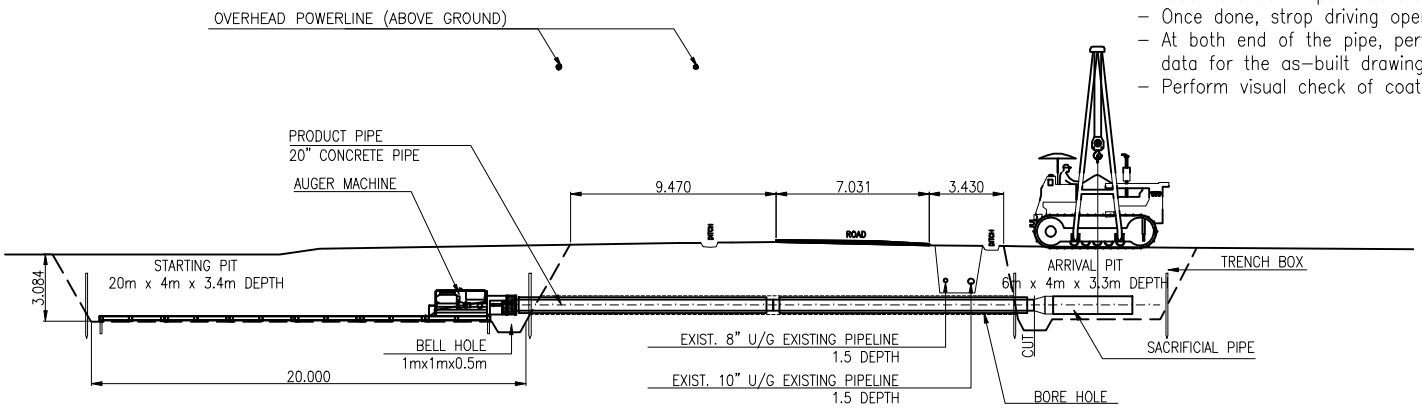
- Disconnect the auger machine from the product pipe then pull back the machine to the first position.
- Lowered the next product pipe (also concrete pipe) into the starting pit.
- Perform welding the first and second product pipe in accordance with the approved WPS.
- Perform visual inspection and all required NDE as soon as possible after welding is completed.
- After all welding inspections are passed; perform field joint coating (use HDD coating type) by the coating crew then perform the coating inspection and test (holiday test).
- Level shall be checked at the both ends of the pipe for every insertion to conform that the alignment is as per the drawing

LIFTING CALCULATION

PIPE LOAD	= 5.5 TONS
CONTINGENCY LOAD	= 0.2 TONS
TOTAL LOAD	= 5.7 TONS
LIFTING RADIUS	= 6m
SIDE BOOM CAPACITY	= 7 TONS
SAFETY FACTOR	= 1.23

AUGER BORING SEQUENCE 15 OF 21

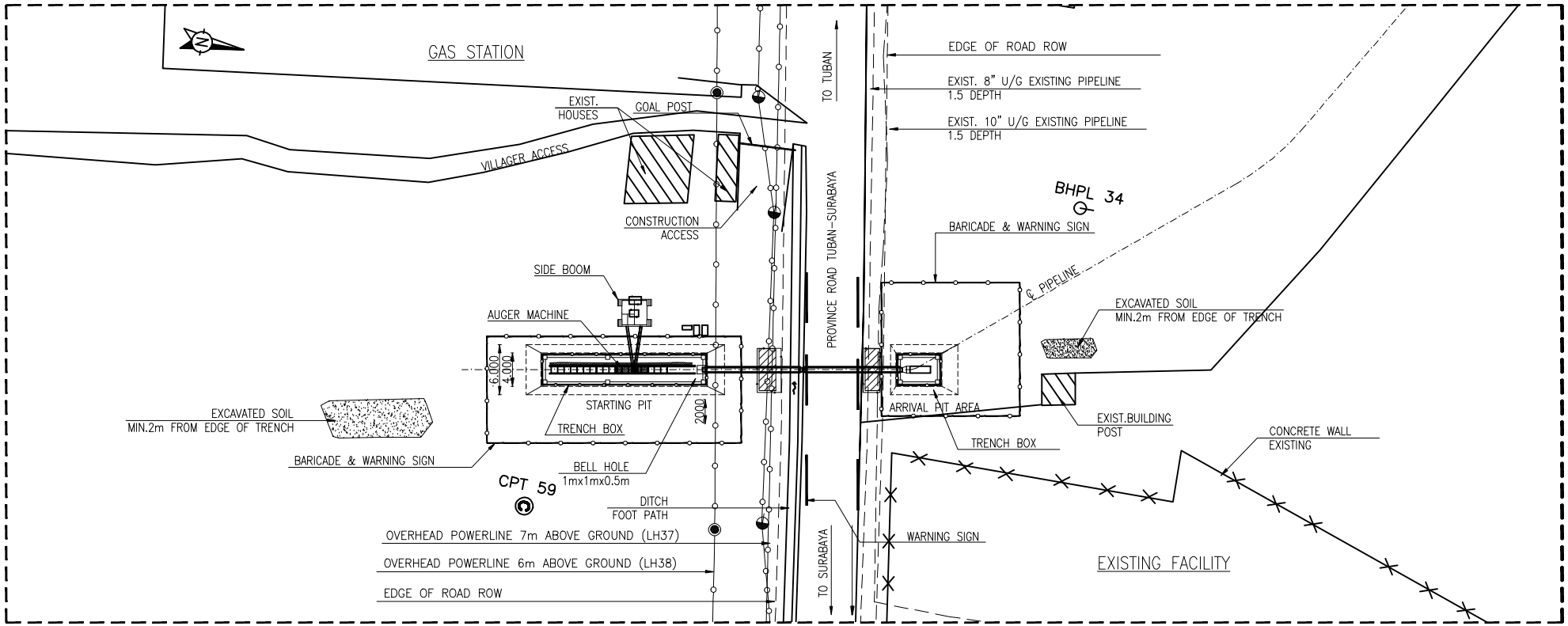




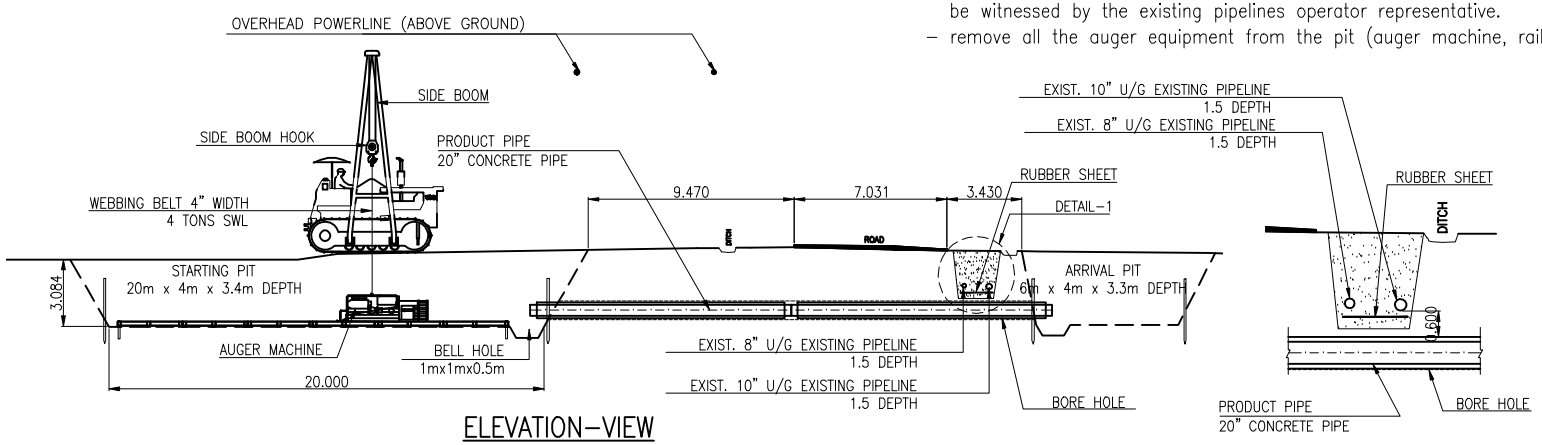
ELEVATION–VIEW

- Continue push the product pipe (as mentioned on sequence 13) until the product pipe end reach the tie–in point at the arrival pit
- Once done, strop driving operation then cut the reducer and disconnect the auger machine
- At both end of the pipe, perform survey to take the elevation and coordinates as reference data for the as–built drawing process.
- Perform visual check of coating, at exit point, for any signs of damage.

AUGER BORING SEQUENCE 16 OF 21



- Install rubber sheet under the existing pipeline then perform backfilling for the open trench at the existing pipeline. The installation of the rubber sheet under the existing pipelines shall be witnessed by the existing pipelines operator representative.
- remove all the auger equipment from the pit (auger machine, rail, etc.)

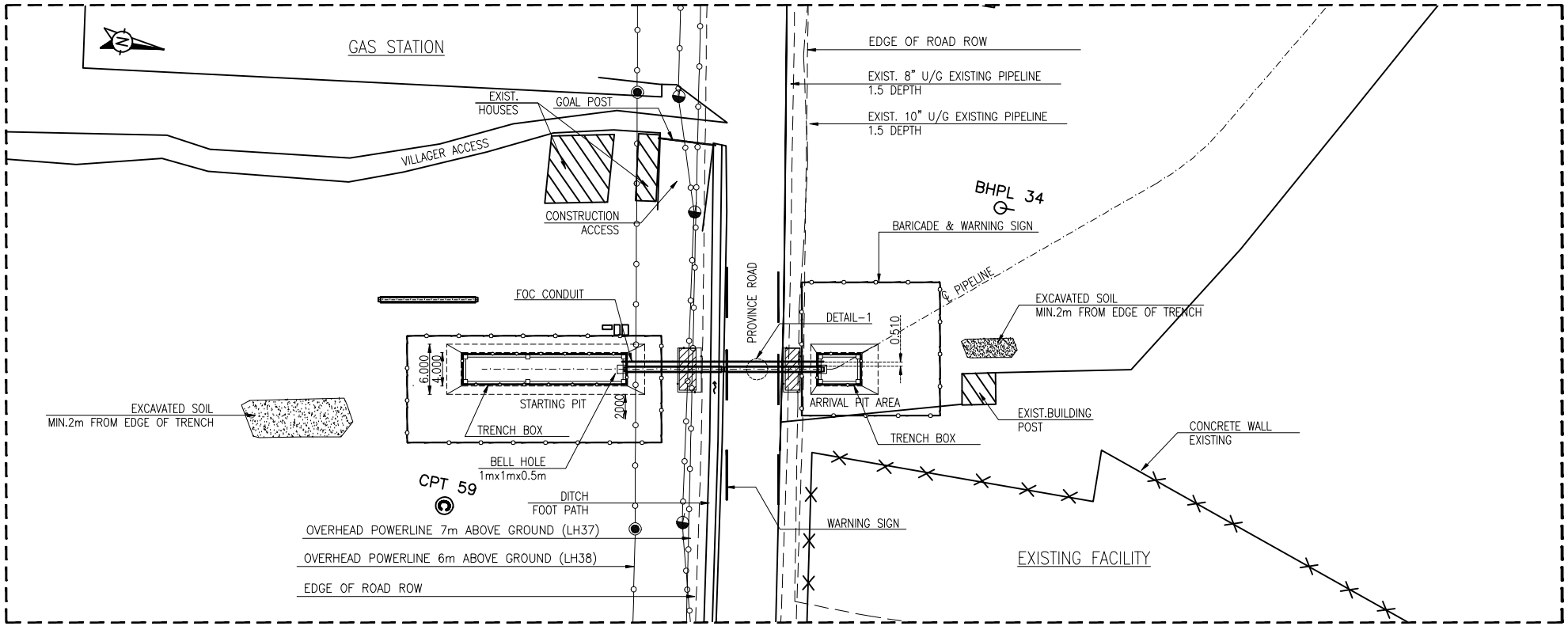


ELEVATION-VIEW

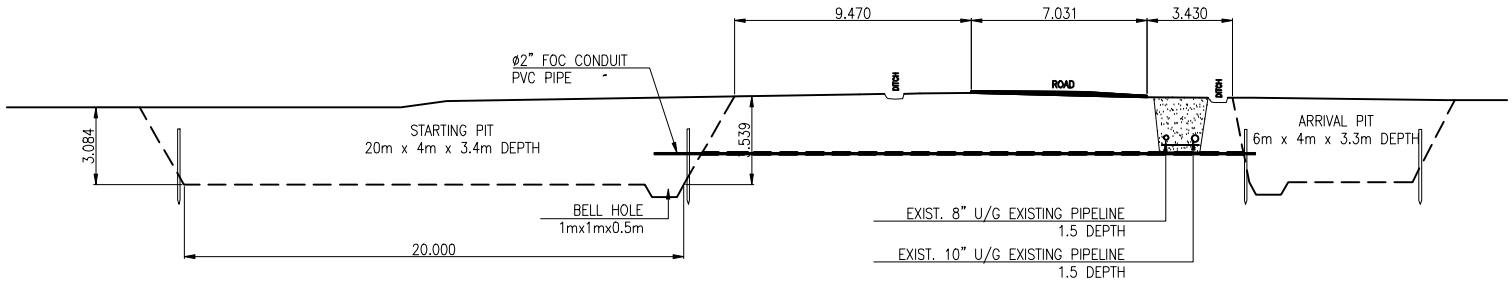
LIFTING CALCULATION

AUGER MACHINE	= 2.5 TONS
CONTINGENCY LOAD	= 0.5 TONS
TOTAL LOAD	= 3 TONS
LIFTING RADIUS	= 6m
SIDE BOOM CAPACITY	= 7 TONS
SAFETY FACTOR	= 2.33

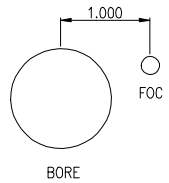
AUGER BORING SEQUENCE 17 OF 21



- Prepare the manual boring equipment inside the starting pit for FOC conduit installation at this crossing.
- Perform manual boring for FOC conduit; refer to document no. IDBE-IK-KPZZZ-ENXXX Boring Procedure for FOC Conduit Installation

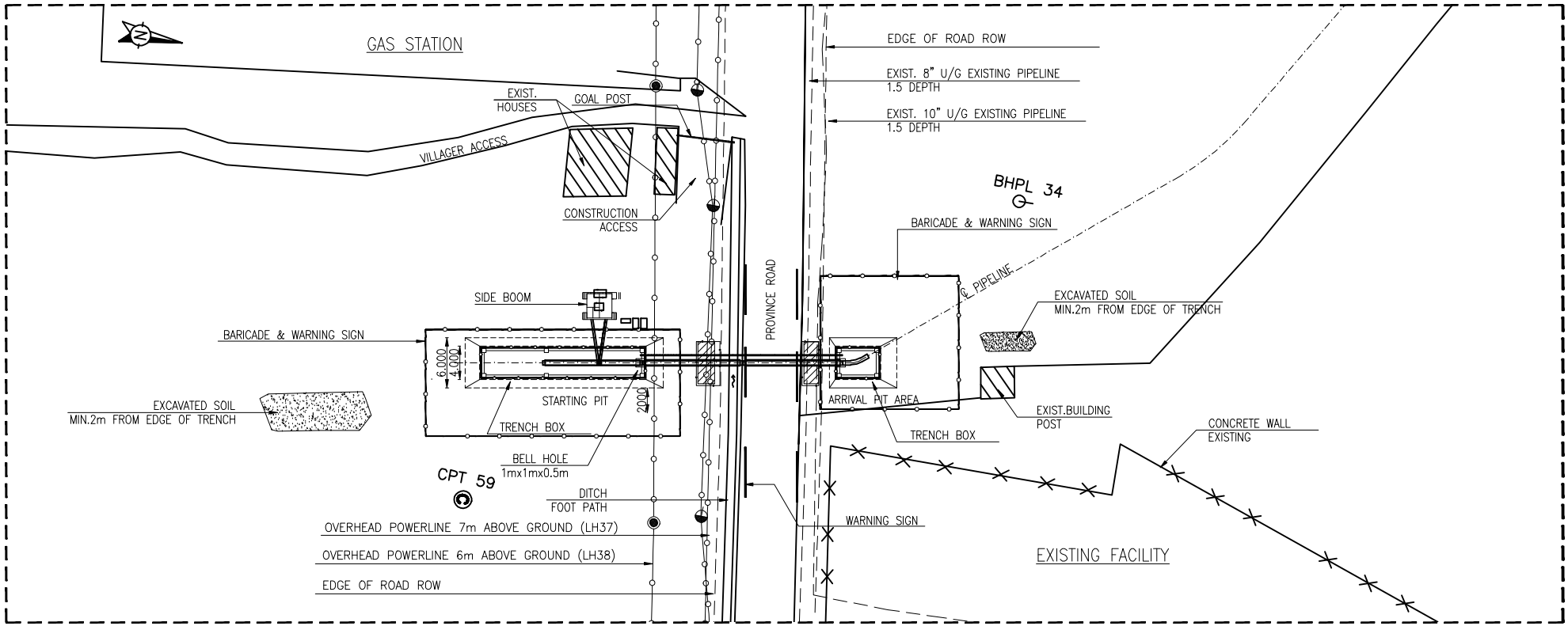


ELEVATION-VIEW

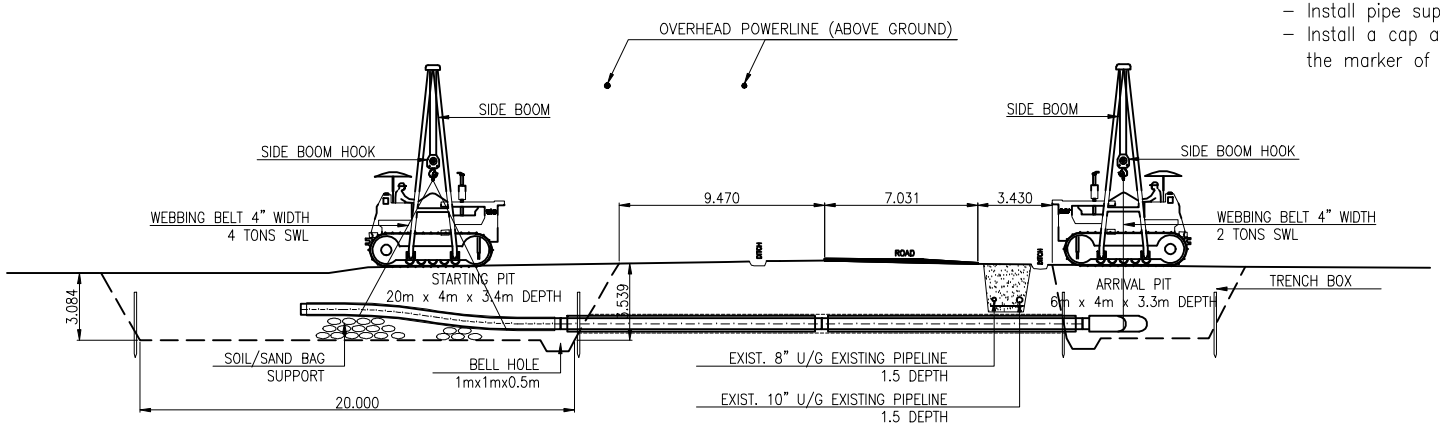


DETAIL-1

AUGER BORING SEQUENCE 18 OF 21



- Install the vertical bend (weld to the bored pipe) and perform NDE and FJC on both sides of the crossing (bore start and arrival sides).
- Install pipe support (soil/sand bag) after the weld is finished
- Install a cap at the both ends of the pipe and install a vertical stick as the marker of the end pipe position (if required).

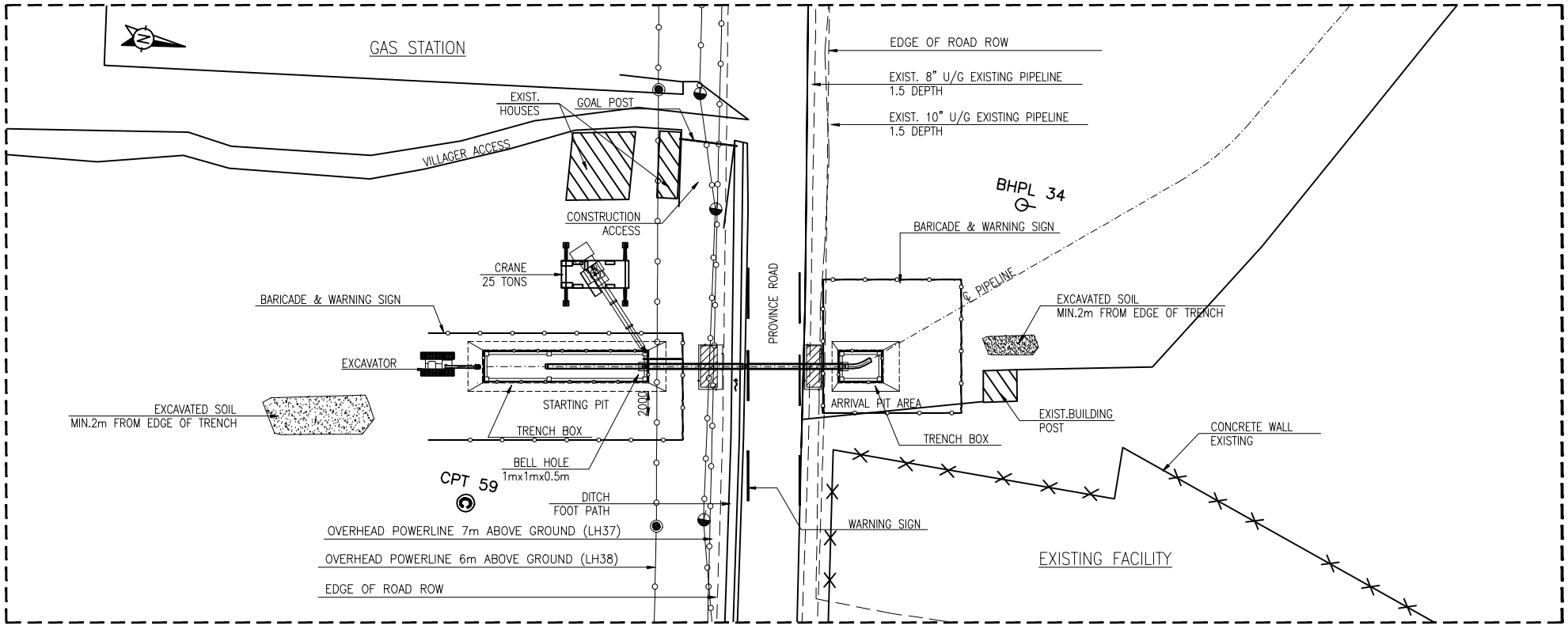


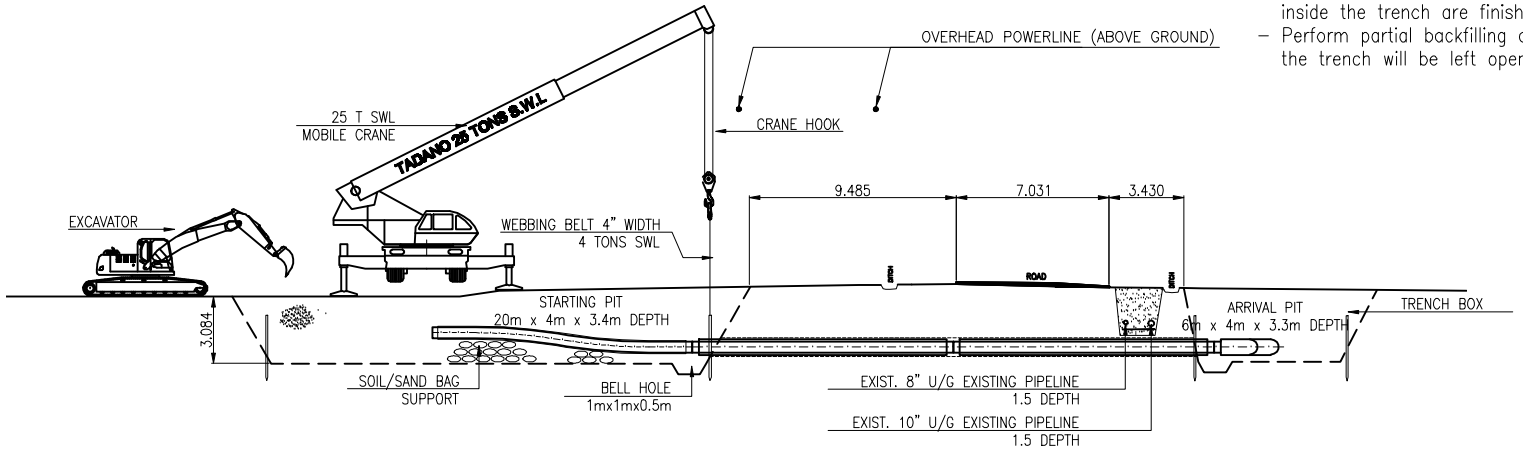
ELEVATION–VIEW

LIFTING CALCULATION

BEND PIPE LOAD	= 2.0 TONS
CONTINGENCY LOAD	= 0.2 TONS
TOTAL LOAD	= 2.2 TONS
LIFTING RADIUS	= 6m
SIDE BOOM CAPACITY	= 7 TONS
SAFETY FACTOR	= 3.18

AUGER BORING SEQUENCE 19 OF 21





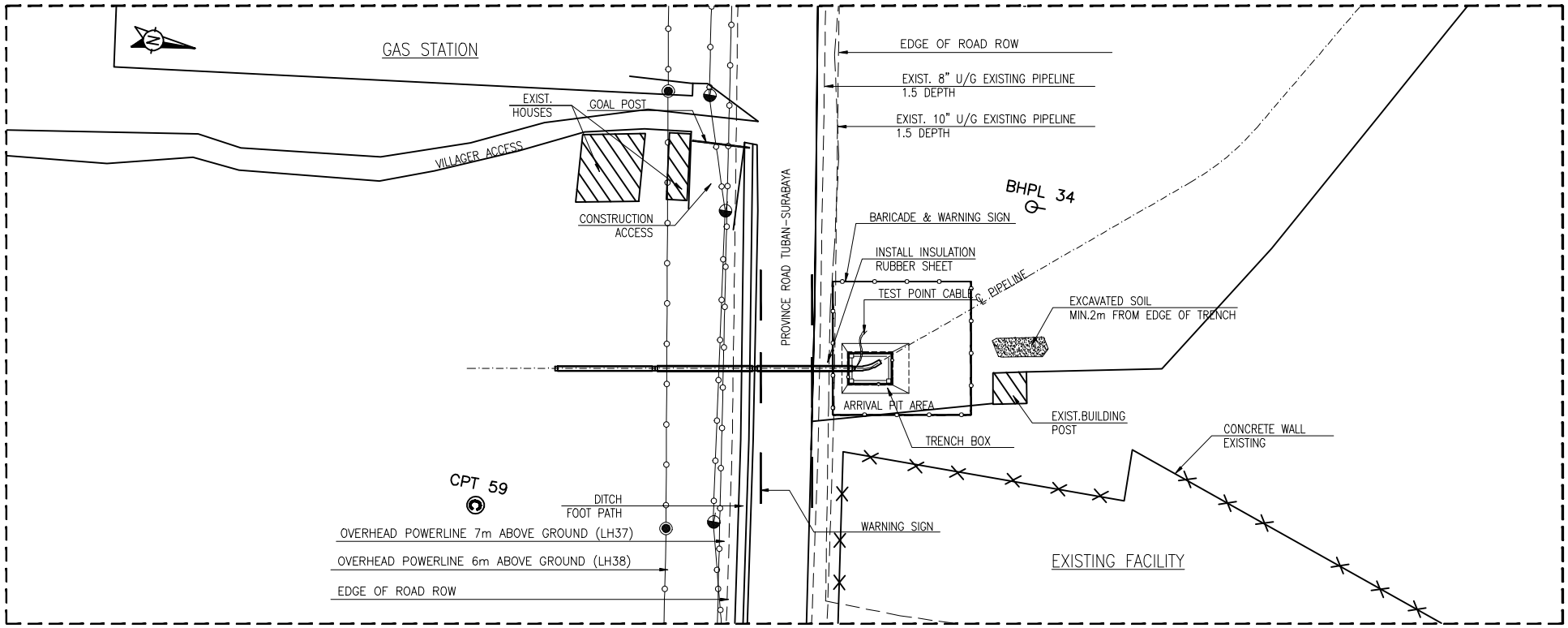
ELEVATION–VIEW

- Remove the shore protection box from starting pit after all activities inside the trench are finished by using crane (sling–up)
- Perform partial backfilling and compaction of the pit; at the ends of each pipe, the trench will be left open to provide access for tie–ins

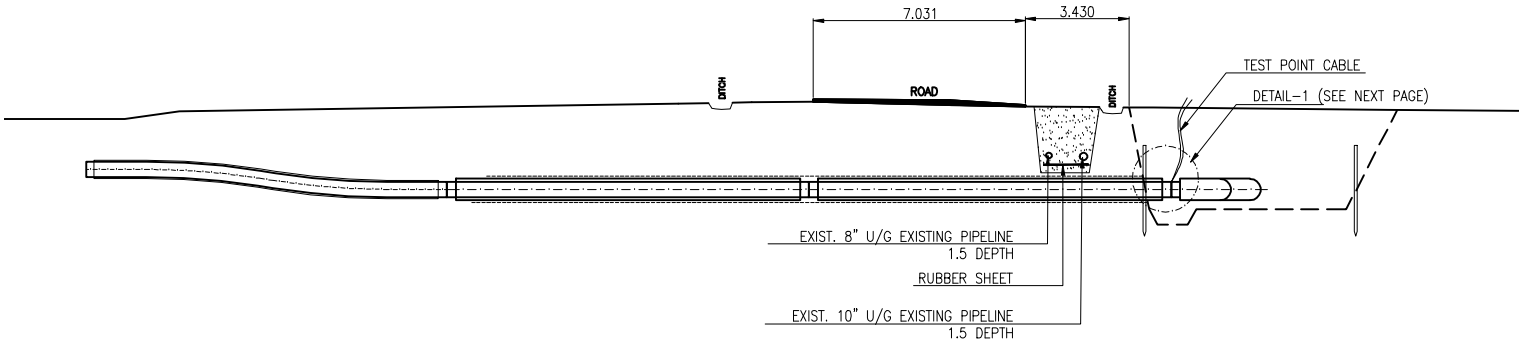
LIFTING CALCULATION

PROTECTION PULL LOAD	= 2 TONS
CONTINGENCY LOAD	= 0.5 TONS
TOTAL LOAD	= 2.5 TONS
LIFTING RADIUS	= 15m
CRANE CAPACITY	= 3.2 TONS
SAFETY FACTOR	= 1.28

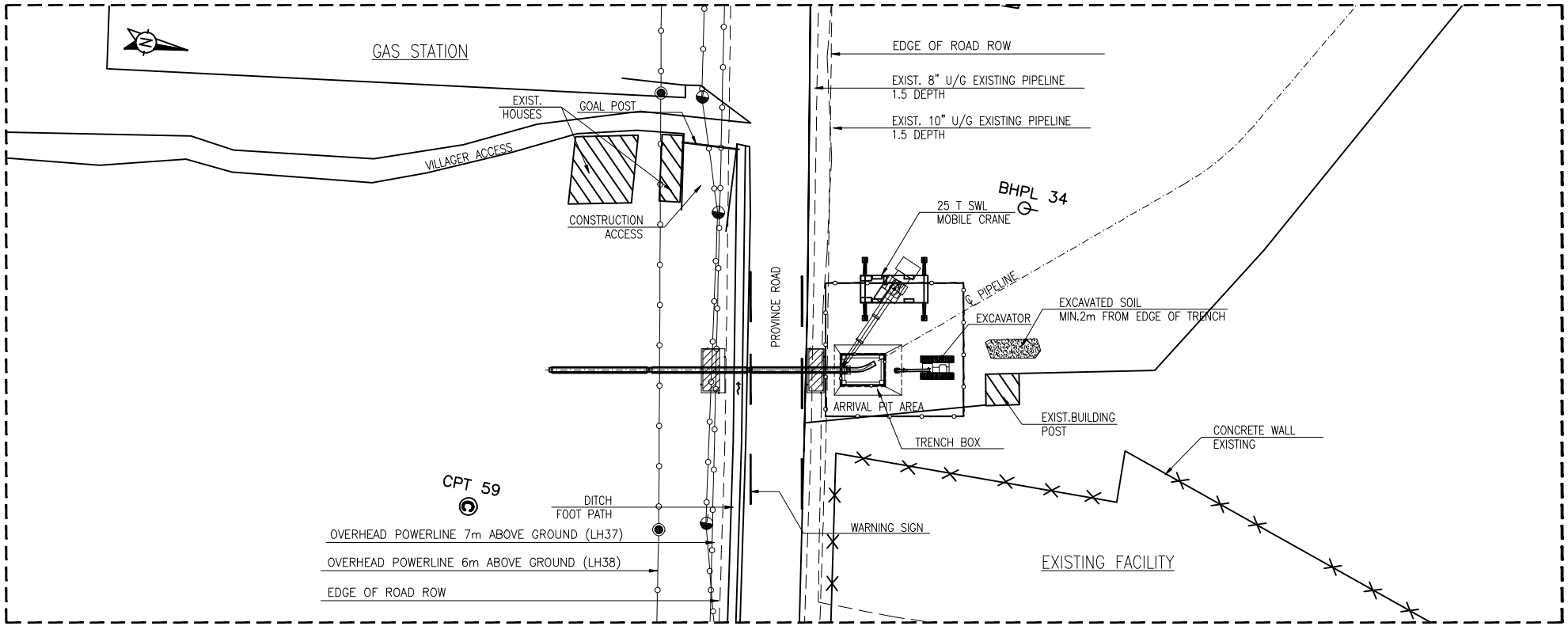
AUGER BORING SEQUENCE 20 OF 21



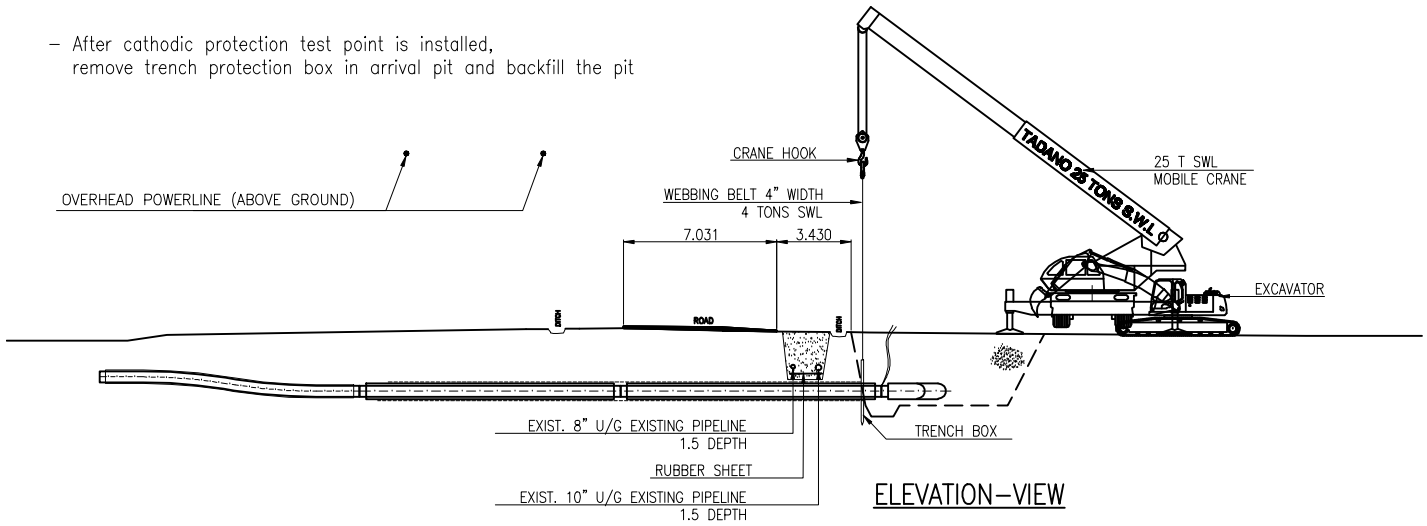
– Cathodic Protection test point will be installed after the tie–in work between boring and mainline pipe in arrival pit, the position will be at near of the tie–in poin



AUGER BORING SEQUENCE 21 OF 21



– After cathodic protection test point is installed, remove trench protection box in arrival pit and backfill the pit



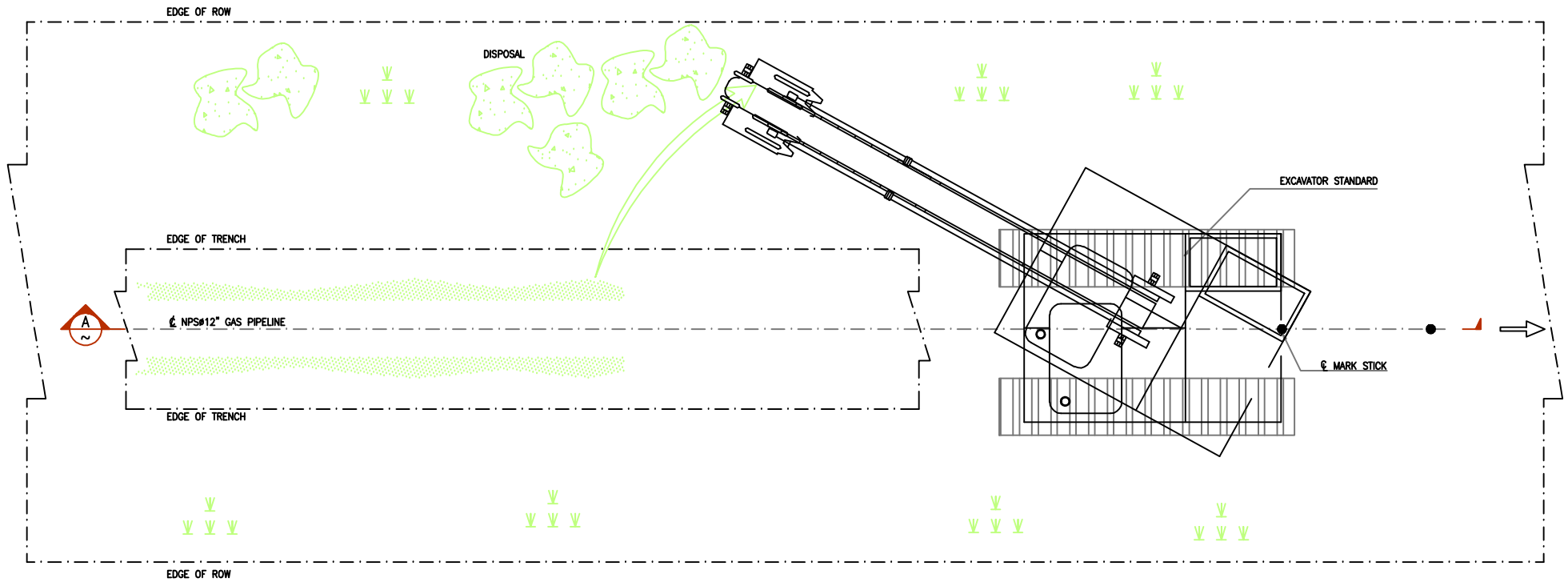
ELEVATION–VIEW

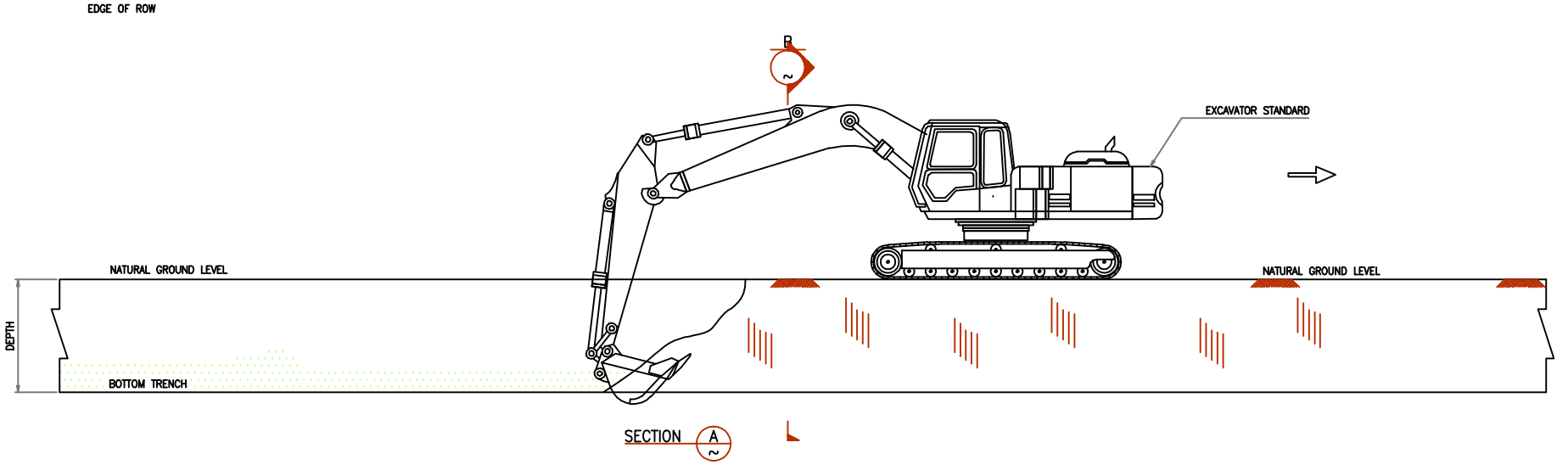
LIFTING CALCULATION

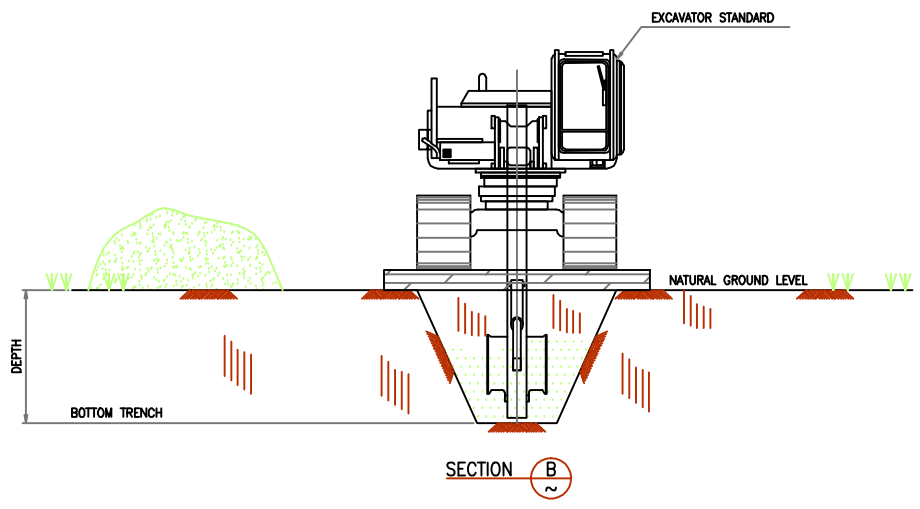
PROTECTION PULL LOAD	= 2 TONS
CONTINGENCY LOAD	= 0.5 TONS
TOTAL LOAD	= 2.5 TONS
LIFTING RADIUS	= 15m
CRANE CAPACITY	= 3.2 TONS
SAFETY FACTOR	= 1.28

Attachment – 5: Typical Trench Excavation & Lowering Operation

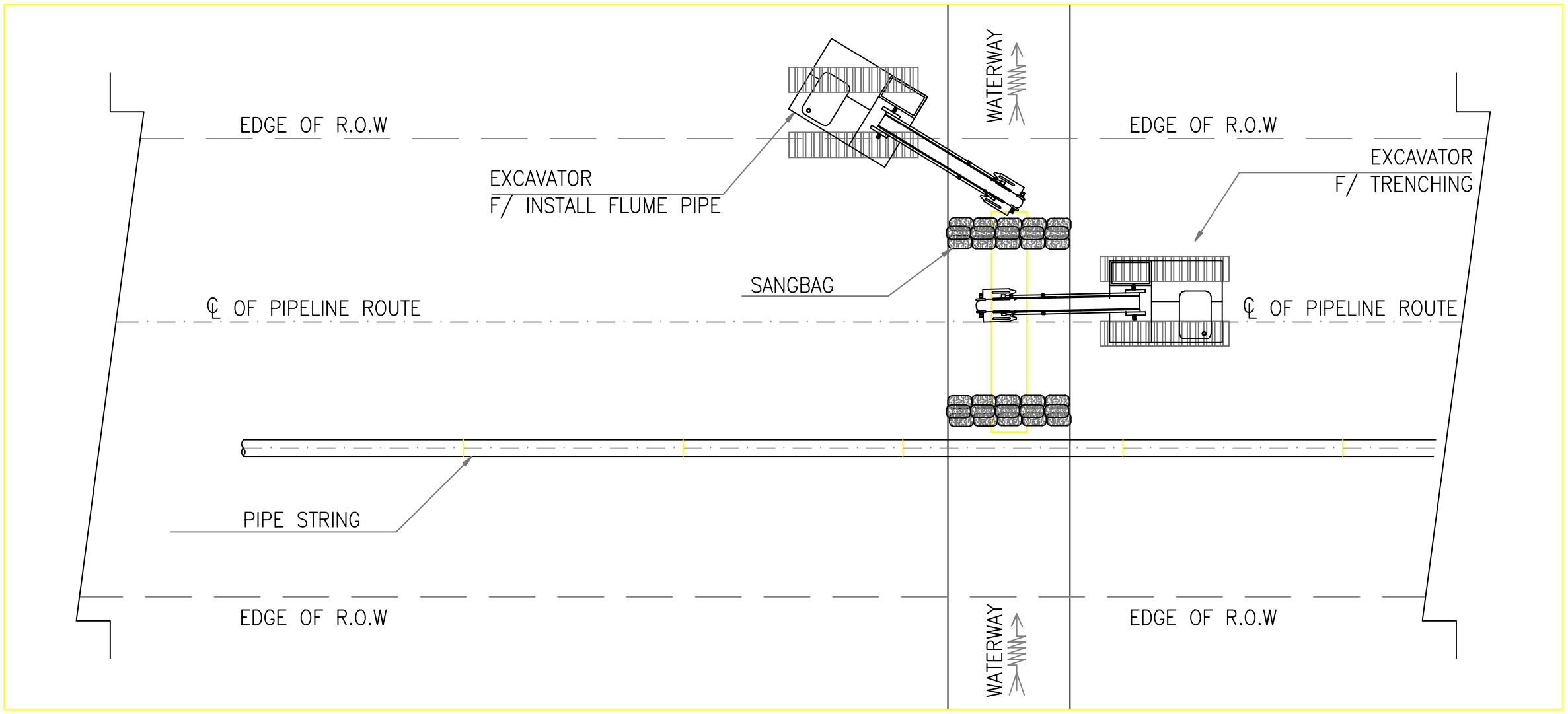
TYPICAL TRENCHING FOR NORMAL AREA







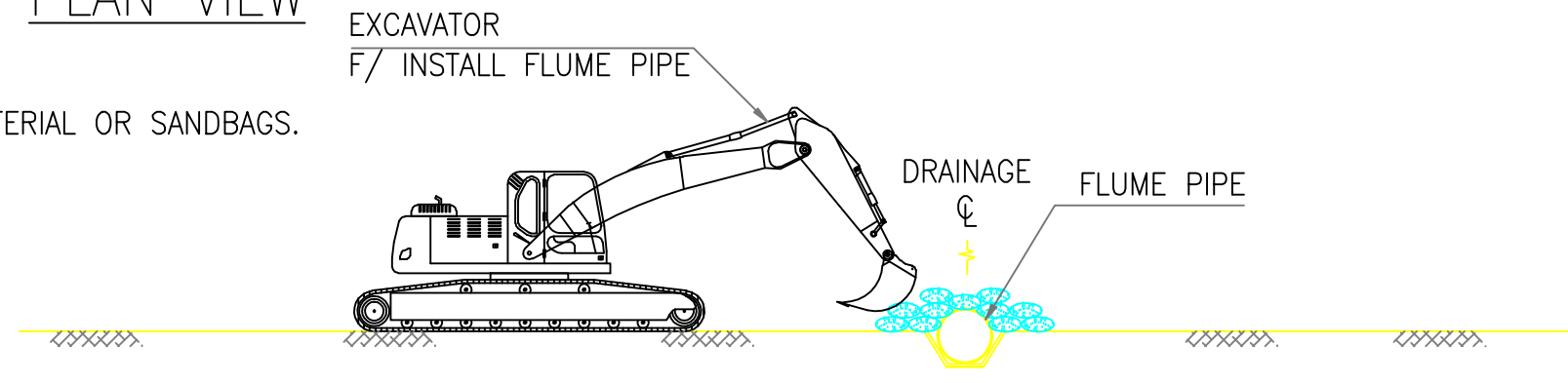
TYPICAL TRENCH EXCAVATION AT WATERWAY CROSSING



PLAN VIEW

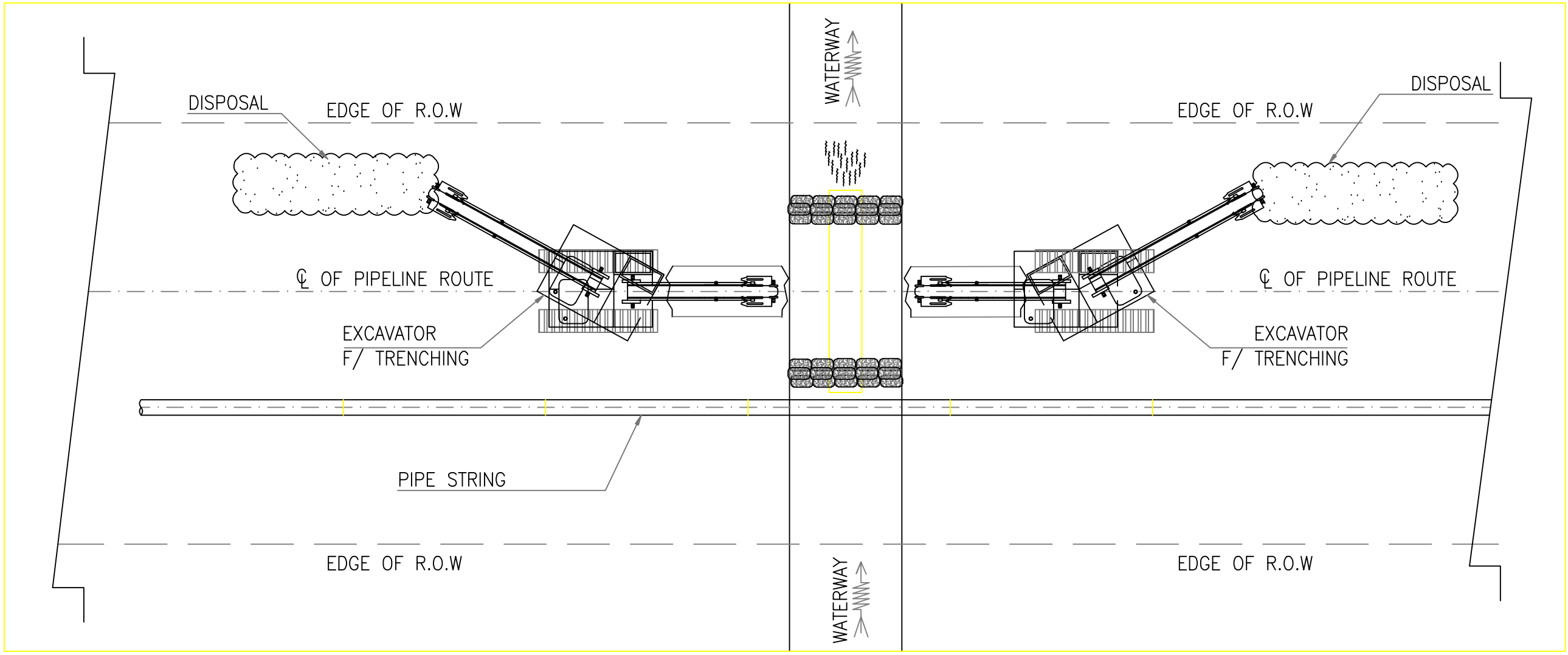
SEQUENCE–1:

- INSTALL THE FLUME PIPE AND BACKFILL ON TOP THE FLUME PIPE WITH SUITABLE MATERIAL OR SANDBAGS.
- MAKESURE THE WATER COMPLETELY FLOWS ONLY THROUGH THE PIPES;
  MEANS THE WORK AREA DOWNSTREAM OF THE BLOCKAGE BECOMES DRY.



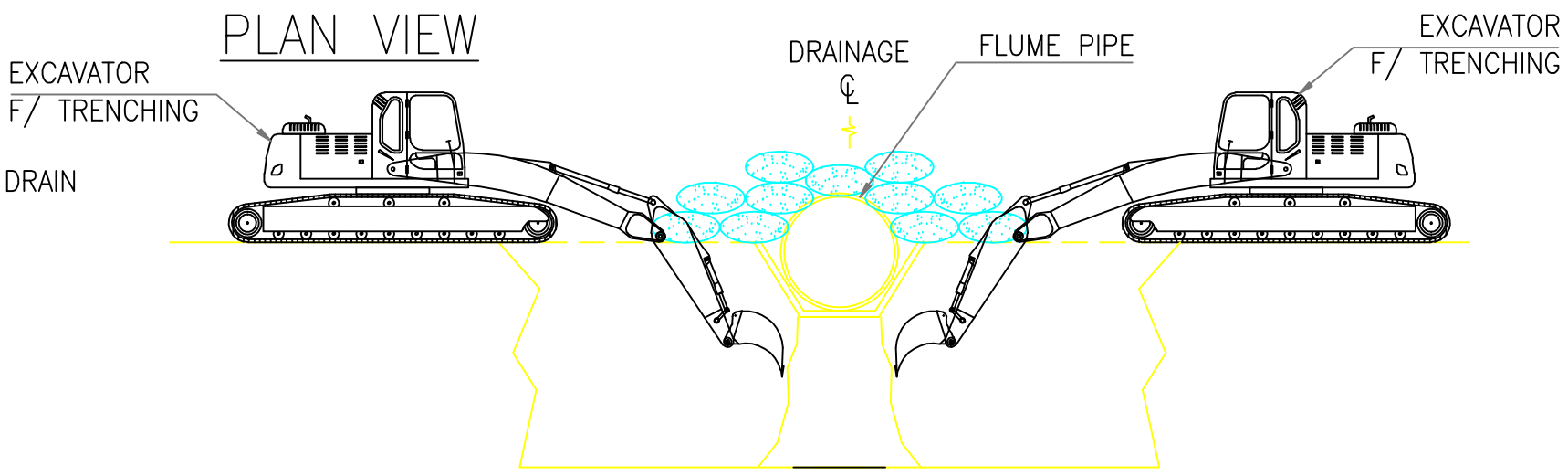
ELEVATION VIEW

TYPICAL TRENCH EXCAVATION AT WATERWAY CROSSING

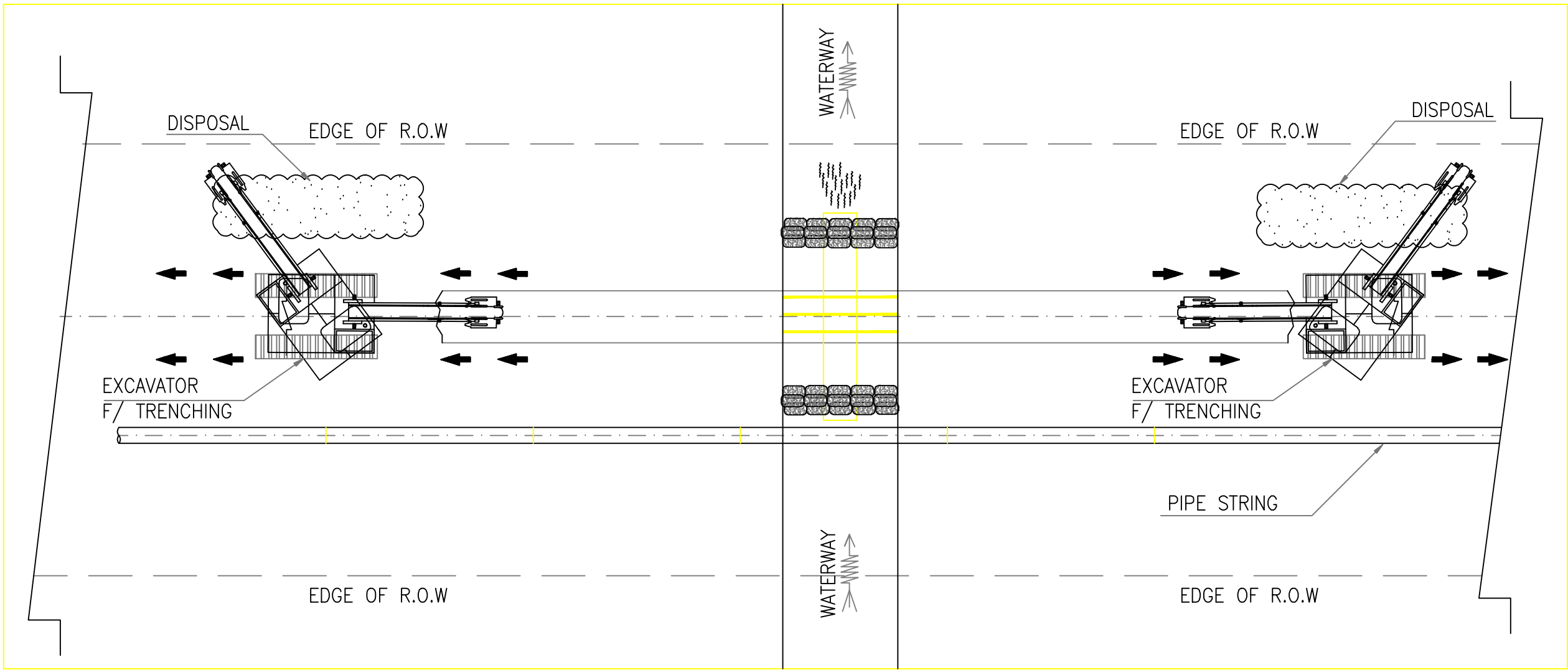


SEQUENCE–2:

- START EXCAVATION THE OPEN TRENCH IN THE RIGHT AND LEFT SIDES OF THE DRAIN FOLLOW THE CENTERLINE WITH SIMILAR DEPTH AS THE DESIGN DRAWING.
- LAY THE EXCAVATED SOIL ON THE DEDICATED DISPOSAL AREA.



TYPICAL TRENCH EXCAVATION AT WATERWAY CROSSING

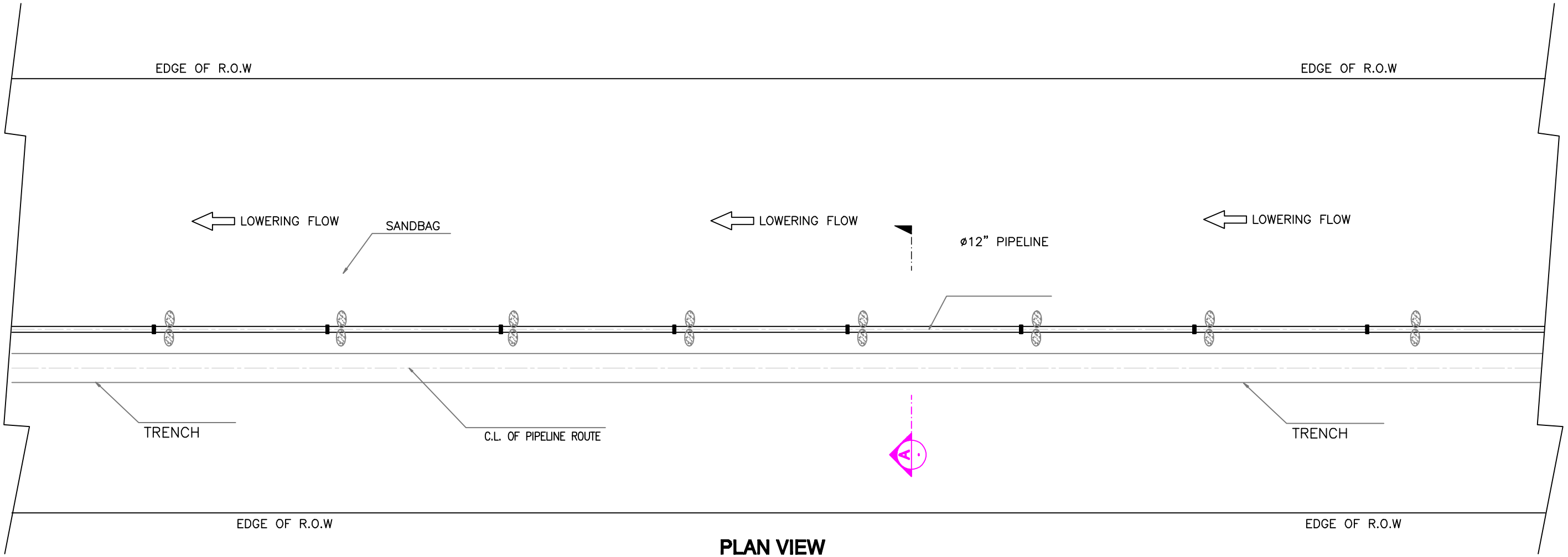


PLAN VIEW

SEQUENCE–3:

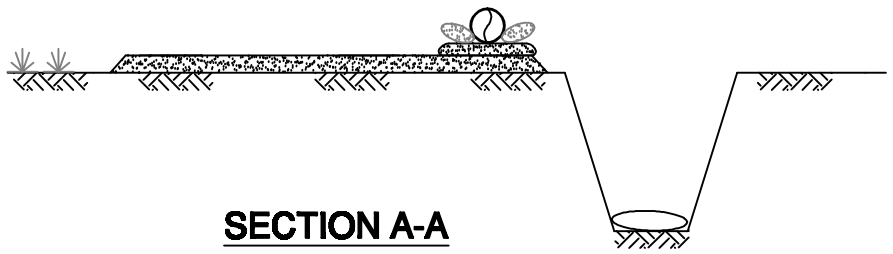
– EXCAVATOR WILL CONTINUE EXCAVATION FOLLOW THE CENTERLINE WITH SIMILAR DEPTH AS THE DESIGN DRAWING.
– THE SURVEYOR WILL MAKESURE THE DEPTH OF THE TRENCH USING LEVEL STICK.
– ENSURE THE SURVEYOR POSITION IS SAFE FROM EXCAVATOR MANEUVER.

LOWERING SEQUENCE 1 OF 8



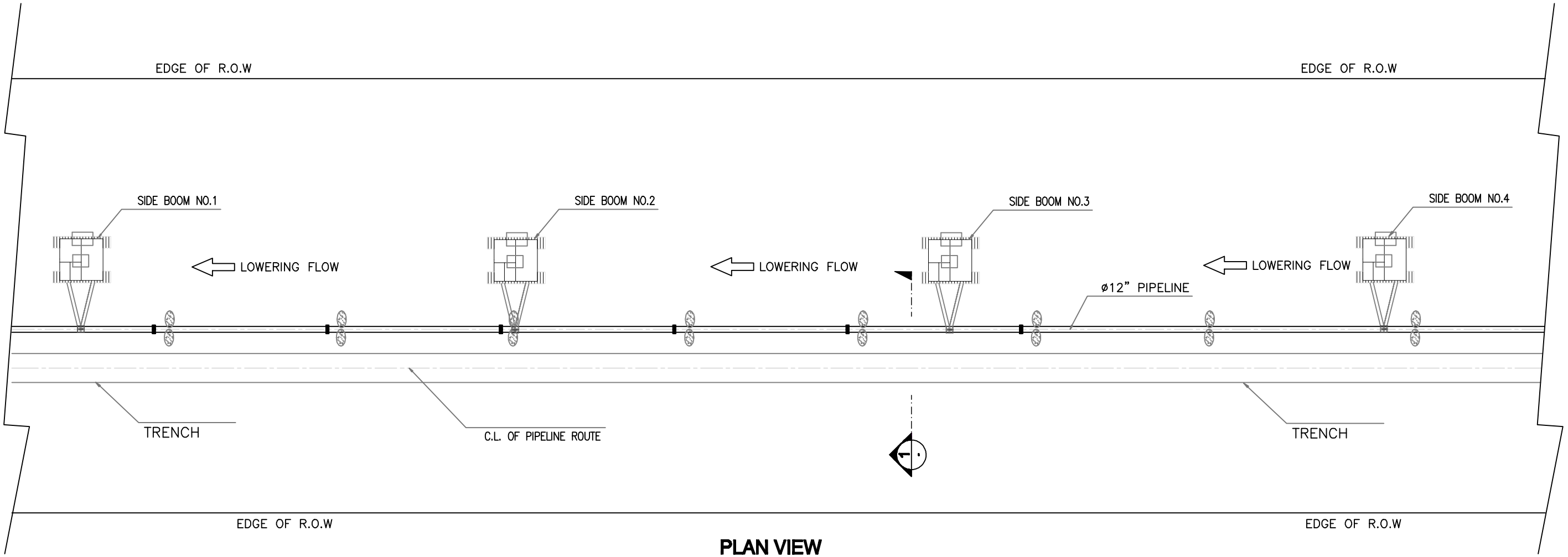
PLAN VIEW

PIPE READY FOR LOWERING

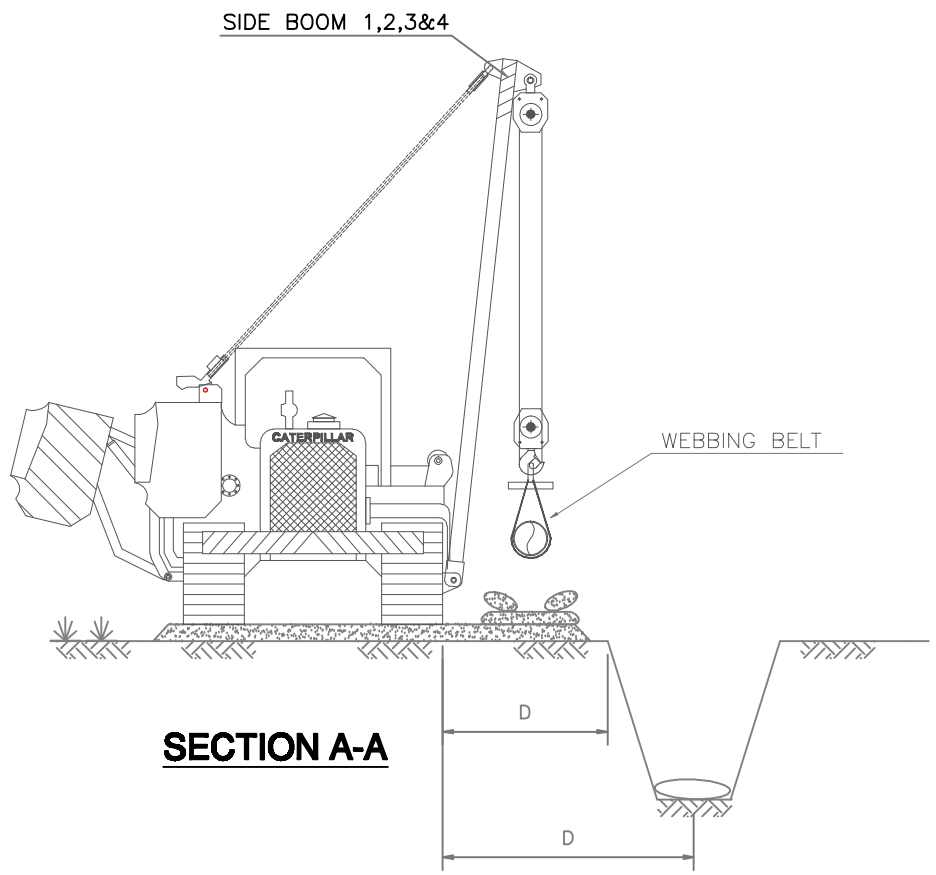


SECTION A-A

LOWERING SEQUENCE 2 OF 8



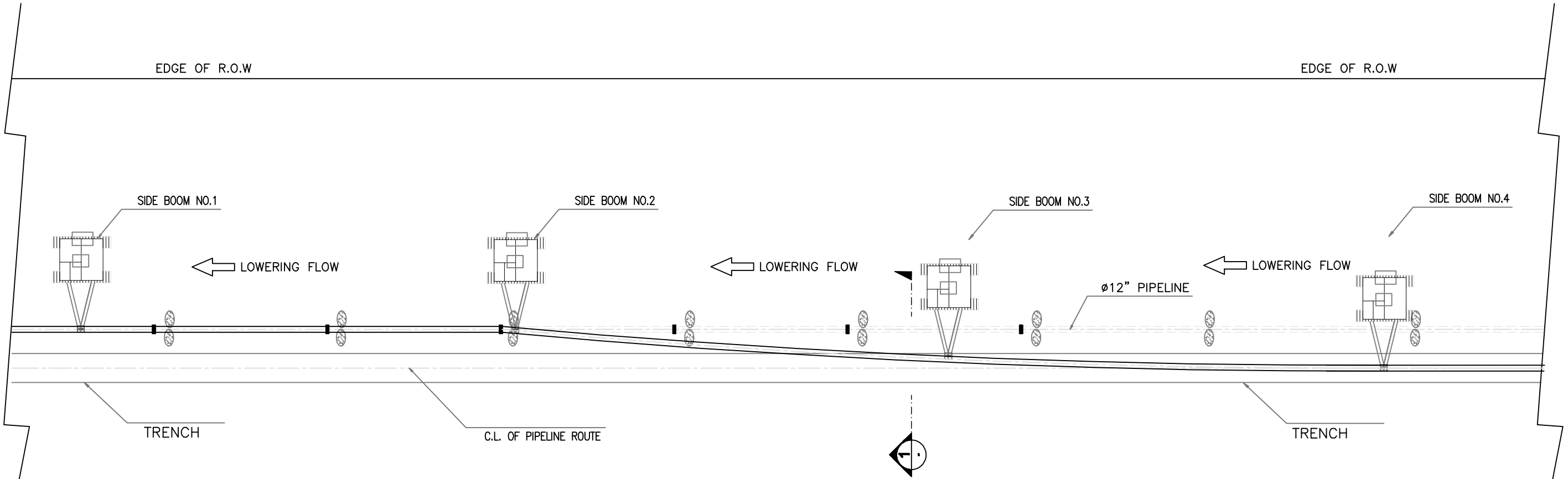
PLAN VIEW

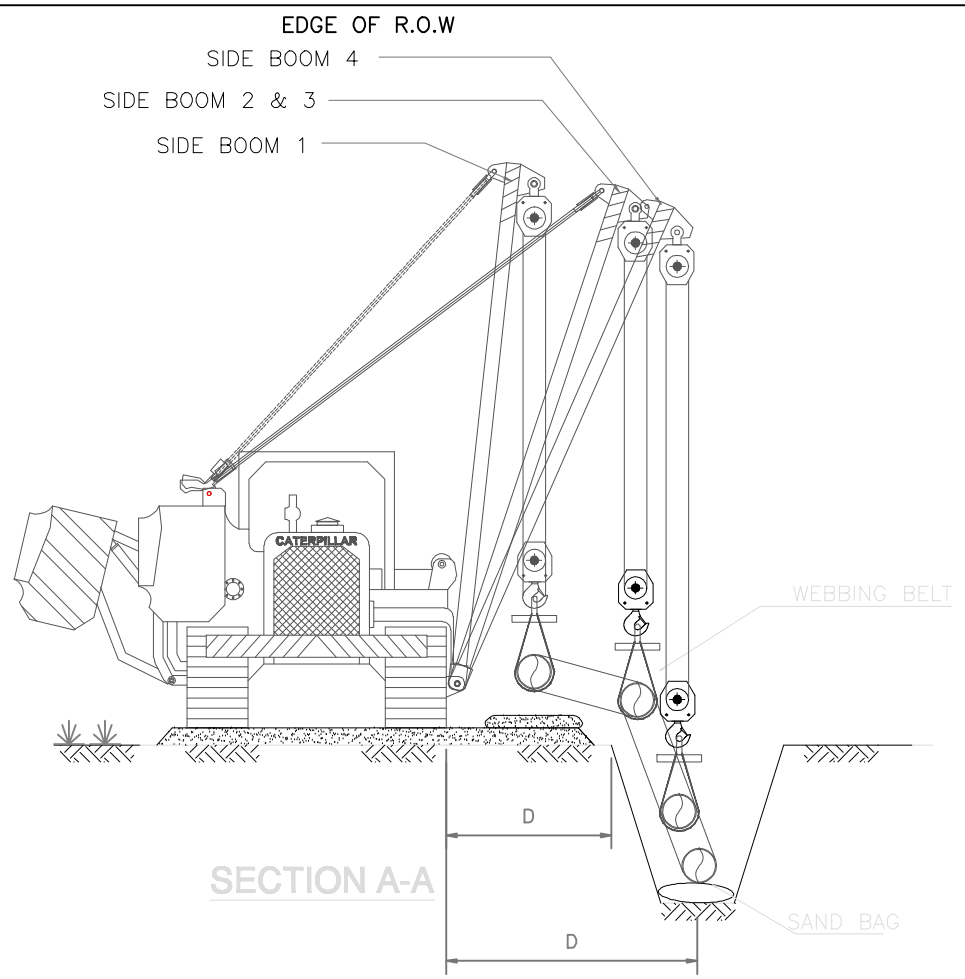


SECTION A-A

SIDE BOOM READY AT EACH POSITION

LOWERING SEQUENCE 3 OF 8





EDGE OF R.O.W

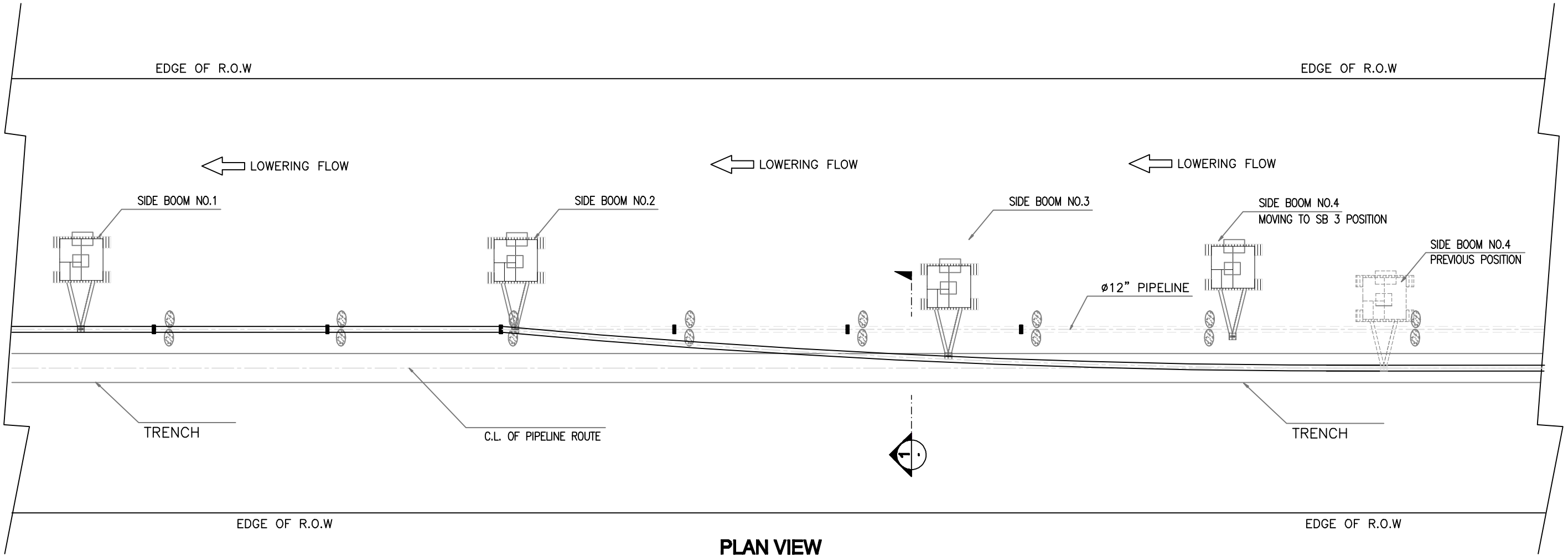
PLAN VIEW

SIDE BOOM AT EACH POSITION

SEQUENCE:

STEP 1 : SIDE BOOM 1, 2 & 3 SLIGHTLY LIFT PIPE ABOVE SUPPORT
STEP 2 : SIDE BOOM 2, 3 & 4 WILL BOOM OUT TO MOVE THE PIPE UNTIL THE PIPE IS DIRECTLY ABOVE ITS TRENCH POSITION, THEN SIDE BOOMS 4 & 3 WILL LOWERING-IN THE PIPE.

LOWERING SEQUENCE 4 OF 8

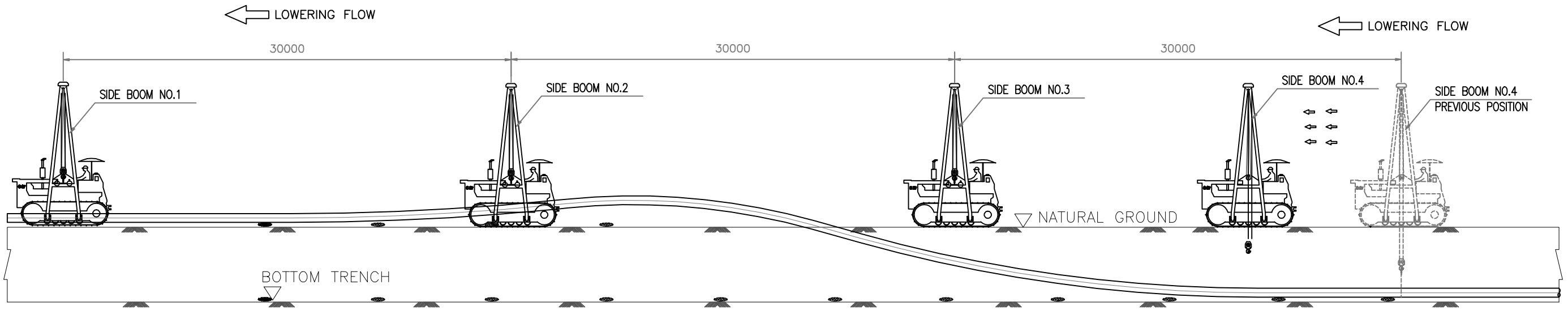


PLAN VIEW

SIDE BOOM AT NEXT POSITION

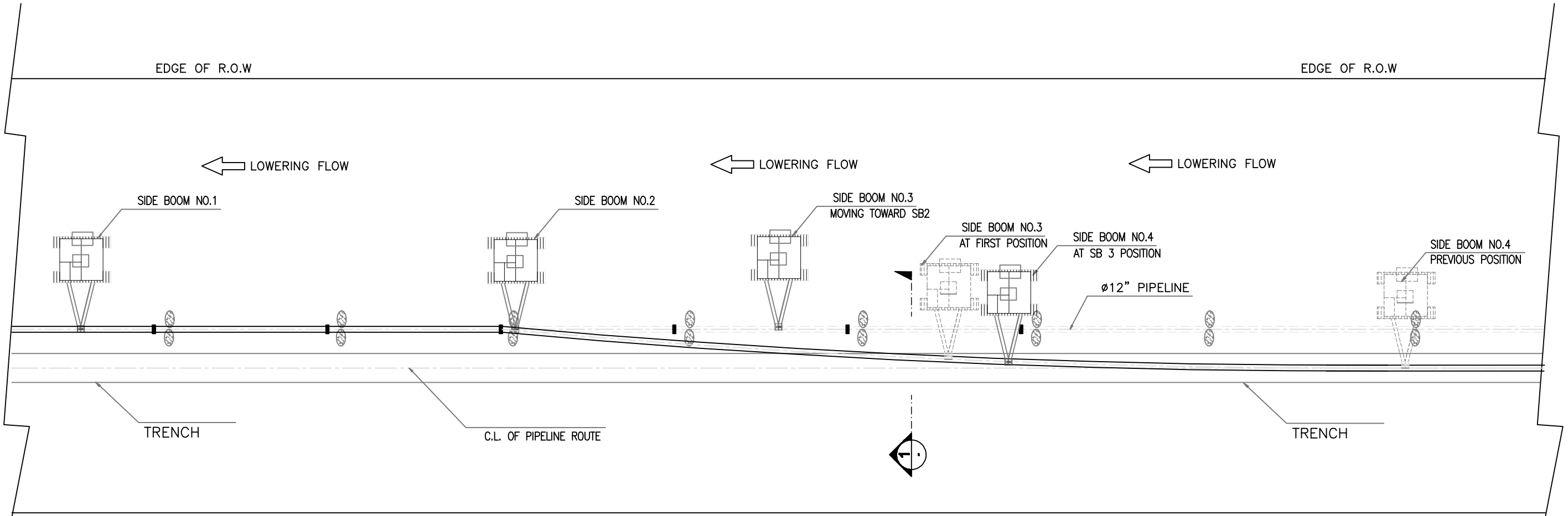
SEQUENCE:

STEP 1 : AFTER SIDE BOOM 4 HAS LOWERED IN THE PIPE, SIDE BOOM 1, 2, & 3 WILL HOLD THE PIPE.
STEP 2 : SIDE BOOM 4 WILL MOVE TOWARD SIDE BOOM 3 POSITION.



ELEVATION VIEW

LOWERING SEQUENCE 5 OF 8

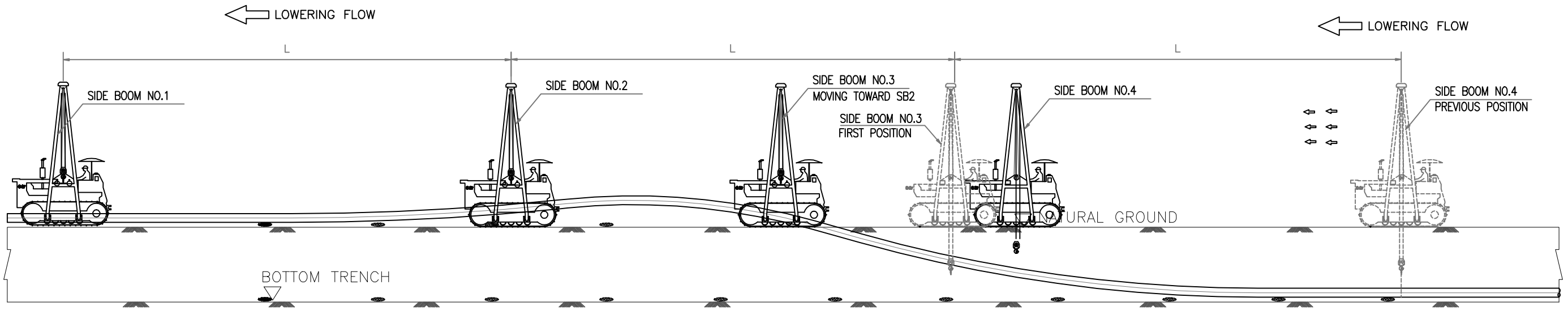


PLAN VIEW

SIDE BOOM AT NEXT POSITION

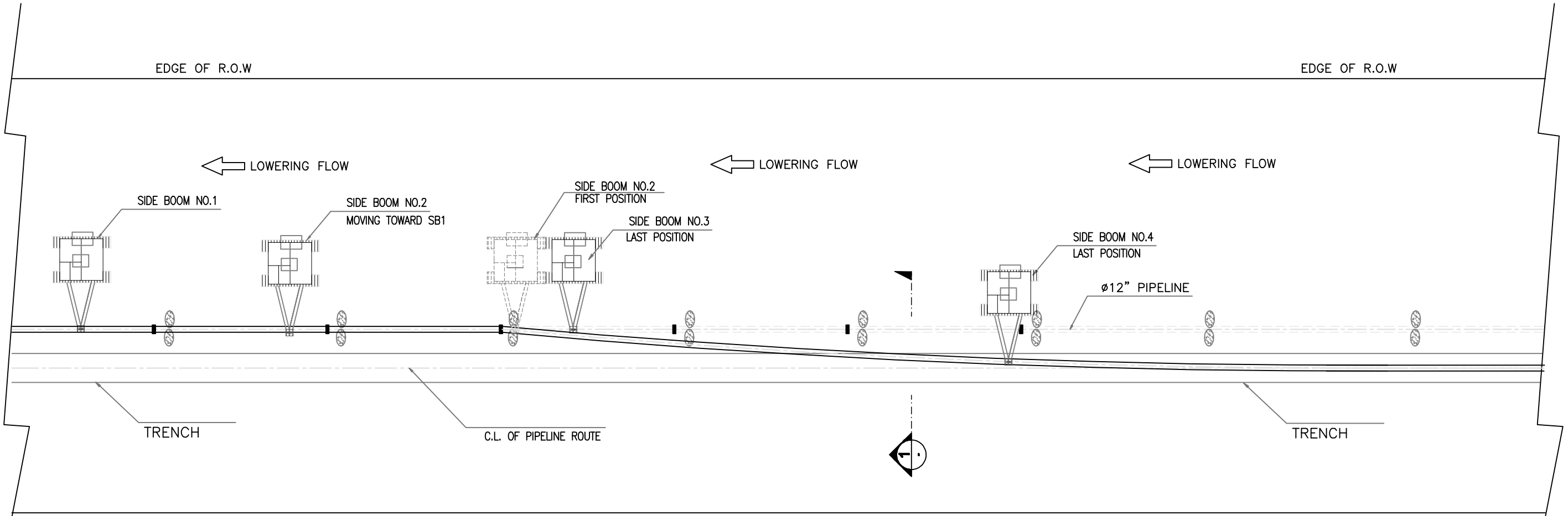
SEQUENCE:

STEP 1 : AFTER SIDE BOOM 4 HASMOVED TOWARD SIDE BOOM 3 POSITION, SIDE BOOM 1, 2 & 4 WILL HOLD THE PIPE.
STEP 2 : SIDE BOOM 3 WILL MOVE TOWARD SIDE BOOM 2 POSITION.



ELEVATION VIEW

LOWERING SEQUENCE 6 OF 8

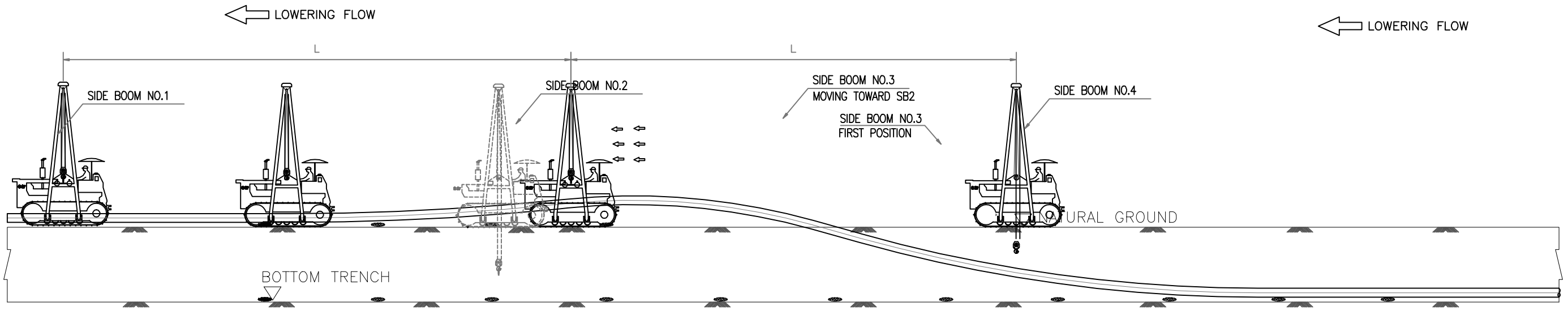


PLAN VIEW

SIDE BOOM AT NEXT POSITION

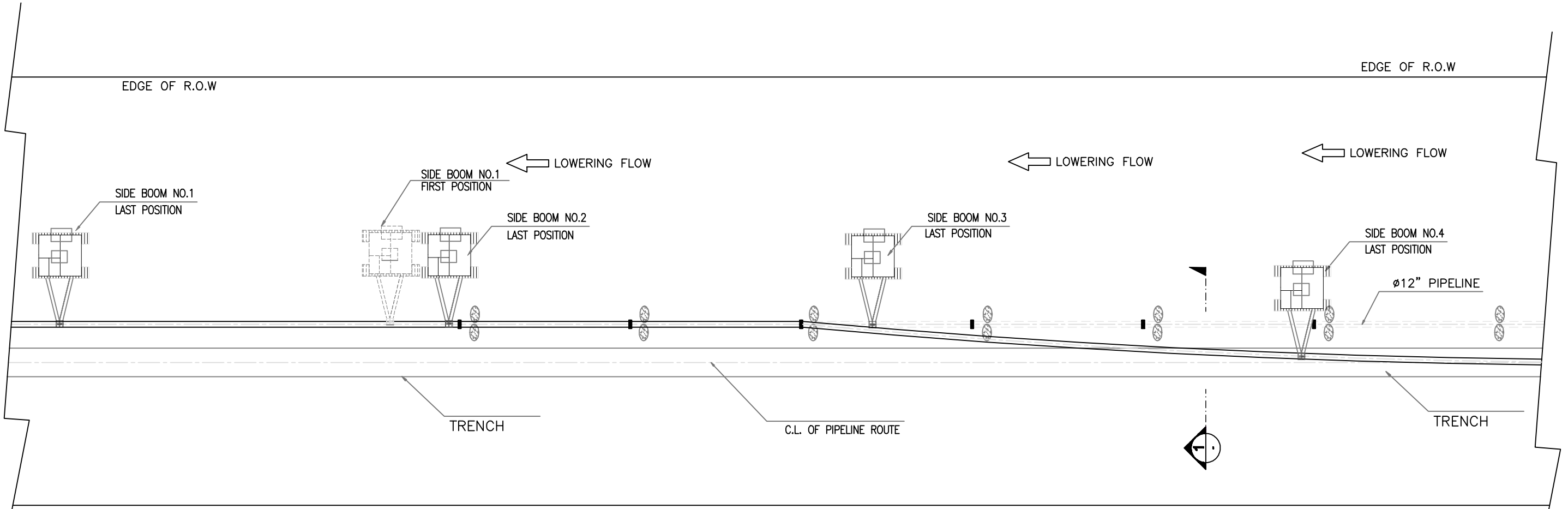
SEQUENCE:

STEP 1 : AFTER SIDE BOOM 3 HAS MOVED TOWARD SIDE BOOM 2 POSITION, SIDE BOOM 1, 3 & 4 WILL HOLD THE PIPE.
STEP 2 : SIDE BOOM 2 WILL MOVE TOWARD SIDE BOOM 1 POSITION.



ELEVATION VIEW

LOWERING SEQUENCE 7 OF 8

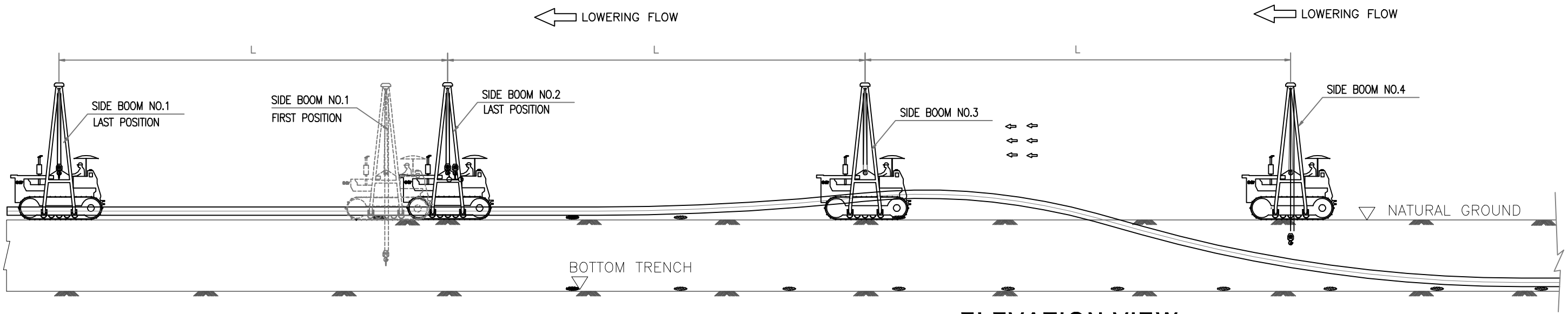


PLAN VIEW

SIDE BOOM AT NEXT POSITION

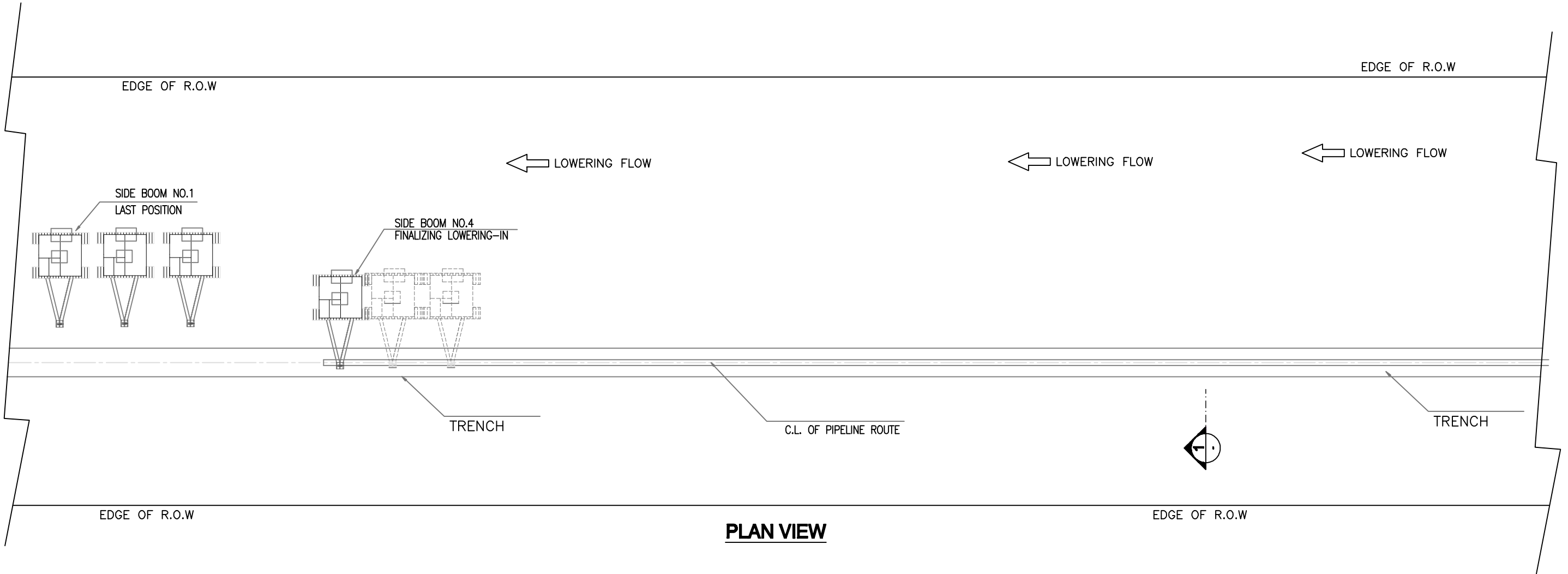
SEQUENCE:

STEP 1 : AFTER SIDE BOOM 2, 3 & 4 HAVE MOVED TO THE LAST POSITION, SIDE BOOM 2, 3 & 4 WILL HOLD THE PIPE.
STEP 2 : SIDE BOOM 1 WILL MOVE TO THE NEXT POSITION WITH INTERVAL 30m FROM SIDE BOOM 2.



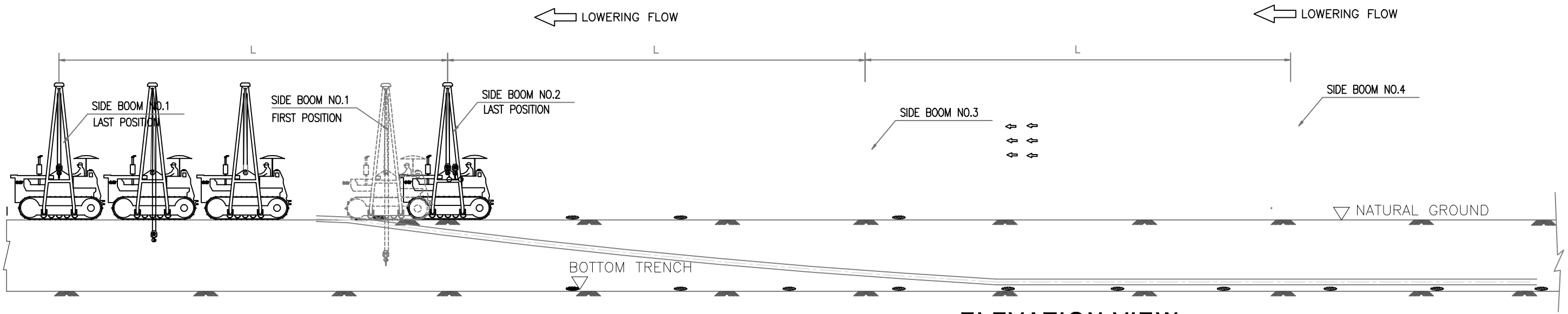
ELEVATION VIEW

LOWERING SEQUENCE 8 OF 8



PLAN VIEW

TYPICAL LOWERING-IN PROFILE AT END OF PIPE



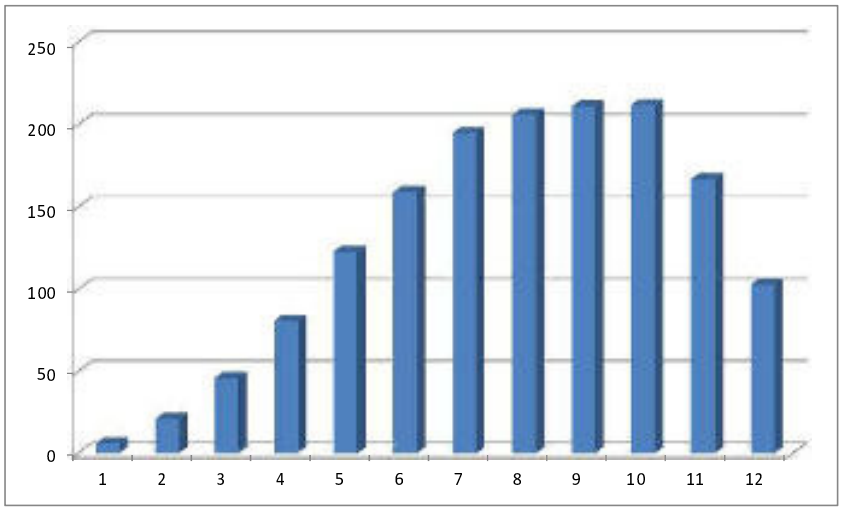
ELEVATION VIEW

RIAU GFPP 250 MW PIPELINE PROJECT
MANPOWER LOADING
PIPELINE 48 KM # 12"

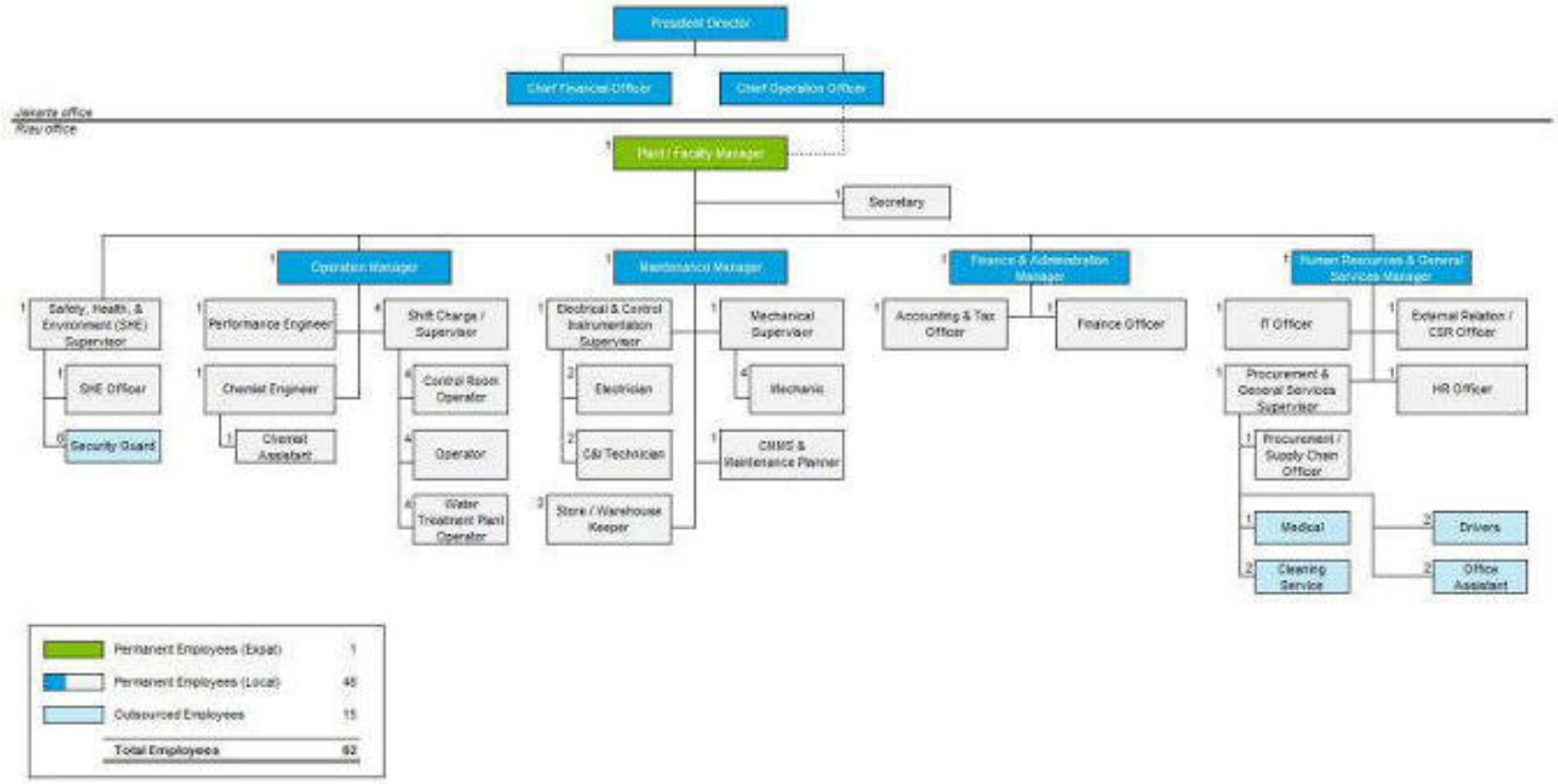
No.	Manpower Description	Bulan												Remarks
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-11	M-12	
A	**INDIRECT LABOR**	**23**	**48**	**51**	**57**	**62**	**78**	**80**	**80**	**78**	**70**	**65**	**56**	
I	**PROJECT MANAGEMENT**													
1	Project Manager	1	1	1	1	1	1	1	1	1	1	1	1	
2	Construction Manager	1	1	1	1	1	1	1	1	1	1	1	1	
3	Deputy Construction Manager	1	1	1	1	1	1	1	1	1	1	1	1	
4	HDR & Public Affair Manager	1	1	1	1	1	1	1	1	1	1	1	1	
5	Project Control / Planning Manager	1	1	1	1	1	1	1	1	1	1	1	1	
6	Quantity Surveyor	1	1	1	1	1	1	1	1	1	1	1	1	
7	Field Scheduler	1	1	1	1	1	1	1	1	1	1	1	1	
8	QA/QC Coordinator		1	1	1	1	1	1	1	1	1	1	1	
9	QA/QC Inspector					4	6	8	8	8	6	6	4	
10	Engineering Manager	1	1	1	1	1	1	1	1	1	1	1	1	
11	Disiplin Engineer	4	6	6	6	6	8	8	8	6	6	4	4	
12	CAD Operator	2	4	4	4	4	6	6	6	6	5	4	4	
13	Chief Surveyor	2	3	3	3	3	3	3	3	3	3	3	2	
14	Document Control	2	2	2	2	2	2	2	2	2	2	2	2	
15	Procurement Manager	1	1	1	1	1	1	1	1	1	1	1	1	
16	Expeditor		1	2	2	2	2	2	2	2	2	2	2	
17	Buyer		1	2	2	3	3	3	3	3	3	3	2	
18	Logistik		1	2	4	4	4	4	4	4	3	3	2	
19	HSE Manager		1	1	1	1	1	1	1	1	1	1	1	
20	HSE Coodinator		1	1	1	1	1	1	1	1	1	1	1	
21	Project Finance / Accounting	2	2	2	4	4	6	6	6	6	6	6	4	
22	Office Staff		4	4	6	6	8	8	8	8	6	6	6	
23	Driver	2	4	4	4	4	8	8	8	8	8	6	4	
24	Clerks / Secretary		4	4	4	4	6	6	6	6	4	4	4	
25	Office Eqp Operator		2	2	2	2	2	2	2	2	2	2	2	
26	Janitor		2	2	2	2	2	2	2	2	2	2	2	
B	**DIRECT LABOR**	**23**	**41**	**65**	**125**	**172**	**244**	**284**	**289**	**299**	**299**	**267**	**155**	
1	Surveyor	2	4	4	6	6	6	6	6	6	6	6	4	
2	Spread Boss (Superintendent)			2	2	2	2	2	2	2	2	2	2	
3	QA/QC Welding Engineer		2	2	2	2	2	2	2	2	2	2	2	
4	Field Engineers			2	2	3	3	3	3	3	3	3	2	
5	Cummunity Dev & HRD Supervisor	1	1	1	2	4	4	4	4	4	4	4	2	
6	Pipeline Foreman				4	6	8	8	8	10	10	8	6	
7	Civil Work Foreman					2	3	3	3	3	3	3	3	
8	Pipeline Welder (Cs)	0	0	4	15	15	30	30	30	30	30	20	10	
9	Structure Welder		2	2	2	2	2	2	2	4	4	4	2	
10	Pipe Fitters & Grinderman				10	20	20	40	45	45	45	30	10	
11	Mechanics		4	4	6	6	6	6	6	6	6	6	4	
12	Riger			4	4	4	4	4	4	4	4	4	2	
13	HE Operator			10	15	20	20	30	30	30	20	20	10	
14	Driver	10	10	10	17	26	30	30	30	30	30	30	26	
15	Material man		2	4	2	4	10	10	10	10	10	8	4	
16	Iron Woker						3	3	3	3	3	3	2	
17	Carpenter						6	6	6	6	6	6	2	
18	Mason						6	6	6	6	6	6	2	
19	Painter / Coater						4	4	4	4	4	4	2	
20	Skilled Labor / Helper		6	6	6	10	15	15	15	15	15	12	6	
21	Common Labor	10	10	10	30	40	60	70	70	70	70	70	40	
22	Pigging & Hydrotest										6	6	6	
23	Drying Specialist										4	4	4	
24	Operators									2	2	2	2	
25	HDD Team									4	4	4		
TOTAL INDIRECT LABOR		**23**	**48**	**51**	**57**	**62**	**78**	**80**	**80**	**78**	**70**	**65**	**56**	
TOTAL DIRECT LABOR		**23**	**41**	**65**	**125**	**172**	**244**	**284**	**289**	**299**	**299**	**267**	**155**	
TOTAL MANPOWER		**46**	**89**	**116**	**182**	**234**	**322**	**364**	**369**	**377**	**369**	**332**	**211**	

RIAU GFPP 250 MW PIPELINE PROJECT
EQUIPMENT LOADING
PIPELINE 48 KM # 12"

No.	Description	AMOUNT	MONTH												AMOUNT UNIT PER MONTH
			M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-11	M-12	
1	Side Boom / Pipe Layer	5				2	5	5	5	5	5	5	5	4	4,6
2	Swamp Backhoe	2					2	2	2	2	2	2	2	2	2,0
3	Mobile Crane 40T	1					1	1	1	1	1	1	1	1	1,0
4	Dozer	2			1	1	1	1	2	2	2	2	1	1	1,4
5	Grader	2			1	1	1	1	2	2	2	2	1	1	1,4
6	Long Arm Excavator	1							1	1	1	1	1	1	1,0
7	Normal Excavator	15			2	4	8	10	15	15	15	15	10	8	10,2
8	Separate Ponton & Boot	0				0	0	0	0	0	0	0	0	0	-
9	Bending Machine 8 - 22 Inch	1				1	1	1	1	1	1	1	1	1	1,0
10	Welding Machine 500 A - 600 A	40	0	0	4	15	15	40	40	40	40	40	20	10	22,0
11	Truck Crane 5 T	3		1	2	2	3	3	3	3	3	3	2	2	2,5
12	High Bed Trailer + Prime Mover	6		2	2	2	6	6	6	6	6	4	2	2	4,0
13	Low Bed Trailer + Prime Mover	2		2	2	2	2	2	2	2	2	2	2	2	2,0
14	Dump Truck	2						2	2	2	2	2	2	1	1,9
15	Light Truct	6						4	4	4	6	6	6	4	4,9
16	Auger Boring	2									2	2	2	2	2,0
17	Thrust Boring	1									1	1	1	1	1,0
18	Compressor 1100 CFM	1										1	1	1	1,0
19	Compressor 750 CFM	2				2	2	2	2	2	2	2	2	2	2,0
20	Compressor 350 / 375 CFM	1					1	1	1	1	1	1	1	1	1,0
21	Generator Set 50 KVA	2		2	2	2	2	2	2	2	2	2	2	2	2,0
22	Generator Set 30 KVA	4		4	4	4	4	4	4	4	4	4	4	4	4,0
23	Fuel Truck	2		1	1	2	2	2	2	2	2	2	2	2	1,8
24	MPV Vehicle	15	3	3	10	10	15	15	15	15	15	15	15	5	11,3
25	SUV Vehicle	15	3	3	10	10	15	15	15	15	15	15	15	5	11,3
26	Crew Bus / Manhoul	6					4	4	4	6	6	6	4	2	4,5
27	Pick up Vehicle	2			2	2	2	2	2	2	2	2	2	2	2,0
28	Ambulance Vehicle	1		1	1	1	1	1	1	1	1	1	1	1	1,0
29	Concrete Mixcer 350 Ltr	4							4	4	4	4	4	2	3,7
30	Concret Vibrator	4							4	4	4	4	4	2	3,7
31	NDT Equipment Set	2					2	2	2	2	2	2	2	2	2,0
32	HDD Equipment Set	1										1	1	1	1,0
33	Hydrotest & Drying Equipment Set	1										1	1	1	1,0
34	Survey Equipment Set	2		2	2	2	2	2	2	2	2	2	2	2	2,0
35	Painting Tools Set	2				2	2	2	2	2	2	2	2	2	2,0
36	Fitter Tools Set	45				10	20	20	40	45	45	45	30	10	29,4
37	Civil Works Tools Set	3						3	3	3	3	3	3	1	2,7
38	Electrical Tools Set	2								2	2	2	2	2	2,0
39	Instrument Tools Set	2								2	2	2	2	2	2,0
40	HP Pumps Set	1											1	1	1,0
41	Water Filling Pump's	1											1	1	1,0
42	Internal Clamp's	4				4	4	4	4	4	4	4	4	4	4,0
TOTAL			**6**	**21**	**46**	**81**	**123**	**159**	**195**	**206**	**211**	**212**	**167**	**103**	



Appendix G. Station Staffing and Organisation Chart



Appendix C. ESIA Baseline Survey Terms of Reference (Dry)

JACOBS

Memorandum

Level 6, 30 Flinders Street
Adelaide SA 5000 Australia
T +61 8 8113 5400
F +61 8 8113 5440
www.jacobs.com

Subject	Baseline Environmental Data Collection Terms of Reference (TOR)	**Project Name**	Riau 275 MW GFPP Project (Medco Ratch Power Riau)
Attention	NBC, Medco Ratch Power Riau	**Project No.**	AM039100
From	PT Jacobs Indonesia		
Date	05.07.17		

1. Introduction

This Baseline Environmental Data Collection Terms of Reference (TOR) has been developed by PT Jacobs Group Indonesia (PT JGI) to collect sufficient baseline data to quantify the receiving environmental and social baseline status for both the power plant site (including 700m of transmission line) and gas supply pipeline route for the Riau 250 MW CCGT Power Plant Project for the ESIA, and is in addition to the baseline sampling required under Indonesian legislation for the power plant AMDAL and the UKL/UPLs for the gas pipeline and transmission line . The project consists of a 275 MW combined cycle power plant and ancillary facilities, a 40 km long 12-inch gas pipeline, and a switchyard and 150 kV transmission line (750m) - collectively referred to hereafter as the 'Project'.

This TOR should be read in conjunction with the Riau Environmental and Social Impact Assessment (ESIA) – Scoping Report (to be completed), which provides details on the known existing environmental and social site conditions and explains the approach taken to ESIA.

2. Summary Project Description

The Project will be located approximately 10 km due east of Pekanbaru City, approximately 5 km south of the Siak River. The power plant and switchyard will be comfortably accommodated inside the 9 ha of land being procured by the Sponsors. The power plant is a 2 x 1 combined cycle plant, designed to deliver up to 275MW over the 20 year term of the PPA. It will burn gas fuel only. Key components of the project will comprise the following:

- Power generated by 2 x 1 combined cycle plant, delivering up to 275 MW;
- River water intake and outlet;
- Air emissions will be released to the atmosphere via 2 x 45 m tall, 3.8 m diameter chimneys;
- Wet mechanical draft cooling tower;
- Earthworks to level and raise the power plant platform to approximately 28m above mean sea level;
- Gas will be supplied from TGI Gas Station 40 km from the power plant via a 12 inch diameter pipeline; and
- a 150kV switchyard at the plant, with a 750 m double-phi connection to intercept the Tenayan – Pasir Putih 150 kV transmission line (TL).

2.1 Power Plant and Transmission Line

The power plant site is located to the east of Pekanbaru City, in Sail Sub District. The site bounded by palm oil plantation to the west, south and east and Road 45 on the North. The Project Sponsors proposes to construct a 750m long 150kV transmission line to tie in to Tenayan – Pasir Putih 150kV existing transmission line. Four transmission towers will be erected between the power plant and the existing transmission line. The proposed power plant and transmission line sites are shown in Appendix A.

2.2 Gas Pipeline Route

The gas supply line is approximately 46 km long from the PGN Gas Terminal Port at Perawang (Future Line of KP 457 – SV 1401.1 of the Grissik Duri Pipeline – coordinate: 47N 791885 E81526 (UTM Format)) to the gas receiving facility located within the Riau CCGT Power Plant at Tenayan district, Pekanbaru City, Riau Province. The proposed pipeline route is shown in Appendix C.

3. Baseline Sampling

3.1 Introduction

This TOR sets out the baseline survey environmental data that is required to be collected by NBC (hereafter referred to as 'the subconsultant'). It describes:

- The type of data to be collected by the baseline sampling surveys;
- The sampling locations, number of samples, sampling methodology to be followed and frequency of sampling;
- Analysis methods for ecological samples collected;
- Parameters that samples should be analysed for (water, sediment, soil and groundwater samples); and
- Reporting formats for the data collected.

3.2 Requirements of the Subconsultant

The baseline sampling as set out in this ToR will be conducted for the Environmental and Social Impact Assessment (ESIA) for the overall Project adhering to international Asian Development Bank (ADB) International Safeguards and is in additon to the baseline sampling conducted in accordance with Indonesian environmental regulations for the the power plant AMDAL and UKL/UPLs for the transmission line and gas pipeline. The ESIA baseline sampling will be conducted prior to the sampling required for the AMDAL and UKL/UPL.

The subconsultant is required to report on the progress of the baseline data collection surveys to PT JGI. The subconsultant shall provide informal fortnightly progress reporting (email) to PT JGI and monthly face to face meetings with PT JGI's Project Manager during the baseline data collection phase. The progress meetings between the subconsultant and PT JGI during this phase will confirm progress in the data collection, discuss outcomes of consultation undertaken and identify any issues in the collection of the baseline data, thus avoiding schedule/scope creep. For all surveys the raw data that underpins the statistical analysis undertaken as part of the survey should be provided.

Any issues encountered by the subconsultant that prevent the subconsultant undertaking the baseline survey by the method specified in this TOR or where data is not available or cannot be obtained must be advised to PT JGI as soon as the issue comes to the notice of the

subconsultant. PT JGI will then in discussions with the subconsultant and the Project Sponsors determine whether the data is required or an alternative survey method or modification to the proposed survey can be used.

The subconsultant will provide PT JGI with sampling and monitoring methodologies prior to undertaking the baseline data collection for review to ensure JGI's data requirements for the ESIA will be met.

A maximum of three months has been allowed in the ESIA preparation schedule for the undertaking of baseline studies, as the baseline surveys need to be completed before end of September 2017. At this stage we have only aloowed for dry season sampling and based on the findings limited wet season sampling may be required. The TOR may be changed based on environmental and social data currently being collected by the Project Sponsors, which will be made available to PT JGI for this Project.

4. Freshwater Aquatic Survey, including Water Quality

The subconsultant shall conduct a baseline survey to characterise regional freshwater communities and ecology of the Siak River and other water courses in the vicinity of the Project power plant, TL and gas pipeline route that includes:

- Fish;
- Macroinvertebrates;
- Algae and macrophytes;
- Aquatic habitats; and
- Water quality.

Water quality, and ecological (macroinvertebrate and net fishing) sampling of the above water courses is required at locations shown in Appendix B and Appendix D.

4.1 Water Quality Samples

4.1.1 Methodology

Water samples should be collected from the Siak River, an unnamed creek to the south of the proposed power plant site and from four watercourses along the gas pipeline route. Samples will be collected under dry season flow conditions at minimum two sampling locations (one upstream and one downstream). The proposed water quality sample locations are shown in Appendix B (power plant / TL) and Appendix D (gas pipeline route).

Samples will be collected and stored in accordance with the requirements specified in Government Regulation No. 82 Year 2001 regarding Water Quality Management and Pollution Control Class II (as minimum, unless otherwise regulated by local government regulation) and ISO 5667.6:2004 Water quality – Sampling Part: 6 Guidance on sampling of rivers and streams or its equivalent. The sampling will be conducted to determine the physical, chemical and biological parameters of the rivers prior to the power plant development. The parameters that the samples are to be analysed for are set in Table 4.1 below.

For metals the samples jars will be acid preserved. One set of metal samples will be for total metal and the water sample will be placed in the sample container without filtration. Another sample will be collected for soluble metals and the sample will be filtered to remove suspended solids in the field prior to it being placed in the container containing acid preservative. Laboratory analysis of water samples should be carried out in accordance with APHA method.

Organic parameters must be collected in glass jars and that only the first set of samples from each sampling location needs to be analysed for the organic parameters being organochlorine pesticides, Dioxins, Furans, other toxics such as PAH (Polycyclic Aromatic Hydrocarbons), and Polychlorinated Biphenyls (PCB). This would be for the first set of samples collected.

Table 4.1: Analysis Parameters for Water Samples

Parameter		Siak River	Unnamed Creek Connecting power Plant to Siak River	Spot sampling on watercourses crossed by proposed gas pipeline
pH		✓	✓	✓
Total Suspended Solids		✓	✓	✓
BOD		✓	✓	✓
COD		✓	✓	✓
Oil and Grease		✓	✓	✓
Arsenic		✓	✓	✓
Boron		✓	✓	✓
Cadmium		✓	✓	✓
Chromium	Hexavalent	✓	✓	✓
	Total	✓	✓	✓
Copper		✓	✓	✓
Iron		✓	✓	✓
Lead		✓	✓	✓
Mercury		✓	✓	✓
Manganese		✓	✓	✓
Nickel		✓	✓	✓
Zinc		✓	✓	✓
Soluble Heavy Metals (filtered) as per bulleted list above		✓	✓	✓
Ammonia		✓	✓	✓
Fluoride		✓	✓	✓
Total nitrogen		✓	✓	✓
Nitrate		✓	✓	✓
Nitrite		✓	✓	✓
Phosphorus		✓	✓	✓

Parameter	Siak River	Unnamed Creek Connecting power Plant to Siak River	Spot sampling on watercourses crossed by proposed gas pipeline
Total Coliform Bacteria	✓	✓	✓
Organochlorine pesticides	✓	×	×
Dioxins, Furans, other toxics such as PAH (Polyaromatic Hydrocarbons)	✓	×	×
Polychlorinated Biphenyls (PCB)	✓	×	×
Temperature	✓	✓	✓
Conductivity	✓	✓	✓
Turbidity (NTU)	✓	✓	✓

4.1.2 Sampling Frequency and Field Data

As a minimum, water samples should be collected from the identified sampling locations on at least two occasions during the dry season and on one occasion during the wet season (to be confirmed at the end of dry season sampling). Measurements of pH, temperature, dissolved oxygen and conductivity should be recorded in the field at the time the samples are collected. The date and time that the samples were collected and the weather conditions at the time of sampling and for the previous 24 hours should also be noted.

The flow rate of the river at each of the sampling point should be estimated at each sample location. At each sampling point the cross section of the river should be determined along with the velocity of the river at that point. Velocity can be determined by use of flow measuring device or by timing a device floating in the main current of the river between two points marked on the opposite bank. Cross sectional areas will need to be determined, depth and width of the river at the sampling points. Cross sections may be available from the survey of the rivers, which is to be conducted either as part of the baseline data collection by the subconsultant or by the power plant designers. If not they will need to be measured as part of the water sampling programme.

4.2 Freshwater Ecological Sampling

4.2.1 Macro-invertebrate Sampling

Macro-invertebrate sampling will be conducted at one location (unnamed creek near the power plant) and at one location on Siak River, as identified in Section 4.1 and shown in Appendix B. Sediment samples will collected at this location by grab or box corer methods. A total of three samples will collected at this point following a transect across the rivers. The sediment samples will be composited and a sample taken and sent to the laboratory to determine the chemical contaminants present in the sediments.

The benthic fauna will be treated in a standard manner - sieved through 1 mm mesh size, identified to species level and enumerated, weighed and subjected to ABC analyses. Abundance, species diversity and distribution frequency will be determined for each sampling location. The sampling should not be carried out within two weeks of a storm event as this has the potential to flush organisms out of their ecosystems and thereby potentially reducing the number of organisms present.

The sampling should be conducted by a recognised laboratory or university with the facilities to store and count the species. Sampling should be conducted following the guidance provided in the ANZECC Water Quality Guidelines for Fresh and Marine Waters, 2000.

A report will be provided setting out the sampling methodology followed, sample locations, raw data and the analysis of abundance and diversity.

4.2.2 Net Fishing

If appropriate, net fishing will be conducted at the upstream and downstream sampling locations identified for both the Siak River and other watercourses to determine the abundance and diversity of fish species in the rivers prior to the power plant development. Any protected species identified in the survey will need to be clearly identified so that the impact of effluent discharged to rivers from the power plant development can be assessed. The sampling should be conducted by a recognised laboratory or university with experience in conducting similar surveys.

4.3 Reporting

Reports on the baseline data collected by these studies will be prepared by the subconsultant and submitted to PT JGI within one month of the data collection being undertaken.

5. Terrestrial Ecology

The baseline survey will assist in determining the baseline for terrestrial ecosystems and the representative flora and fauna in each of the habitats at the power plant/TL site and the gas pipeline route. As a minimum, flora and fauna samples should be collected from a number of identified sampling locations along the gas pipeline route on at least one occasion during the dry season only. Due to the area being predominantly palm oil plantation and therefore low in biodiversity, it is considered that dry season sampling is only required for terrestrial ecology. Date and time that the samples were collected and the weather conditions at the time of sampling and for the previous 24 hours should be noted.

5.1.1 Site Survey Preparation – All Sites

The task includes review of background information on the locality, field work to survey habitats and species, and reporting of methodologies, results and conclusions. A literature review shall be conducted before carrying out field surveys. This will also include screening of international databases to identify international recognised key biodiversity risks such as designated or protected areas and threatened species. Specific tasks include:

1) Describing and mapping the various terrestrial habitats on the sites. This is to include the fish ponds if any.

2) Within each habitat, use internationally accepted, standard sampling techniques to identify:
   - Habitat type (wetland / agriculture / forest; intact / degraded / modified; man-made; significance of biodiversity – local, national, international). Include information on hydrology, soils or other habitat characteristics that are relevant.
   - Species - including introduced, indigenous, noxious pest or weed, economic value, significance – local, national, international. The significance of species shall be noted in the report.
   - Note the ecological uses of the site for significant faunal species (i.e. feeding, nesting, migrating)

3) Sampling techniques shall be adequate to provide a detailed list of species, abundance, and habitats condition using primarily visual and aural methods. Trapping, handling, specimen collection of species is not expected as part of this study (except for the fish survey, as discussed above).

4) Type of survey will include:
   a) Vegetation / flora;
   b) Avifauna (birds);
   c) Herpetofauna (amphibians and reptiles);
   d) Mammals

5.1.2 Survey methodologies

Vegetation / flora

A preliminary land-use/habitat classification of the study area shall be prepared in GIS by interpretation of satellite imaginary and/or aerial photography. This information shall be used to stratify the vegetation and habitat types for further detailed survey. Stratification is necessary to ensure that the full range of potential habitats and vegetation types are systematically sampled. Stratification shall consider land-use, elevation and vegetation type (shrub, cleared agriculture / plantation / off-stream wetlands).

Power Plant / TL

Habitat classification maps will be ground-truthed through a combination of walked transects through habitat-types to provide further detailed information on vegetation boundaries, floristic diversity and the possible presence of rare and threatened plants.

Walked transect surveys shall aim to record all plant species within the vicinity of the Project. There will be 3-4 transects for the power plant / TL site. Particular attention shall be paid to the dominant, rare, endemic, threatened, protected, invasive species, and the species that are of importance to local communities. Locations of rare or threatened plant species shall be identified using a GPS and data on the size and distribution of the population shall be recorded.

The following general data shall be along each route:

- location using handheld GPS to record coordinates;
- photographs showing habitat structure and any notable plant species;
- habitat types and structure.

Additional habitat conditions data shall be recorded per transect, including the level of modification or disturbance of habitat found per transect and this shall be assessed according to the following grading:

- relatively stable or undisturbed communities (e.g. old growth, unlogged forest);
- late successional or lightly disturbance communities (e.g. old growth mangrove swamp that was selectively logged in recent years);
- mid-successional or moderately to heavily disturbed communities (e.g. young to mature secondary forest); and
- early successional or severely disturbed communities.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable floristic diversity, the site will be assessed in more detail with 100m transects running perpendicular to the road. Notable species will be recorded as above for the power plant / TL site.

Avifauna

Power Plant / TL

The survey shall focus on sampling bird species' richness and abundance located within the range of different habitat strata present. Line transects surveys will be used with a point count method. There will be 3-4 for the power plant / TL site.

Transect surveys and point count surveys involving a 20 minute time-based survey and each transect/point to record all birds seen or heard within a 50 m radius of the census point. Bird surveys shall be conducted within four hours of sunrise to sample peak activity time and surveys shall avoid adverse weather (e.g. high wind or rain). Geographic coordinates shall be recorded at each survey point

Observations on birds shall be done primarily through visual observation and call identification. Nests and important food source/trees for any protected and rare species shall be recorded and captured with GPS. Where possible, surveys will also cover the foreshore area for seabirds.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable potential for avifauna, the site will be assessed in more detail with 100m transects running perpendicular to the road, on the same side as that the pipeline will run. Notable species will be recorded as above for the power plant / TL site.

Herpetofauna

Power Plant / TL

The type and number of reptile and amphibian species shall be recorded during the walked transect surveys. Areas of high concentrations of individuals shall be captured with GPS. Study area and observations of significance shall be photographed.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable potential for herpetofauna, the site will be assessed in more detail with 100m transects running perpendicular to the road, on the same side as that the pipeline will run. Notable species will be recorded as above for the power plant / TL site.

Mammals

Power Plant / TL

The type and number of mammal species shall be recorded during the walked transect surveys. Visual identification of animals, refuges, scat or other signs is expected. It is not deemed necessary to use camera traps in this study.

Gas Pipeline Route

The gas pipeline route will be driven with all habitats recorded in detail on route. In areas of notable potential for mammals, the site will be assessed in more detail with 100m transects running perpendicular to the road, on the same side as that the pipeline will run. Notable species will be recorded as above for the power plant / TL site.

5.1.3 Reporting

Reports delivered by subconsultants shall include the follows:

- Background context, from desk top study.
- Sampling methodology including limitations to methodology (weather, season, timeframe, sampling biases, etc.). Cite references for standard sampling methodologies.
- Results, including species lists and abundance (including indigenous and introduced), observations of refuges / nests etc., significant habitats or species (rare, threatened, noxious etc.), ecosystem uses for key species (nesting, migrating, foraging etc.).
- Conclusions on the significant issues or factors that should be addressed in the environmental impact assessment study, including recommendations for further study work if required.

6. Groundwater Resources (Power Plant Only)

6.1 Collect and Review Background Information

Background information needs to be obtained by the subconsultant on the existing groundwater use and hydrogeological characteristics of the power plant site. Data required to be obtained as part of this assessment includes:

- Determine the location, depth and groundwater levels (both static and pumping levels if available) of existing groundwater /bores and wells within two kilometres of the site.
- Obtain available geological and construction information for bores/wells within two kilometres of the power plant site. Bore construction data may include information on bore casing, well screens, and pump installation, such as depth, diameter, material types, screen slot sizes, and pump specifications.
- Determine the locations of existing groundwater users in nearby villages.
- Advise PT JGI what data is available and whether it is sufficient to prepare hydrogeological maps.
- Prepare hydrogeological maps if there is sufficient data available that show the locations of existing boreholes in relation to the proposed power station and ash disposal site. These maps should clearly identify existing groundwater supply bores, surface geology, groundwater catchment boundary, and hydrogeological features (e.g. springs).
- Determine seasonal fluctuation of the groundwater levels from either existing monitoring data, or undertake regular water level monitoring of accessible bores.
- Arrange and undertake a water sampling programme of three bores/wells within one kilometre of the proposed site to determine baseline water quality of the groundwater system surrounding the project site. Selection of appropriate sampling sites will be undertaken in discussions with PT JGI based on the results of the above review and will target wells which have information on geology, bore construction and yield. It will likely include a borehole drilled on the project site, assuming that this has accessible piezometer installation. A total of three water samples are to be collected once the well volume has

sufficiently purged such that field parameters (pH, total dissolved solids, temperature) have stabilised. The samples are to be analysed for the same parameters as set out in Table 4.1, excluding dioxins.

6.2 Reporting

The subconsultant shall provide the base datasets identified above to PT JGI in appropriate electronic format to enable data manipulation and integration. These data will be used by PT JGI to develop a preliminary conceptual understanding of the hydrogeology of the area surrounding the site. The results of this work will be used to refine the scope and specific requirements for additional investigations and ongoing base data collection to be undertaken.

7. Contaminated Land (Power Plant Only)

Surface soil samples to a depth of 300m are to be collect at the power plant area and analysed for pesticides being organochlorine, organophosphorous and organo nitrous. A total of 10 soil samples on a grid based system shall be collected and analysed.

8. Air Quality

8.1 Ambient Air Quality

The construction activities for both the power plant/TL and the have the potential to adversely impact on the ambient air quality therefore baseline monitoring should be undertaken by the subconsultant at a selection of potentially sensitive sites that could be affected by the construction activities.

The monitoring sites must be located in suitable areas that comply with the guidelines set out in Australian Standard AS 2922 Ambient Air – Guide for the Siting of Sampling Units 1987. The purpose of AS 2922 is to ensure that the location of the sampling site is such that the collected data is representative of that location. The standard has a number of guidelines to facilitate the site location conformity. The guidelines also outline sites to avoid including those that:

- Restrict airflows in the vicinity of the sampling inlet.
- May alter pollutant concentrations by adsorption or absorption.
- Chemical interference with the pollutant being measured may occur.
- Physical interference may produce atypical results.

Consideration is also given to vandalism, adequate access, services and local activities when selecting a site. In addition, for the data to be applicable to human health the sampling inlet should be located near the breathing zone, i.e. around 1 to 2 m above ground level.

Figure 7.1 of AS 2922 documentation and shows the generalised layout and guidelines for a typical sampling site. It is noted that security is an issue in respect to the sampling equipment and local schools, mosques or other relatively secure sites should be used. Discussions should be entered with village chiefs to fine secure sites.

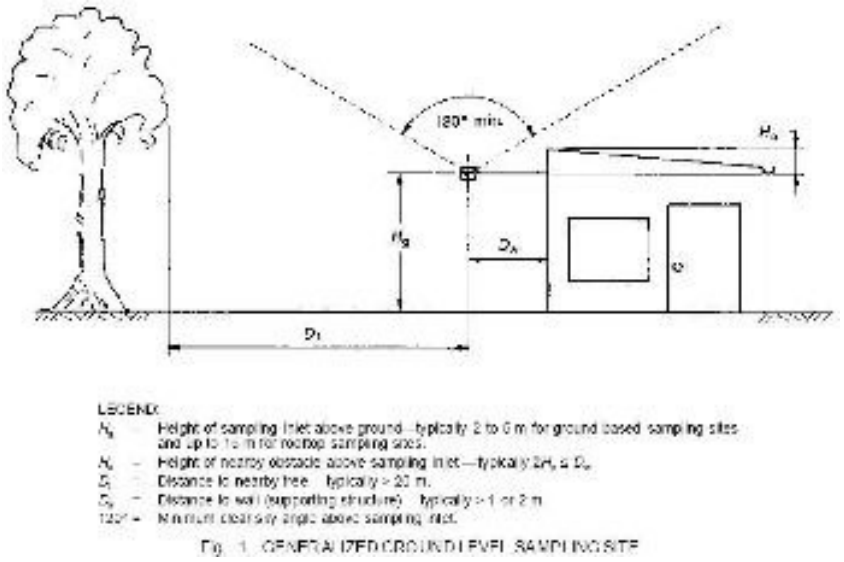


Figure 7.1: Generalised Ground Level Sampling Site

At this initial stage it is proposed that the following monitoring is conducted at the two sites:

- PM10/Total suspended particulate using high volume sampler or low volume method.
- Nitrogen dioxide by either active sampling or by passive diffusion tubes

8.1.1 PM_{10}/PM2.5Total Suspended Particulate

PM10 and PM2.5 will be collected at each of the monitoring sites following Method IO-2.1 Sampling of Ambient Air for PM10 and PM2.5 Using High Volume (HV) Sampler. Ambient air is drawn at a known flow rate through a prepared filter via a PM10 and a PM2.5 inlet, which effectively acts as a hood to prevent precipitation and debris from falling onto the filter. . The sample volume is calculated from the average flow rate and sample duration. The material collected on the filter is determined gravimetrically. Sampling duration is for a 24-hour period.

Sampling would be carried out twice a month for a minimum of three months at each of the monitoring sites.

Subconsultant is to advise which method will be followed and when sampling can commence.

8.1.2 Passive Sampling

Table 7-1 lists the gaseous pollutants to be measured using integrated passive samplers. It also lists a brief description of the reaction occurring in each passive sampler, the analytical method used to measure the reacted product, the sensitivity required, and references for the method discussed. Weather shields have been installed at all sites to protect the passive sampler units.

Table 7.1: Passive Sampling Methods

Pollutant	Reaction & Analysis	Detection Limit
NO_2	Nitrogen (NO_2) is chemiadsorbed onto TEA as nitrite. Nitrite is quantified by visible spectrophotometry. Sampling is selective for gaseous molecules. Any airborne nitrite will not cross the diffusive membrane.	± 2 ppb for 14 day mean

The radiello passive samplers will be exposed for 14 day periods for the three months prior to site works commencing at each of the four monitoring sites. For AMDAL requirements the monitoring will be for one 24 hour period per month.

9. Noise

9.1 Methodology

Construction and operational activities have the potential to adversely impact on the noise environment therefore baseline monitoring should be undertaken by the subconsultant at a selection of noise sensitive sites affected by the activities. These locations must be situated away from existing noise sources such as roads or industry and be representative of the ambient noise environment. Samples will be collected in accordance with the requirements specified in the WBG EHS General ..

Long-term measured background noise levels over a minimum period of 48 hours of good weather should be undertaken to provide information on the background noise environment in the absence of industrial or extraneous noise sources. The subconsultant in their Baseline Noise Report should comment on any current activities near the pipeline sites that may cause a background level of noise and ground vibration (e.g. other industry, railway, major roads, etc.).

The daily variation of background noise levels recorded every 15 minutes at nearby noise sensitive sites should be recorded and reported as mean daily noise levels in the Baseline Noise Report with particular regard to the different periods of the day and night. The survey conditions, meteorology, location and results for each location for the baseline monitoring should also be recorded and included in the Baseline Noise Report. Noise measurements were performed by integrating sound level meter which have facilities L_{TMS}, namely L_{eq} recorded every 5 seconds for 60 minutes measurement. Measurements were taken during the 24-hour activity (L_{SM}). Each measurement should be able to represent a certain time interval with a set of at least four time measurements during the day and three at night time measurements, such as the following example:

- L_1 measured at 07:00 to 08:00 to represent at 06:00 to 9:00
- L2 measured at 10:00 to 11:00 to represent at 09:00 to 11:00
- L3 measured at 15:00 to 16:00 to represent at 14:00 to 17:00
- L4 measured at 20:00 to 21:00 to represent at 17:00. to 22:00
- L5 measured from 23.00 to 24.00 for representing 22.00 to 24.00
- L6 measured at 1:00 to 2:00 for representing 24.00 - 3:00
- L7 measured at 4:00 to 5:00 to represent at 03:00 to 6:00

Where possible, sufficient noise data should be collected to account for variations in seasonal and meteorological conditions. This will provide a baseline for comparison of predicted noise levels as well as information to be used in later studies.

9.2 Sampling locations – Power Plant

The noise sample locations should represent all potentially affected receivers. This will typically be residential properties and excludes unoccupied buildings and should be continuous over at least four days. It should also cover seasonal variations (however as the location is equatorial, this may not be relevant). The sites for noise monitoring are as following (also shown in Appendix B):

1) Rural property to the north (affected by existing PS noise)

2) Rural property to the south (unaffected by existing PS noise)

3) Outskirts of Penkanbaru to the west

4) Outskirts of Penkanbaru to the south

9.3 Sampling locations – Gas Pipeline Route

Noise monitoring along the gas pipeline should be representative of the main noise environments along the route. This monitoring can be a single 15 minute period at each location, however if night works are proposed, monitoring should also be done at night. The sites for noise monitoring are as following (also shown in Appendix D):

1) Outskirts of Penkanbaru close to the proposed pipeline route

2) Rural environment

3) River crossing

4) Outskirts of Jln Koperasi

5) Close to main road (Ji Raya Minas Perawang)

9.4 Reporting

A short Baseline Noise Report will be prepared setting out the above data and provided to PT JGI along with the raw noise monitoring data to enable a noise impact assessment to be prepared. The subconsultant will provide technical details (specification) of the proposed sound level meter to be used, so that PT. JGI can check that it will produce the data required.

10. Social and Economic

10.1 General

The subconsultant will collect data on the current farming activities in the vicinity of the power plant site, TL and gas pipeline route. This includes:

- A breakdown of the crops being grown, number of hectares covered and the annual tonnages harvested and the number of local people who farm or are supported by these fields.
- Demographic data on the number of people involved in the farming activities, where they reside, and age profile.

The subconsultant is required to collect information on:

- Historical settlement of the area and traditional activities;
- Known archaeological sites within two kilometre radius of the gas supply pipeline;
- Traditional and present-day social and tribal structures in the proposed sites;
- Identify and describe of sites of cultural and heritage importance within two kilometre radius of the power plant site, TL and gas pipeline route;
- Determine the values(importance) placed on these sites in terms of local, regional and national significance;
- Identify and record existing activities of cultural and heritage value within two kilometre radius of the power plant site, TL and gas pipeline route;
- Identify potential effects of the proposed power plant site, TL and gas pipeline route on the cultural and heritage sites and values;

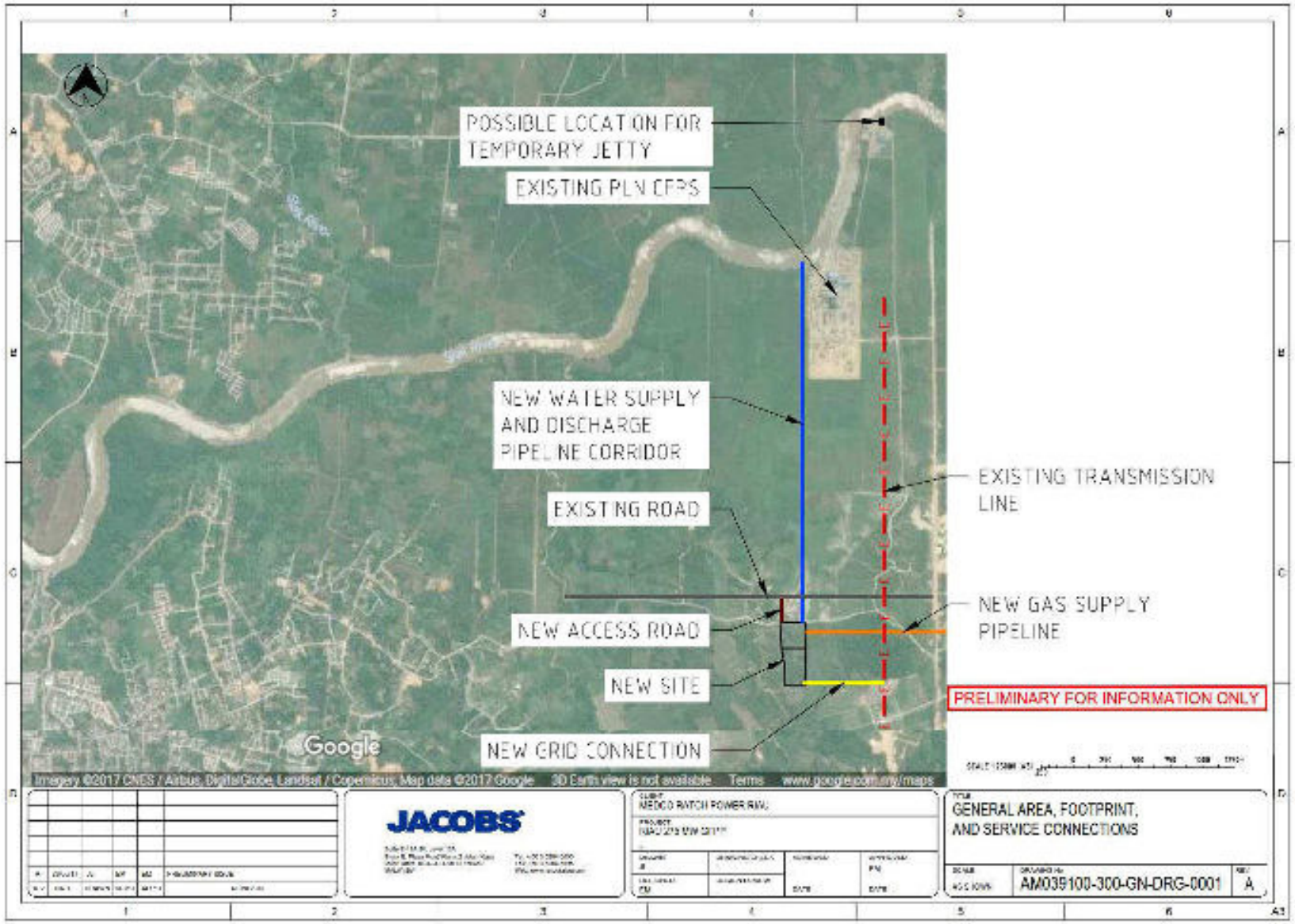
- The views of the key local, regional and national groups, as relevant on the heritage and cultural sites near the site; and
- Provide a report that sets out the methodology used to collect the baseline data and the data collect in respect to cultural activities and heritage sites in the surrounding area.

10.2 Public Health

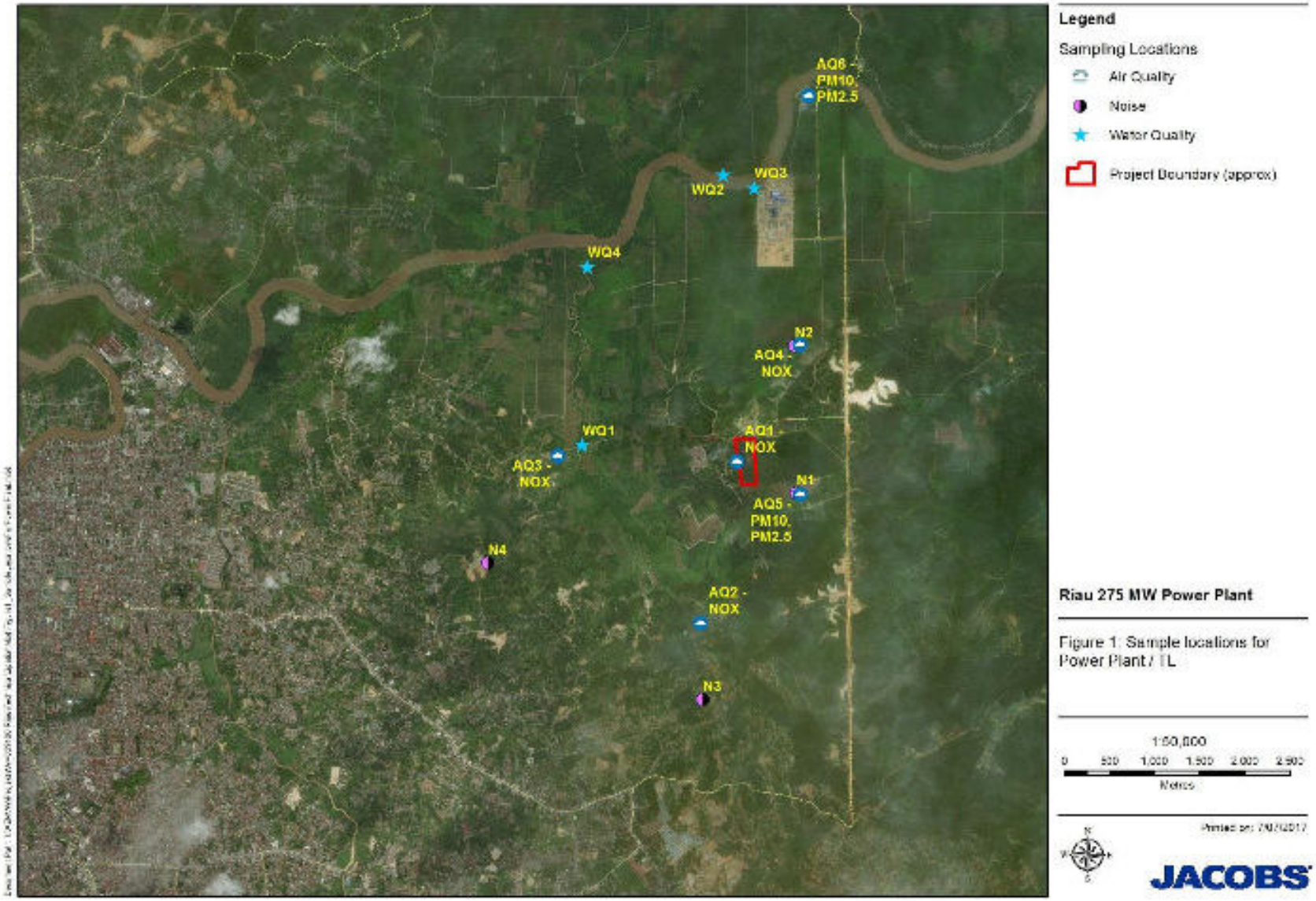
The subconsultant is required to collect information on:

- Historical information of public health in the vicinity of the power plant site, TL and gas pipeline route, to include:
  - Identify and describe of type of public disease on the area;
  - Determine the values (dominance) of the disease on the area;
  - Identify public health facilities to include availability of health worker on the area;
  - Identify potential effects of the proposed transmission line on community public health; and
  - Provide a report that sets out the methodology used to collect the baseline data and the data collect in respect to public health in the surrounding area.

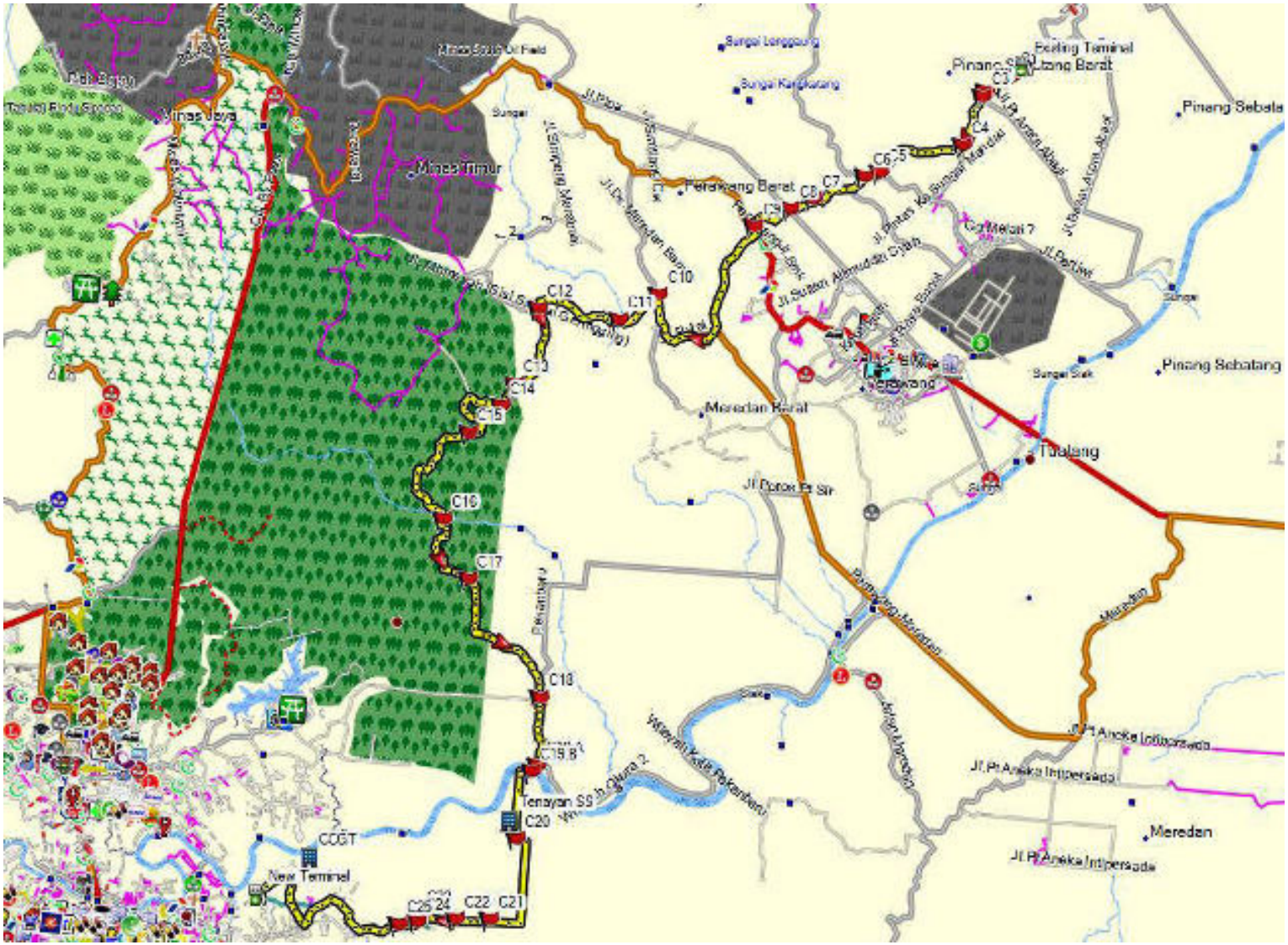
Appendix 1 Proposed Location of Power Plant and Transmission Line



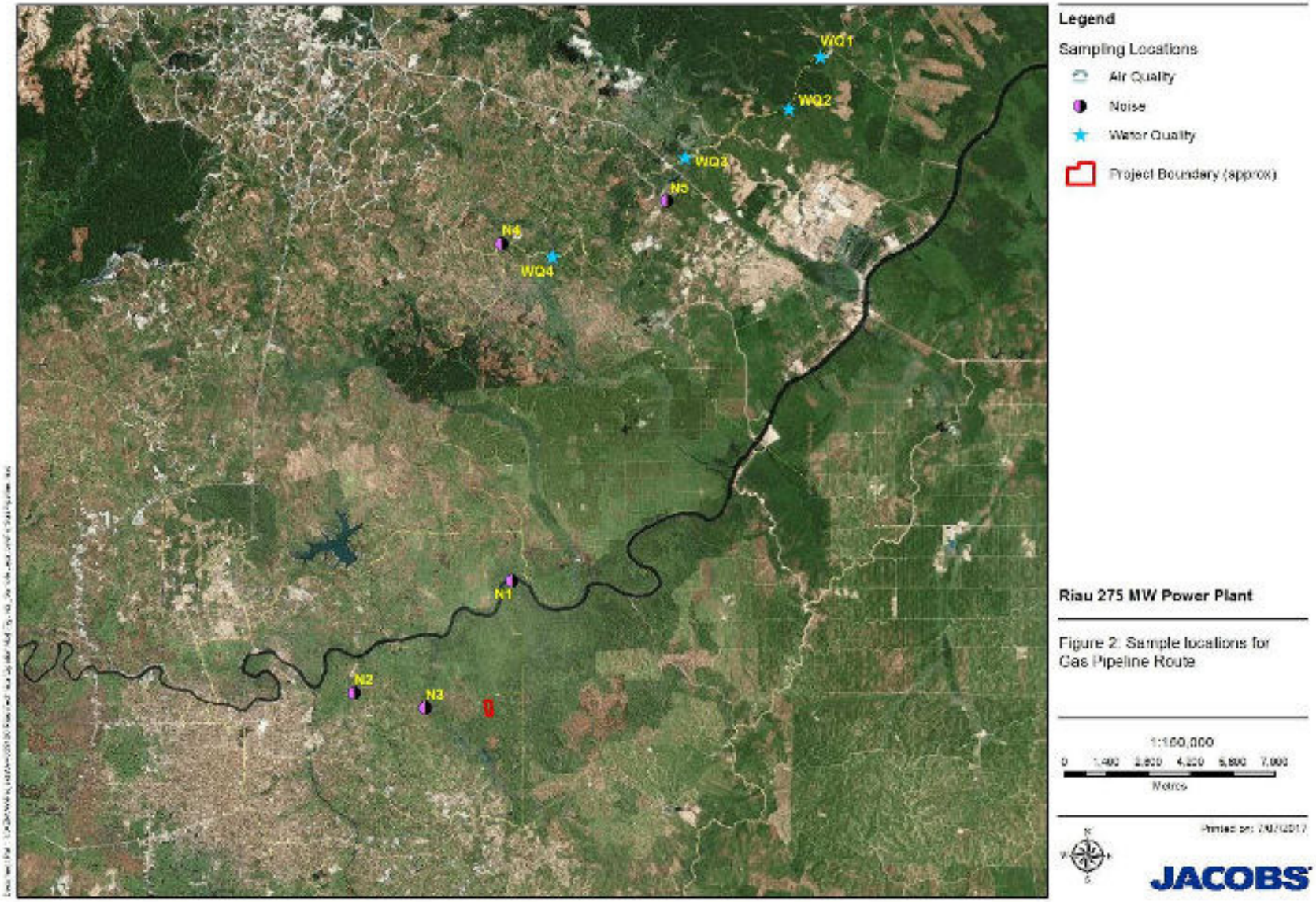
Appendix 2 Proposed Sampling Locations – Power Plant



Appendix 3 Proposed Location of Gas Pipeline Route



Appendix 4 Proposed Sampling Locations – Gas Pipeline



Appendix D. ESIA Baseline Survey Terms of Reference (Wet)

JACOBS

Memorandum

Level 6, 30 Flinders Street
Adelaide SA 5000 Australia
T +61 8 8113 5400
F +61 8 8113 5440
www.jacobs.com

Subject	Baseline Environmental Data Collection Terms of Reference (ToR) – Wet Season and Gas Pipeline	**Project Name**	Riau 275 MW GFPP Project (Medco Ratch Power Riau)
Attention	NBC, Medco Ratch Power Riau	**Project No.**	IZ095300
From	Jacobs		
Date	22.12.17		

1. Introduction

Dry season sampling for the power plant site has been completed and there is now a new gas pipeline route. This Baseline Environmental Data Collection Terms of Reference (ToR) has been developed by Jacobs New Zealand (Jacobs) to collect further baseline data to quantify the receiving environmental and social baseline status over the wet season for both the power plant site (including 750 m of transmission line) and the new gas pipeline route. This sampling is required for the ESIA, and is in addition to the baseline sampling required under Indonesian legislation for the power plant AMDAL and the UKL/UPLs for the gas pipeline and transmission line.

The project consists of a 275 MW combined cycle power plant and ancillary facilities, a 40 km long 12-inch gas pipeline, and a switchyard and 150 kV transmission line (750 m) - collectively referred to hereafter as the 'Project'.

This ToR should be read in conjunction with the Riau Environmental and Social Impact Assessment (ESIA) – Scoping Report, which provides details on the known existing environmental and social site conditions and explains the approach taken to ESIA.

2. Baseline Sampling

2.1 Introduction

This ToR sets out the baseline survey environmental data that is required to be collected by NBC (hereafter referred to as 'the subconsultant'). It describes:

- The type of data to be collected by the baseline sampling surveys;
- The sampling locations, number of samples, sampling methodology to be followed and frequency of sampling;
- Analysis methods for ecological samples collected;
- Parameters that samples should be analysed for (water, sediment, soil and groundwater samples); and
- Reporting formats for the data collected.

2.2 Requirements of the Subconsultant

The subconsultant is required to report on the progress of the baseline data collection surveys to Jacobs. The subconsultant shall provide informal weekly progress reporting (email) to Jacobs and monthly face to face meetings with Jacobs Project Manager during the baseline data collection phase. For all surveys the raw data that underpins the statistical analysis

undertaken as part of the survey should be provided. To align with the ESIA schedule, the baseline surveys need to commence in mid-January 2018 and be conducted over a maximum four-week period with all results and analysis provided to Jacobs by end of February 2018.

Any issues encountered by the subconsultant that prevent the subconsultant undertaking the baseline survey by the method specified in this ToR or where data is not available or cannot be obtained must be advised to Jacobs as soon as the issue comes to the notice of the subconsultant. Jacobs will then in discussions with the subconsultant and the Project Sponsors determine whether the data is required or an alternative survey method or modification to the proposed survey can be used.

It is assumed that the sampling and monitoring methodologies to be followed by the subconsultant is the same as the previously agreed for the dry season sampling. Any change in methodology should be agreed with Jacobs before sampling commences.

3. Freshwater Ecology and Water Quality

The subconsultant shall conduct a baseline survey to characterise regional freshwater communities and ecology of the Siak River and three other watercourses the gas pipeline route will cross.

The survey will include:

- Fish;
- Macroinvertebrates;
- Algae and macrophytes;
- Freshwater habitats; and
- Water quality.

3.1 Water Quality Samples

3.1.1 Methodology

Water quality sampling will be undertaken at the following locations (also shown in Appendix 1 and Appendix 2):

- WQ2 (Siak River);
- WQ3 (Siak River);
- WQ5 – Proposed jetty location (Siak River – new location);
- RW1 (gas pipeline route);
- RW2 (gas pipeline route); and
- RW3 (gas pipeline route).

Samples will be collected and stored in accordance with the requirements specified in Government Regulation No. 82 Year 2001 regarding Water Quality Management and Pollution Control Class II (as minimum, unless otherwise regulated by local government regulation) and ISO 5667.6:2004 Water quality – Sampling Part: 6 Guidance on sampling of rivers and streams or its equivalent. The sampling will be conducted to determine the physical, chemical and biological parameters of the rivers prior to the power plant development. The parameters that the samples are to be analysed for are set in Table 3.1 below.

For metals the samples jars will be acid preserved. One set of metal samples will be for total metal and the water sample will be placed in the sample container without filtration. Another set of samples collected will be for soluble metals at the same sampling location and the sample will be filtered to remove suspended solids in the field prior to it being placed in the container containing acid preservative. Laboratory analysis of water samples should be carried out in accordance with APHA method.

Organic parameters must be collected in glass jars and that only the first set of samples from each sampling location needs to be analysed for the organic parameters being organochlorine pesticides, Dioxins, Furans, other toxics such as PAH (Polycyclic Aromatic Hydrocarbons), and Polychlorinated Biphenyls (PCB). This would be for the first set of samples collected.

Table 3.1: Analysis Parameters for Water Samples

Parameter		Siak River	Spot sampling on watercourses crossed by proposed gas pipeline
pH		✓	✓
Total Suspended Solids		✓	✓
BOD		✓	✓
COD		✓	✓
Oil and Grease		✓	✓
Arsenic		✓	✓
Boron		✓	✓
Cadmium		✓	✓
Chromium	Hexavalent	✓	✓
	Total	✓	✓
Copper		✓	✓
Iron		✓	✓
Lead		✓	✓
Mercury		✓	✓
Manganese		✓	✓
Nickel		✓	✓
Zinc		✓	✓
Soluble Heavy Metals (filtered) as per bulleted list above		✓	✓
Ammonia		✓	✓
Fluoride		✓	✓

Total nitrogen	✓	✓
Nitrate	✓	✓
Nitrite	✓	✓
Phosphorus	✓	✓
Total Coliform Bacteria	✓	✓
Organochlorine pesticides	✓	×
Polychlorinated Biphenyls (PCB)	✓	×
Temperature	✓	✓
Conductivity	✓	✓
Turbidity (NTU)	✓	✓

3.1.2

Sampling Frequency and Field Data

Measurements of pH, temperature, dissolved oxygen and conductivity should be recorded in the field at the time the samples are collected. The date and time that the samples were collected and the weather conditions at the time of sampling and for the previous 24 hours should also be noted.

3.2 Freshwater Ecological Sampling

Freshwater ecological sampling will be undertaken at the following locations (also shown in Appendix 1 and Appendix 2):

- WQ2 (Siak River);
- WQ3 (Siak River);
- WQ5 – Proposed jetty location (Siak River – new location);
- RW1 (gas pipeline route);
- RW2 (gas pipeline route); and
- RW3 (gas pipeline route).

3.2.1 Macro-invertebrate Sampling

Macro-invertebrate samples will be collected by grab or box corer methods. A total of three samples will collected following a transect across the watercourses.

The benthic fauna will be treated in a standard manner - sieved through 1 mm mesh size, identified to species level and enumerated, weighed and subjected to ABC analyses. Abundance, species diversity and distribution frequency will be determined for each sampling location. The sampling should not be carried out within two weeks of a storm event as this has the potential to flush organisms out of their ecosystems and thereby potentially reducing the number of organisms present.

The sampling should be conducted by a recognised laboratory or university with the facilities to store and count the species. Sampling should be conducted following the guidance provided in the ANZECC Water Quality Guidelines for Fresh and Marine Waters, 2000.

3.2.2 Sediment Sampling

Sediment samples will be taken using a grab or box corer method at the following locations:

- WQ5 – proposed jetty location;
- RW1; and
- RW2.

The samples will be sent to the laboratory to determine the chemical contaminants present in the sediments based on parameters identified in Table 3.1.

3.2.3 Net Fishing

If appropriate, net fishing will be conducted at the upstream and downstream sampling locations identified for both the Siak River and other watercourses to determine the abundance and diversity of fish species in the rivers prior to the power plant development. Any protected species identified in the survey will need to be clearly identified so that the impact of effluent discharged to rivers from the power plant development can be assessed. The sampling should be conducted by a recognised laboratory or university with experience in conducting similar surveys.

3.3 Reporting

Reports on the baseline data collected by these studies will be prepared by the subconsultant and submitted to Jacobs within one month of the data collection being undertaken.

4. Terrestrial Ecology

The baseline survey will assist in determining the baseline for terrestrial ecosystems and the representative flora and fauna in each of the habitats at the power plant/TL site (to include the proposed jetty, the water intake and water pipeline areas) and the gas pipeline route. Sampling of the power plant during the wet season should be collected from the same locations at the power plant site that were conducted during the dry season but should include the new transmission route. Sampling of the gas pipeline should be along the new route as show in Appendix 1. Date and time that the samples were collected and the weather conditions at the time of sampling and for the previous 24 hours should be noted.

4.1.1 Site Survey Preparation – All Sites

The task includes review of background information on the locality, field work to survey habitats and species, and reporting of methodologies, results and conclusions. Specific tasks include:

1) Describing and mapping the various terrestrial habitats on the sites. This is to include the fish ponds if any.

2) Within each habitat, use internationally accepted, standard sampling techniques to identify:
    - Habitat type (wetland / agriculture / forest; intact / degraded / modified; man-made; significance of biodiversity – local, national, international). Include information on hydrology, soils or other habitat characteristics that are relevant;
    - Species - including introduced, indigenous, noxious pest or weed, economic value, significance – local, national, international. The significance of species shall be noted in the report; and

- Note the ecological uses of the site for significant faunal species (i.e. feeding, nesting, migrating).

3) Sampling techniques shall be adequate to provide a detailed list of species, abundance, and habitats condition using primarily visual and aural methods. Trapping, handling, specimen collection of species is not expected as part of this study (except for the fish survey, as discussed above).

4) Type of survey will include:
   a) Vegetation / flora;
   b) Avifauna (birds);
   c) Herpetofauna (amphibians and reptiles);
   d) Mammals

4.1.2 Survey methodologies for Power Plant and Transmission Line

Vegetation / flora

The surveys will comprise walked transects through habitat-types to provide detailed information on vegetation boundaries, floristic diversity and the possible presence of rare and threatened plants.

Walked transect surveys shall aim to record all plant species within the vicinity of the Project. Particular attention shall be paid to the dominant, rare, endemic, threatened, protected, invasive species, and the species that are of importance to local communities. Locations of rare or threatened plant species shall be identified using a GPS and data on the size and distribution of the population shall be recorded.

The following general data shall be along each route:

- location using handheld GPS to record coordinates;
- photographs showing habitat structure and any notable plant species; and
- habitat types and structure.

Additional habitat conditions data shall be recorded per transect, including the level of modification or disturbance of habitat found per transect and this shall be assessed according to the following grading:

- relatively stable or undisturbed communities (e.g. old growth, unlogged forest);
- late successional or lightly disturbance communities (e.g. old growth mangrove swamp that was selectively logged in recent years);
- mid-successional or moderately to heavily disturbed communities (e.g. young to mature secondary forest); and
- early successional or severely disturbed communities.

Avifauna

The survey shall focus on sampling bird species' richness and abundance located within the range of different habitat strata present. Line transects surveys will be used with a point count method.

Transect surveys and point count surveys involving a 20 minute time-based survey and each transect/point to record all birds seen or heard within a 50 m radius of the census point. Bird surveys shall be conducted within four hours of sunrise to sample peak activity time and surveys shall avoid adverse weather (e.g. high wind or rain). Geographic coordinates shall be recorded at each survey point

Observations on birds shall be done primarily through visual observation and call identification. Nests and important food source/trees for any protected and rare species shall be recorded and captured with GPS.

Herpetofauna

The type and number of reptile and amphibian species shall be recorded during the walked transect surveys. Areas of high concentrations of individuals shall be captured with GPS. Study area and observations of significance shall be photographed.

Mammals

The type and number of mammal species shall be recorded during the walked transect surveys. Visual identification of animals, refuges, scat or other signs is expected. It is not deemed necessary to use camera traps in this study.

4.1.3 Survey Methodology for Gas Pipeline Route

An ecological specialist from Jacobs and the subconsultant will conduct an initial screening survey of the gas pipeline route. The screening survey will identify habitats and areas of vegetation along the route that the subconsultant will focus further detailed terrestrial ecology surveys in accordance with the methodologies outlined in Section 4.1.2 above. These areas may include scrub and fringes of regrow and secondary forest, where observational sampling is required which covers dawn and dusk periods. This should be repeated every five km on paved road and every one km on plantation roads. Where the pipeline goes through palm oil plantations transects/quadrats will be run perpendicular to the pipeline.

4.1.4 Reporting

Reports delivered by subconsultants shall include the follows:

- Sampling methodology including limitations to methodology (weather, season, timeframe, sampling biases, etc.). Cite references for standard sampling methodologies;
- Results, including species lists and abundance (including indigenous and introduced), observations of refuges / nests etc., significant habitats or species (rare, threatened, noxious etc.), ecosystem uses for key species (nesting, migrating, foraging etc.); and
- Conclusions on the significant issues or factors that should be addressed in the environmental impact assessment study, including recommendations for further study work if required.

5. Soils

The subconsultant will undertake soil sampling at four locations along the gas pipeline route, to be identified by the subconsultant and agreed with Jacobs. The locations samples should be adjacent to the road and not within plantation areas. The soil sampling will comprise the following:

- Using a hand auger, a soil sample will be taken and tested for parameters outlined in Table 5.1 below.

Table 5.1: Analysis Parameters for Soil Samples

Parameter
Arsenic
Boron
Cadmium
Chromium
Copper
Iron
Lead
Mercury
Manganese
Nickel
Zinc
Organochlorine pesticides
PAH
PCB

6. Groundwater Resources

6.1 Power Plant

6.1.1 Collect and Review Background Information

Use background information obtained by the subconsultant from dry season sampling on the existing groundwater use and hydrogeological characteristics of the power plant site. Data required to be obtained as part of this assessment includes:

- Undertake a water sampling programme of the bores/wells previously sampled from dry season sampling to determine baseline water quality of the groundwater system surrounding the project site during the wet season. A total of three water samples are to be collected once the well volume has sufficiently purged such that field parameters (pH, total dissolved solids, temperature) have stabilised. The samples are to be analysed for the same parameters as set out in Table 3.1, excluding dioxins.

6.1.2 Reporting

The subconsultant shall provide the base datasets identified above to Jacobs in appropriate electronic format to enable data manipulation and integration. These data will be used by Jacobs to develop a preliminary conceptual understanding of the hydrogeology of the area surrounding the site. The results of this work will be used to refine the scope and specific requirements for additional investigations and ongoing base data collection to be undertaken.

6.2 Gas Pipeline

6.2.1 Collect and Review Background Information

Background information needs to be obtained by the subconsultant on the existing groundwater use and hydrogeological characteristics of the gas pipeline route. Data required to be obtained as part of this assessment includes:

- Determine the locations of existing groundwater users in nearby villages that the pipeline route runs through or is 50 – 100 m distance from.
- Determine the location, depth and groundwater levels (both static and pumping levels if available) of existing groundwater /bores and wells within 50 – 100 m of the pipeline route.
- Obtain available geological and construction information for bores/wells within 50 – 100 m of the pipeline route. Bore construction data may include information on bore casing, well screens, and pump installation, such as depth, diameter, material types, screen slot sizes, and pump specifications.
- Arrange and undertake a water sampling programme of bores/wells identified as being within 50 – 100 m of the pipeline route to determine baseline water quality of the groundwater system along the pipeline route. Selection of appropriate sampling sites will be undertaken in discussions with Jacobs based on the results of the above review and will target wells which have information on geology, bore construction and yield. A total of three water samples are to be collected once the well volume has sufficiently purged such that field parameters (pH, total dissolved solids, temperature) have stabilised. The samples are to be analysed for the same parameters as set out in Table 3.1, excluding dioxins**.**

6.2.2 Reporting

The subconsultant shall provide the base datasets identified above to Jacobs in appropriate electronic format to enable data manipulation and integration.

7. Air Quality

7.1 Ambient Air Quality

Air quality monitoring will be undertaken as follows:

- The monitoring sites at the power plant will be the same as those undertaken during the dry season monitoring (as outlined in Appendix 1) including:
  - AQ1 – AQ4: NO_2; and
  - AQ5 and AQ6: PM10 and PM2.5.
- Sampling will be conducted at 3 locations along the pipeline route (AQ1, AQ2 and AQ3) as outlined in Appendix 2.
- The locations must be located in suitable areas that comply with the guidelines set out in Australian Standard AS 2922 Ambient Air – Guide for the Siting of Sampling Units 1987.

7.1.1 PM_{10}/PM2.5Total Suspended Particulate

- PM10 and PM2.5 will be collected at each of the monitoring sites:
  - AQ 5 and 6 – Power Plant and Transmission Line; and
  - AQ1 – AQ3 – Gas pipeline.
- Method IO-2.1 Sampling of Ambient Air for PM10 and PM2.5 Using High Volume (HV) Sampler will be used;
- Sampling will be carried out twice a month for one month at each of the power plant monitoring sites; and
- Sampling will be conducted twice at each of the gas pipeline locations over a two-week period.

7.1.2 Passive Sampling

Table 7.1 lists the gaseous pollutants to be measured using integrated passive samplers. It also lists a brief description of the reaction occurring in each passive sampler, the analytical method used to measure the reacted product, the sensitivity required, and references for the method discussed. Weather shields have been installed at all sites to protect the passive sampler units.

Table 7.1: Passive Sampling Methods

Pollutant	Reaction & Analysis	Detection Limit
NO_2	Nitrogen (NO_2) is chemiadsorbed onto TEA as nitrite. Nitrite is quantified by visible spectrophotometry. Sampling is selective for gaseous molecules. Any airborne nitrite will not cross the diffusive membrane.	± 2 ppb for 14 day mean

The radiello passive samplers will be exposed for 14 day periods at the power plant sampling locations (AQ1 – AQ4).

8. Noise

8.1 Sampling locations – Gas Pipeline Route

Noise monitoring is required along the new gas pipeline route only and will follow the sample methodology as the Dry Season sampling. Noise monitoring along the gas pipeline should be representative of the main noise environments along the route. This monitoring can be a single 15 minute period at each location. Nine noise monitoring sites have been proposed (N01 – N09) as shown in Appendix 2.

8.2 Reporting

A short Baseline Noise Report will be prepared setting out the above data and provided to Jacobs along with the raw noise monitoring data to enable a noise impact assessment to be prepared. The subconsultant will provide technical details (specification) of the proposed sound level meter to be used, so that Jacobs can check that it will produce the data required.

9. Traffic

9.1 Road Traffic Survey

The subconsultant will undertake a road traffic survey along roads in and adjacent to the power plant and along the gas pipeline route. The survey will comprise the following:

- note the existing road infrastructure;
- traffic counts over two days, particularly focus will be given to main road marked as TS in Appendix 1 and 2; and
- photographs to document the current road conditions.

9.2 River Traffic Survey

The subconsultant will undertake a river traffic survey at the proposed temporary jetty location. The river traffic survey will comprise the following:

- An initial desktop study of any existing river traffic data from the river authorities with focus on the stretch of river adjacent to the power plant site; and
- A river traffic count over two days at the proposed jetty location. The survey should note river traffic associated with the existing Tanayan Power Plant, fishing vessels, recreational users and any others identified.

10. Social and Economic

10.1 General

The subconsultant will collect social baseline data at the water intake area on the Siak River and along the gas pipeline route. Social surveys along the gas pipeline route should be door to door and include residents, food stalls, squatters and any other users of the area identified.

The social survey should collect information on the current farming activities in the vicinity of the gas pipeline route. This includes:

- A breakdown of the crops being grown, number of hectares covered and the annual tonnages harvested and the number of local people who farm or are supported by these fields.
- Demographic data on the number of people involved in the farming activities, where they reside, and age profile.

Similar data should be provided for any other non-farming activities identified.

The subconsultant is required to collect information on:

- Potential areas where land acquisition may be required;
- Identify and determine village boundaries;
- Historical settlement of the area and traditional activities;
- Known archaeological sites within two kilometre radius of the gas supply pipeline;
- Traditional and present-day social and tribal structures in the proposed sites;
- Identify and describe of sites of cultural and heritage importance within two km radius of the gas pipeline route;
- Determine the values(importance) placed on these sites in terms of local, regional and national significance;
- Identify and record existing activities of cultural and heritage value within two km radius of the gas pipeline route;
- Identify potential effects of the proposed gas pipeline route on the cultural and heritage sites and values;
- The views of the key local, regional and national groups, as relevant on the heritage and cultural sites near the site; and
- Provide a report that sets out the methodology used to collect the baseline data and the data collect in respect to cultural activities and heritage sites in the surrounding area.

Before the finalisation of the survey forms and the commencement of the survey campaign, the subsconsultant shall meet with Jacobs and MRPR to clarify all details and procedures.

10.2 Public Health

The subconsultant is required to collect information on:

- Historical information of public health in the vicinity of the gas pipeline route, to include:
  - Identify and describe of type of public disease on the area;
  - Determine the values (dominance) of the disease on the area;
  - Identify public health facilities to include availability of health worker on the area;
  - Identify potential effects of the proposed transmission line on community public health; and
  - Provide a report that sets out the methodology used to collect the baseline data and the data collect in respect to public health in the surrounding area.

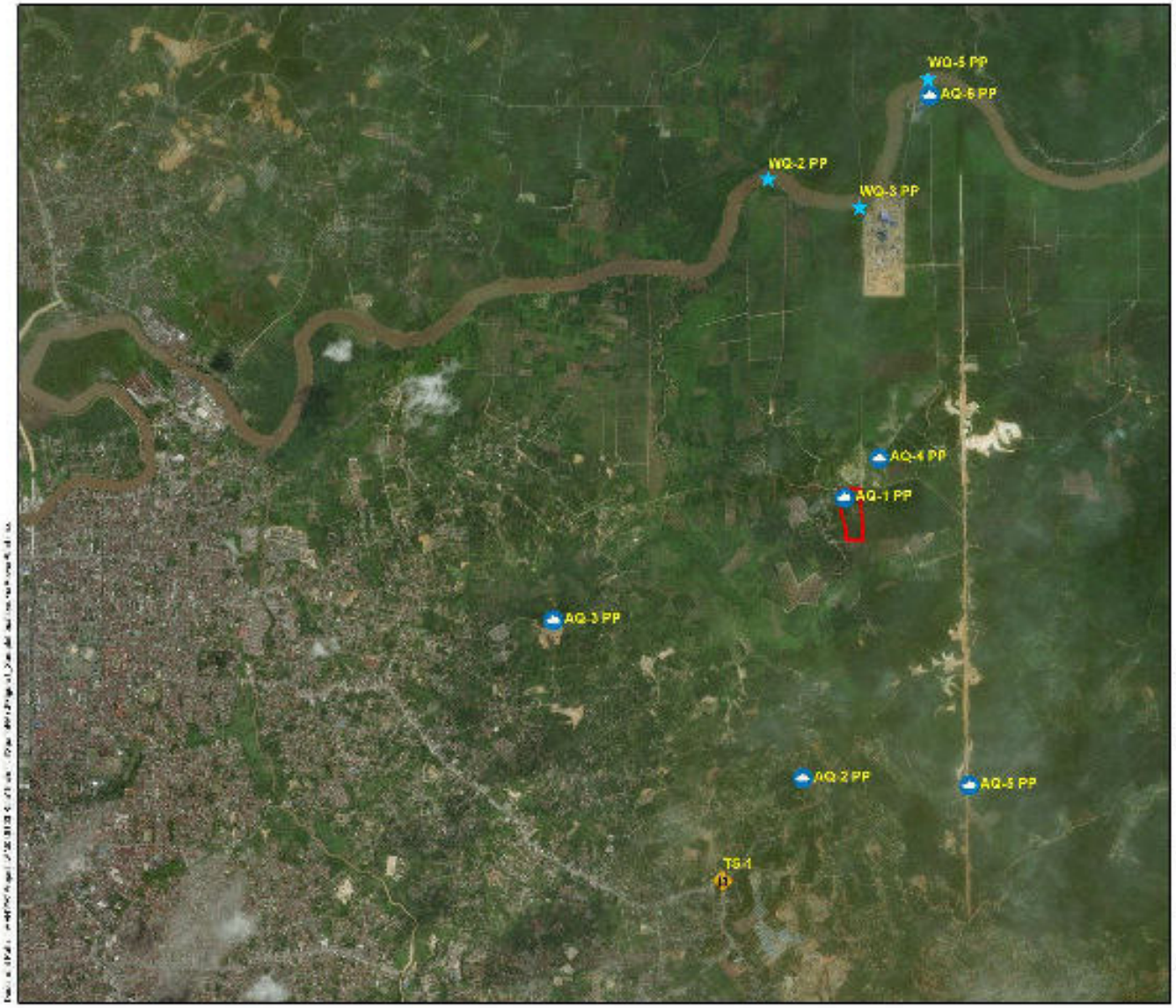
11. Summary of Baseline Surveys

A summary of the baseline surveys required for the wet season sampling is detailed in Table 11.1 below.

Figure 11.1 : Summary of Baseline Surveys

Survey Type		Power Plant / Transmission Line Survey	Gas Pipeline Survey
Water Quality		WQ2, WQ3, WQ5 (proposed jetty location)	RW1, RW2, RW3
Freshwater Ecology		WQ2, WQ3, WQ5 (proposed jetty location)	RW1, RW2, RW3
Sediment Sampling		WQ5	RW1, RW2
Terrestrial Ecology		Same as Dry Season Sampling	To be confirmed from initial screening walkover
Soils		N/A	4 locations to be identified by subconsultant and agreed with Jacobs
Groundwater Resources		Same as Dry Season Sampling	To be identified by subconsultant and agreed with Jacobs
Air Quality	PM10 and PM2.5	AQ4, AQ5	AQ1, AQ2, AQ3
	NO_2	AQ1, AQ2, AQ3, AQ4	N/A
Noise		N/A	N01, N02, N03, N04, N05, N06, N07, N08 and N09
Traffic	Road	Along main road noted in Appendix 1	Along main roads noted in Appendix 2
	River	At proposed jetty location	N/A
Social Economic		At water intake location	Along gas pipeline route

Appendix 1 Proposed Sampling Locations – Power Plant



Legend

SamplingType

- Air Quality
- Water Quality
- Traffic Survey
- Project Boundary (approx)

Riau 275 MW Power Plant

Figure 1: Sample locations for Power Plant / TL

1:50,000

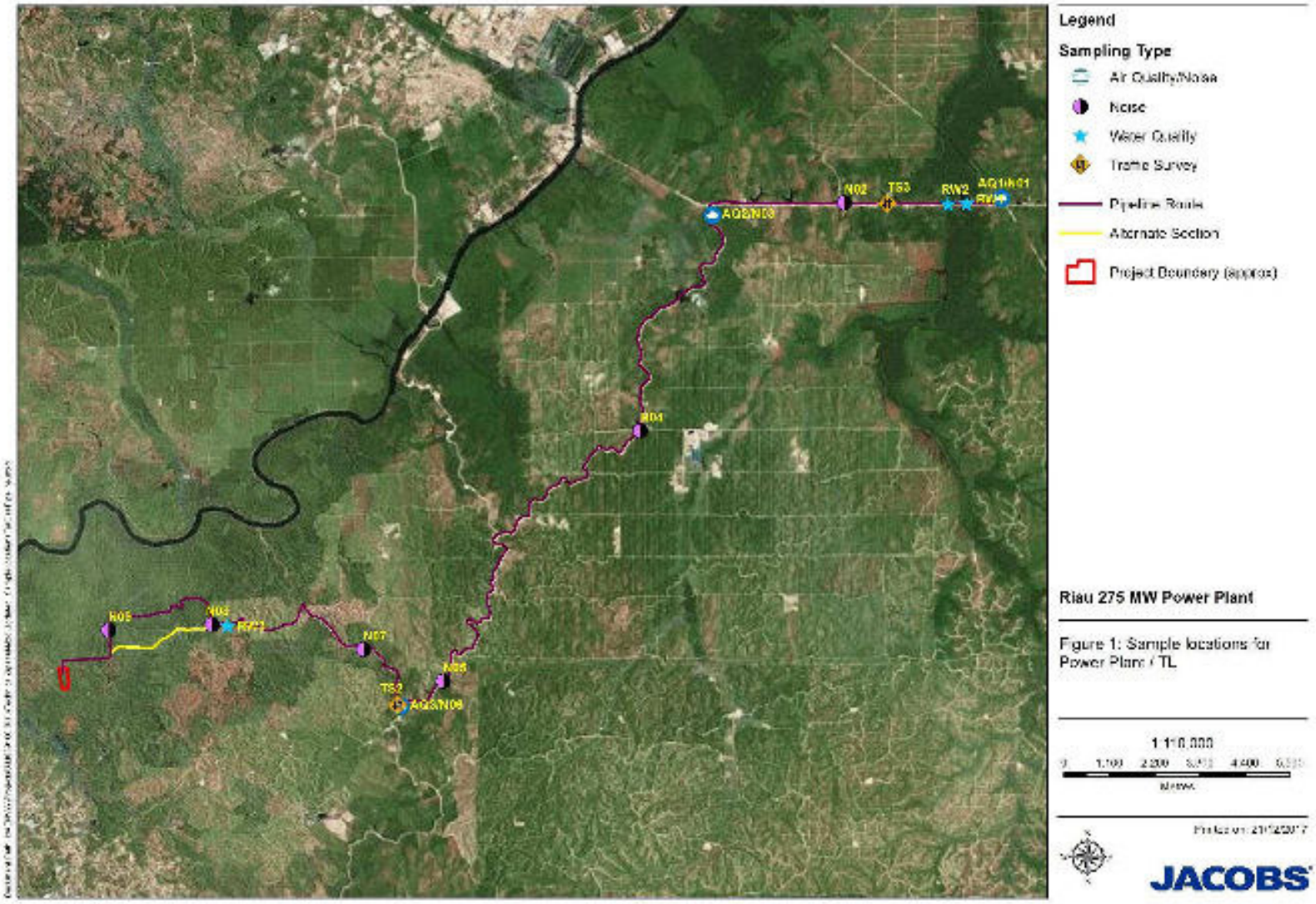
0 500 1,000 1,500 2,000 2,500

Meters

Printed on: 21/12/2017

JACOBS

Appendix 2 Proposed Sampling Locations – Gas Pipeline



Appendix E. Technical Report – Air Quality Impact Assessment

Riau 275 MW Gas Combined Cycle Power Plant IPP - ESIA

Medco Ratch Power Riau

Technical Report - Air Quality Assessment

AM039100-400-GN-RPT-1010 | V2

May 2018

Riau 275 MW Gas Combine Cycle Power Plant IPP - ESIA

Project No:	AM039100
Document Title:	Technical Report - Air Quality Assessment
Document No.:	AM039100-400-GN-RPT-1010
Revision:	V2
Date:	May 2018
Client Name:	Medco Ratch Power Riau
Project Manager:	Eamonn Morrissey
Author:	Chris Bender
File Name:	I:\AENVW\Projects\AM039100 Riau\Deliverables\ESIA\Technical Assessments\Air Quality\AM39100 - Riau ESIA - Air Quality V2_Final Draft for Disclosure.docx

Jacobs New Zealand Limited

Level 3, 86 Customhouse Quay,
PO Box 10-283
Wellington, New Zealand
T +64 4 473 4265
F +64 4 473 3369
www.jacobs.com

Document history and status

Revision	Date	Description	By	Review	Approved
Draft A	February 2018	Draft for internal review	Chris Bender	Bruce Clarke	Bruce Clarke
Draft B	March 2018	Revised draft for internal review	Chris Bender	Bruce Clarke	Bruce Clarke
Draft C	March 2018	Revised draft for internal review	Charlotte Moore	Bruce Clarke	Eamonn Morrissey
V0	April 2018	Draft for MRPR Review	C Moore	Bruce Clarke	E Morrissey
V1	April 2018	Final Draft for Issue	A Kubale	B Clarke	E Morrissey
V2	May 2018	Final Draft for Disclosure	A Kubale	B Clarke	E Morrissey

Distribution of copies

Revision	Issue approved	Date Issued	Issued to	Comments
V0	4 April 2018	5 April 2018	MRPR	Draft for client review
V1	19 April 2018	19 April 2018	MRPR	Final Draft for Issue

V2	18 May 2018	18 May 2018	MRPR	Final Draft for Disclosure

Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs New Zealand Limited (Jacobs) is to describe the air quality impacts for Riau IPP Project Environmental and Social Impact Assessment (ESIA), in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Overview

This Technical Report is part of an Environmental and Social Impact Assessment (ESIA) for the construction and operation of the Riau 275 MW Gas Combined Cycle Power Plant IPP Project (hereafter referred to as 'the Project'). The Project comprises the construction, completion, testing, commissioning, and operation of the Combined Cycle Power Plant (CCPP), associated gas pipeline, transmission lines, water supply lines, and cooling tower.

This document is a technical assessment of the potential impacts of the Project on the air quality in the vicinity of the project.

1.2 Project Description

The Riau 275 MW CCPP will be a new power station constructed on a greenfield site.

The key components of the Project include a 275 megawatt (MW) combined cycle power plant (CCPP), a 40 km long gas supply pipeline which will bring fuel to the site, a 150 kilovolt (kV) switchyard, and an approximately 750 m long transmission line to connect the power plant to the PT Perusahaan Listrik Negara (Persero) ("PLN") grid. Once constructed, ownership of the switchyard and transmission line collectively known as the Special Facilities will be transferred to PLN. At the end of the 20-year term of the Power Purchase Agreement (PPA), PLN will take ownership of the power plant and gas supply pipeline.

The Project will be located approximately 10 km due east of Pekanbaru City, approximately 3 km south of the Siak River. The power plant and switchyard will be comfortably accommodated inside the 9 ha of land being procured by the Project Sponsors. The power plant is a 2 x 1 combined cycle plant, designed to deliver up to 275 MW over the 20-year term of the PPA. It will burn natural gas fuel only. It will consist of:

- 2 x GE 6F.03 gas turbine (GT) generator sets;
- 2 x supplementary fired heat recovery steam generators (HRSGs);
- 1 x steam turbine (ST) generator set;
- A wet mechanical draft cooling tower;
- Gas reception area; and
- All normal balance of plant systems.

In addition, there will be:

- A 150 kV switchyard at the plant, with an approximately 750 m double-phi connection to intercept the Tenayan – Pasir Putih 150 kV transmission line;
- A 40 km gas pipeline running from the gas connection point at an offtake location known as SV1401 on the main Grissik to Duri gas pipeline which is located north-east of the power plant in the Siak Regency;
- Temporary jetty constructed on southern bank of Siak River; and
- Water supply and discharge pipelines to and from the Siak River.

The CCPP will have an emergency black start facility, comprising 4 x 1.2 MWe containerised diesel generator sets. This facility is to supply power to the power plant in the unlikely event of a station blackout due to a national grid failure.

An outline of the Project area is detailed in Figure 1.1.

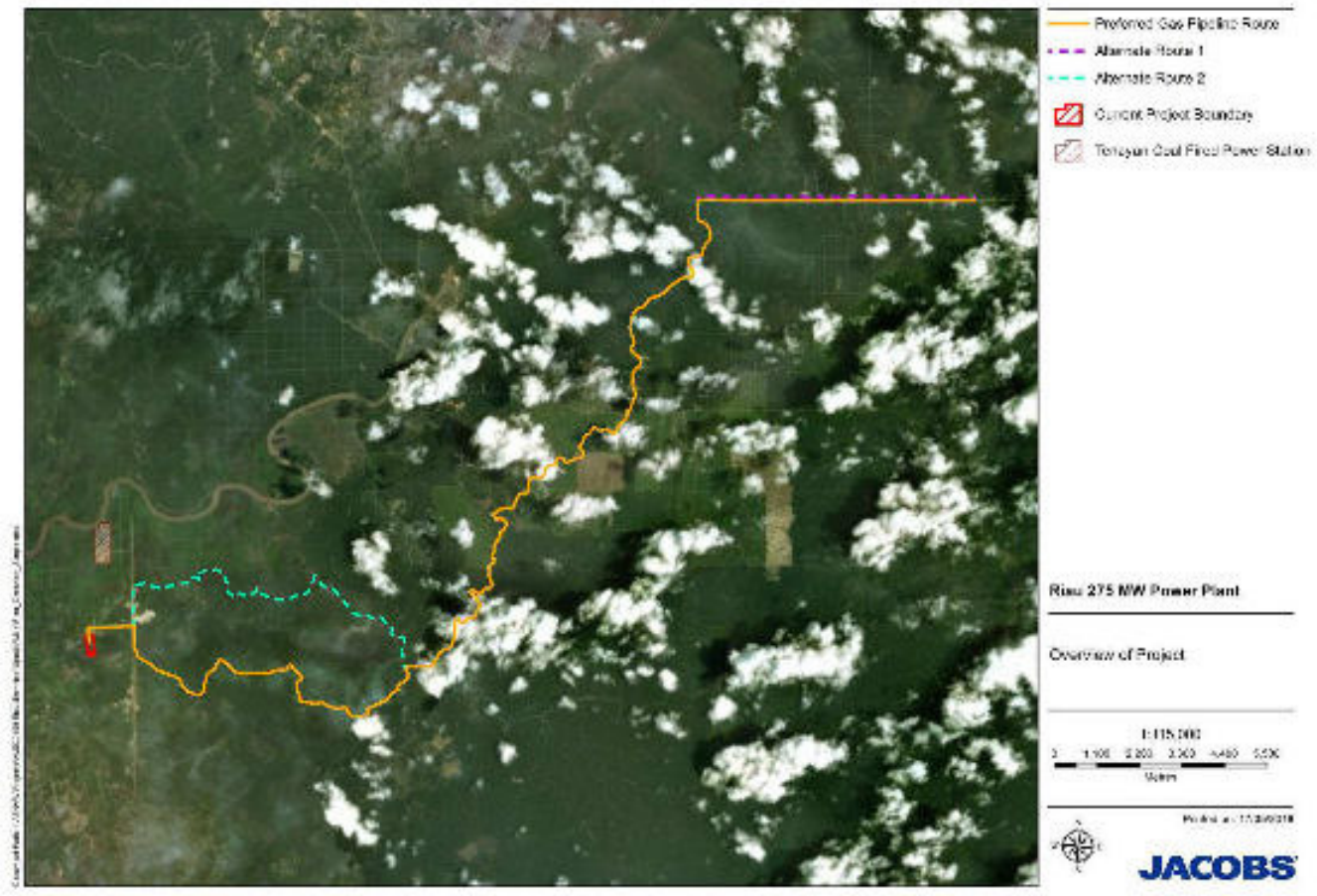


Figure 1.1 : Outline of the Project Area

1.3 Purpose

This report assesses the potential impacts associated with the construction and operation of the Project on air quality, and provides an assessment of potential air quality impacts at nearby residential locations, including:

- Release of air contaminants from the combustion of natural gas, including nitrogen oxides (NO_X), fine particulate matter (PM_{10}), carbon monoxide (CO) and sulphur dioxide (SO_2).
- Dust from construction activities (power plant, gas pipeline and water pipelines).

The report is one of several technical reports prepared as a supporting documentation for the ESIA for the Project.

2. Baseline Air Quality

2.1 Site Description

2.1.1 Terrain and Land Use

The Project area is located in the Sail Sub District, Tenayan Raya District, Pekanbaru City, and Province of Riau. The power plant site is in slightly undulating terrain. The predominant land use in the surrounding area is agricultural, consisting principally of palm oil plantations.

The nearest sensitive receptors to the Project power plant site are residences located approximately 500 m to the south and south-west of the Project site boundary, as indicated in Figure 2.1. These are among other scattered rural residences, though it is understood that these are infrequently inhabited and are predominantly for sheltering agricultural workers. The main residential areas of Pekanbaru are located 10 km to the west of the power plant site and there are rural villages along the pipeline route.

Tenayan CFPP is an existing coal fired power plant located approximately 2 km to the north of the power plant Project area. At the time of writing this report, a new government administration area is also being constructed to the south-west of the Project site.

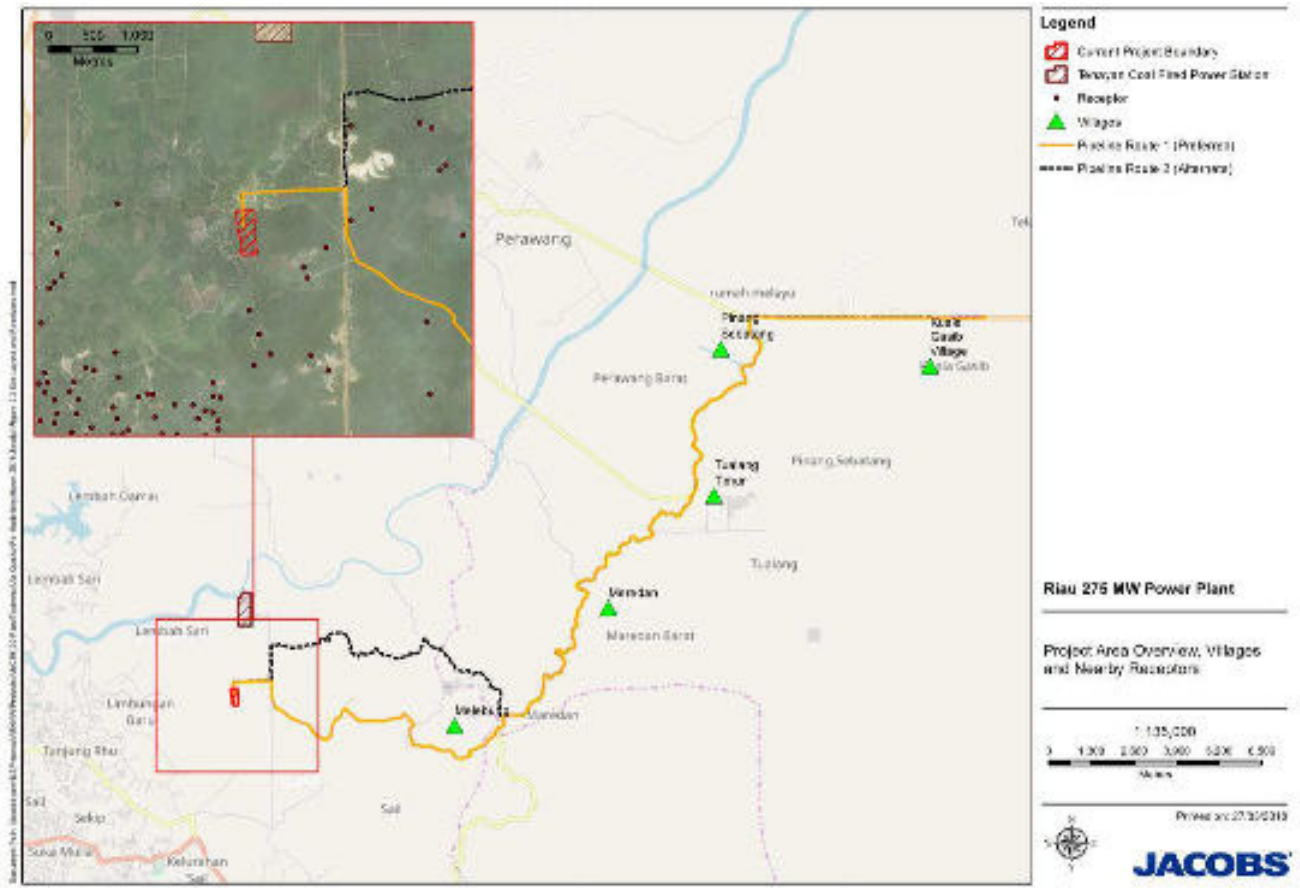


Figure 2.1 : Villages and Receptors surrounding the Project area

2.1.2 Climate and Meteorology

Pekanbaru has a tropical climate, with the area being characterised by seasonally high rainfall and high humidity. Average annual rainfall is around 3,000 mm, and falls mainly between November and April, with a drier period between June and September. Air temperature ranges between 20ºC and 37ºC and humidity ranges between 40 and 100%.

Wind is generally light, but the area is subject to monsoon weather with high winds during the wet months. The predominant wind direction varies throughout the year, with southerly winds occurring primarily during the dry season and northerly winds during the rainy season. The average wind speed is less than 3 m/s. The design and general site climate conditions are provided in Table 2.1.

Table 2.1 : General site ambient climate conditions

Parameter	Value
Ambient air temperature range	20°C-37°C
Design ambient air temperature	28°C
Relative humidity range	40%-100%
Design Relative humidity	80%
River water temperature	Approximately 30°C
Average annual rainfall	Approximately 3,000 mm - rainy season between November and April
Maximum rainfall	Approximately 136 mm/h
Average wind speed	Less than 3 m/s, predominantly from the north or west
Site elevation	Approximately 25 mAMSL

The wind rose shown in Figure 2.2 has been generated from data collected at an ambient air monitoring site in Pekanbaru for 2010 to 2015. The data shows the area is affected by winds predominantly from the north-western and north-eastern sectors, and from the south-southeast. Calm conditions, which are a wind speed of less than 0.5m/s, are predicted to occur for 26.8% of the time and the average wind speed for the data period is 0.54 m/s. A photograph of the monitoring station, provided as Figure 2.6, indicates that the site is in close vicinity to one or more tall buildings which may influence the winds measured at the site. Given the very low wind speeds observed, the wind data is considered to not be representative of meteorological conditions in the wider area.

Meteorological data suitable for running air dispersion models should be measured at a height of 10 m above the ground and away from features that would interfere with the wind speed and direction. For the purpose of this assessment, which includes dispersion modelling of the Project's air discharges, the prognostic meteorological model TAPM has been used to generate a meteorological dataset for the area. This is discussed further in Section 3 of this Technical Report.

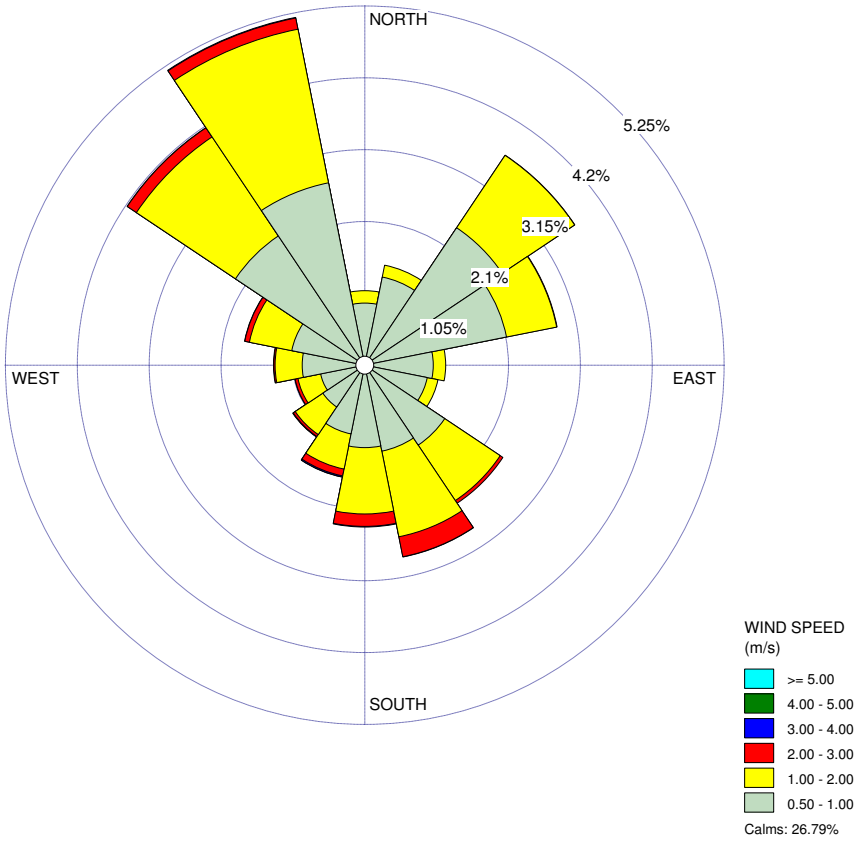


Figure 2.2 : Windrose of Data Collected at Pekanbaru (Years 2010 to 2015)

2.2 Baseline Ambient Air Quality

Energy production, industrial and household discharges from fuel combustion, and vehicular traffic are the primary anthropogenic contributors to air pollution in the Project area. The main pollutants identified of interest are particulate matter (as Total Suspended Particulate (TSP), PM_{10} and $PM_{2.5}$), CO, NO_2, and SO_2.

The Project area primarily consists of palm oil plantations for several kilometres in all directions, with limited residential land use. The main population centre in the area is Pekanbaru City, the nearest residential areas to the power plant site are located more than 3 km to the west of the plant site. The main source of industrial pollution in the local area is the Tenayan CFPP located 2 km to the north of the site.

The scale of residential and industrial activity in the Project area is relatively low, and consequently ambient air quality is expected to be relatively good.

2.2.1 Ambient Air Monitoring Data

Ambient monitoring data has been collected from a variety of sources to assess the existing baseline ambient air quality of the Project area.

Baseline Monitoring for the Project Area (Power Plant)

Baseline ambient monitoring data has been collected in association with the Project at six monitoring sites near the Project area. Two rounds of sampling have been undertaken, one during July 2017 for the dry season, and

one during January-February 2018 for the wet season. A map showing the sampling locations is provided in Figure 2.3. The parameters monitored and sampling times conducted at the four sites included:

- Total suspended particulate using high volume sampler (24-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.3-2005;
- PM_{10} using low volume sampler fitted with a PM_{10} sampling head (24-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.15 (2016);
- $PM_{2.5}$ using low volume sampler fitted with a PM_{10} sampling head (24-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.14 (2016);
- Nitrogen dioxide (NO_2) by active sampling (1-hour sampling period) in accordance with Indonesian Standard Method SNI 19-7119.2-2005, and passive sampling (14-day sampling period per monitoring event) in accordance with NIOSH Standard 6700 (1998);
- Sulphur dioxide (SO_2) by active sampling (1-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.7-2005;
- Ozone (O_3) by active sampling (1-hour sampling period per monitoring event) in accordance with Indonesian Standard Method SNI 19-7119.8-2005;
- Total non-methane hydrocarbons (TNMHC) by active sampling (30-minute sampling period) in accordance with Indonesian Standard Method SNI 19-7119.13-2005; and
- Lead (Pb) by active sampling (1-hour average) in accordance with Indonesian Standard Method SNI 19-7119.4-2005.

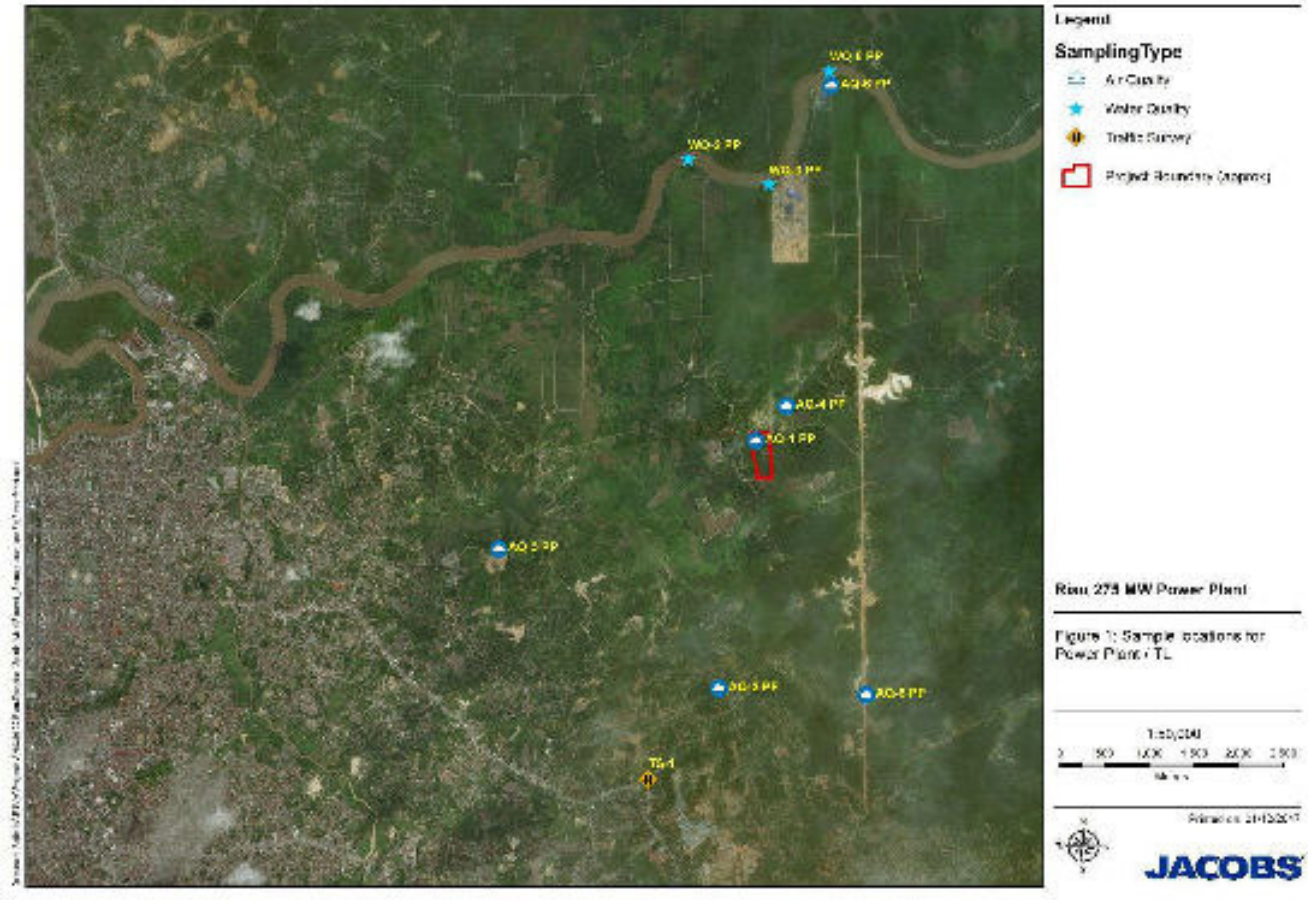


Figure 2.3 : Baseline Sampling Locations for Riau CCPP Power Plant

A summary of the baseline ambient air quality monitoring results for the dry and wet season are provided respectively in Table 2.2 and Table 2.3 below.

Table 2.2 : Baseline Ambient Air Monitoring Results, July 2017 (dry season)

Contaminant	Range of Measured Concentrations (µg/m^3)						Overall Average (µg/m^3)	Indonesian Air Quality Standard (µg/m^3)	WHO Air Quality Guidelines (µg/m^3)
	AQ-1	AQ-2	AQ-3	AQ-4	AQ-5	AQ-6			
SO_2 (1-hr avg)	<34	<34	<34	<34	<34	<34	<34	*900*	*500*
O_3 (1-hr avg)	<30	<30	<30	<30	<30	<30	<30	*235*	*n/a*
NO_2 (1-hr avg)	<17	<17	<17	<17	<17	<17	<17	*400*	*200*
NO_2 (14 day average)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	*n/a*	*n/a*
CO (1-hr avg)	0	1200	0	0	0	0	200	*30000*	*n/a*
TNMHC (30-minute avg)	1.0	1.0	0.7	1.6	1.6	1.3	1.2	*160*	*n/a*
TSP (1-hr avg)	49	92	54	6	55-317 (avg 136)	36-141 (avg 69)	95	*230*	*n/a*

Contaminant	Range of Measured Concentrations (µg/m³)						Overall Average (µg/m³)	Indonesian Air Quality Standard (µg/m³)	WHO Air Quality Guidelines (µg/m³)
	AQ-1	AQ-2	AQ-3	AQ-4	AQ-5	AQ-6			
PM_{10} (24-hr avg)	n/a	n/a	n/a	n/a	20-66 (avg 45)	9-42 (avg 25)	38	*150*	*50*
$PM_{2.5}$ (24-hr avg)	n/a	n/a	n/a	n/a	11-31 (avg 21)	<2-22 (avg 11)	*16*	*65*	*25*
Pb (1-hr avg)	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	*2*	*n/a*

Note: < refers to the detection limit of the sampling method

Table 2.3 : Baseline Ambient Air Monitoring Results, January-February 2018 (wet season)

Contaminant	Range of Measured Concentrations (µg/m³)						Overall Average (µg/m³)	Indonesian Air Quality Standard (µg/m³)	WHO Air Quality Guidelines (µg/m³)
	AQ-1	AQ-2	AQ-3	AQ-4	AQ-5	AQ-6			
NO_2 (1-hr avg)	<17	<17	<17	<17	n/a	<17	*<17*	*400*	*200*
PM_{10} (24-hr avg)	n/a	n/a	n/a	n/a	10-53	13-43	30	*150*	*50*
$PM_{2.5}$ (24-hr avg)	n/a	n/a	n/a	n/a	5-20	17-23	*16*	*65*	*25*

Note: < refers to the detection limit of the sampling method

The ambient monitoring undertaken shows that the ambient air concentrations measured are influenced to some degree by human activity, with concentrations being above what would be typically observed in a rural area. Generally ambient air quality in the project area is good, with ambient air concentrations of contaminants being consistently below the national and international guidelines.

With the exception of particulate matter, the air quality at the sites was determined to be of good quality, with SO_2, NO_2, CO and ozone ambient air concentrations being relatively low, and well below the Indonesian Ambient Air Standards and the World Health Organisation (WHO) Ambient Air Guidelines. PM_{10} concentrations are higher and at times exceeding the WHO 24-hour guideline value of 50 µg/m³ for PM_{10} and 25 µg/m³ for $PM_{2.5}$, though are consistently below the Indonesian ambient air standards. It is likely that the occasionally high TSP measurements are a result of the monitors being placed in locations of cleared and unsealed land where dust can be easily mobilised by wind or vehicular traffic. This is demonstrated in the photograph of air quality sampling site AQ-5, shown as Figure 2.4, which had the highest TSP reading of 317 µg/m³ as a 24-hour average. Measurements of particulate matter taken elsewhere in the area were generally lower, and likely to be more representative of actual conditions during the plant operation. However, the dusty nature of the disturbed soil does indicate the need for good practice dust management procedures during the construction phase of the Project.

Figure 2.4 : Air Quality Sampling Location AQ-5

Passive sampling for NO_2 was also undertaken at four of the baseline monitoring sites (AQ-1, AQ-2, AQ-3 and AQ-4). Passive samplers were deployed for a 14-day sampling duration at each site for three months over the dry season and for six weeks over the wet season. As with the manual sampling, concentrations of NO_2 at each of the sites were also determined to be below the method detection limit (equivalent to an ambient air concentration of around 0.01 µg/m^3).

Ambient Air Quality Monitoring Along the Gas Pipeline Route

Ambient air monitoring data has also been collected along the gas pipeline route, at four locations. A map of these locations is provided as, and the dry and wet season baseline results are provided in Table 2.4 below. Since sampling was undertaken a section of the gas pipeline route has changed and this is also shown in Figure 2.5 below. Monitoring results along the pipeline route were similar to those in the main Project area, with all contaminants measured below Indonesian Ambient Air Standards and WHO Ambient Air Guidelines.

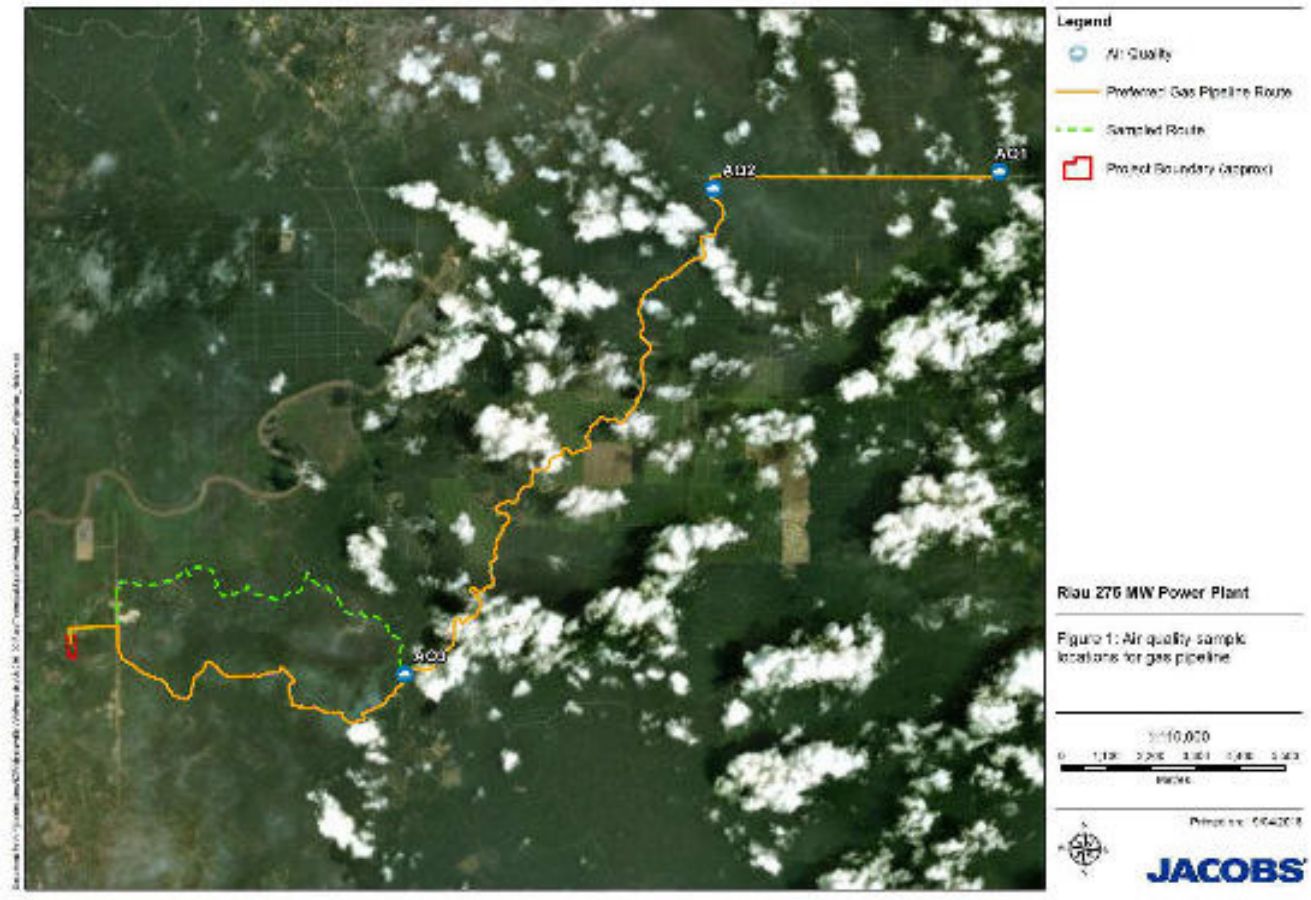


Figure 2.5 : Baseline Sampling Locations for Riau CCPP Gas Pipeline Route

Table 2.4 : Baseline Ambient Air Monitoring Results along Gas Pipeline Route, January-February 2018 (wet season)

Contaminant	Measured Concentrations (µg/m³)			Overall Average (µg/m³)	Indonesian Air Quality Standard (µg/m³)	WHO Air Quality Guidelines (µg/m³)
	AQ-1	AQ-2	AQ-3			
SO_2 (1-hr avg)	<33	<33	<33	<33	*900*	*500*
O_3 (1-hr avg)	<34	<34	69	<46	*235*	*n/a*
NO_2 (1-hr avg)	<17	<17	<17	<17	*400*	*200*
CO (1-hr avg)	<114	<114	<114	<114	*30000*	*n/a*
TNMHC (30-minute avg)	<1.6	<1.6	<1.6	<1.6	*160*	*n/a*
TSP (1-hr avg)	88	81	71	80	*230*	*n/a*
PM_{10} (24-hr avg)	12-34	56	26-38	26	*150*	*50*
$PM_{2.5}$ (24-hr avg)	10-23	24	14-21	*16*	*65*	*25*
Pb (1-hr avg)	<0.06	<0.06	<0.06	<0.06	*2*	*n/a*

Pekanbaru City Continuous Ambient Monitoring

To supplement the manual and passive ambient air sampling undertaken for the Project, Jacobs has sourced continuous ambient air monitoring data from the city of Pekanbaru, which maintains an ambient monitoring station approximately 9 km west of the Project. This data is reproduced in Table 2.5.

A photograph of the Pekanbaru monitoring site is shown as Figure 2.6, with Figure 2.7 showing the location of this station (labelled as PEF2) in relation to the Project. Data collected at this site consists of half-hourly measurements of NO, NO_2, O_3, SO_2 and PM_{10}, measured from 2011 to 2015. This data provides a good indication of existing ambient air quality in the Pekanbaru airshed, including any short-term and seasonal variations that could be expected to occur at the power plant site.

It is expected that contaminant concentrations at the urban Pekanbaru City monitoring location would be higher than that in the Project area, due to higher levels of traffic in the City as compared to the Project site which will result in elevated levels of NO_X. This assumption is supported by the baseline monitoring undertaken as part of the air quality assessment described above, which measured lower concentrations of contaminants in the Project area compared to those measured in Pekanbaru.

Figure 2.6 : Photograph of PEF-2 Ambient Air Monitoring Site in Pekanbaru

Figure 2.7 : Location Map of PEF-2 Ambient Monitoring Site in Pekanbaru in relation to the Project

Table 2.5 : Summary of Ambient Monitoring Data Collected at Pekanbaru, 2011 - 2015

Statistic	NO_2 (µg/m^3)		Ozone (µg/m^3)	PM_{10} (µg/m^3)	SO_2 (µg/m^3)	
	1-hour avg	24-hour avg	1-hr avg	24-hr avg	1-hour avg	24-hour avg
average	10		59	48	67	
median	6.8	6.9	45	25	59	61
70th	14	12	88	37	84	85
95th	30	24	166	174	176	153
99th	45	30	233	424	259	254
99.9th	115	46	312	562	341	305
Indonesian Air Quality Standards	400	150	235	150	900	364
WHO Ambient Air Guidelines	200	n/a	n/a	50	n/a	20

The continuous monitoring data in Pekanbaru indicates that the ambient air quality is relatively good with respect to NO_2. The concentrations measured over the 2011-2015 period are generally (excluding outliers) less than 25% of the Indonesian 1-hour average ambient air standard of 400 ug/m^3, and less than 15% of the 24-hour average standard of 150 µg/m^3. Concentrations of PM_{10} and SO_2 are significantly higher than those observed in the Project area during the baseline air quality monitoring. This is in part due to the more urban nature of the Pekanbaru site, which includes discharges from traffic (including road dust and fuel combustion) and domestic fires etc. It may also be attributed to the longer, continuous nature of the monitoring which is able to capture high pollution events such as that caused by regional-scale agricultural burning and forest fires.

Analysis of PM_{10} concentrations measured during the 2011-2015 period, as shown in Figure 2.8 below, shows the concentrations to be highly variable over the course of a year, with significantly elevated concentrations occurring during the June to October dry season when open agricultural burning and forest fires are common throughout the region. These sources contribute to a regional haze which is not attributable to individual industrial sources. The 2015 fire season has been noted[1] as being the worst year for haze on record in Pekanbaru, resulting in widespread mobilisation of the population to combat brush fires. Since then government intervention has greatly reduced the incidence of these fires, and the regional haze problem has been less of a problem.

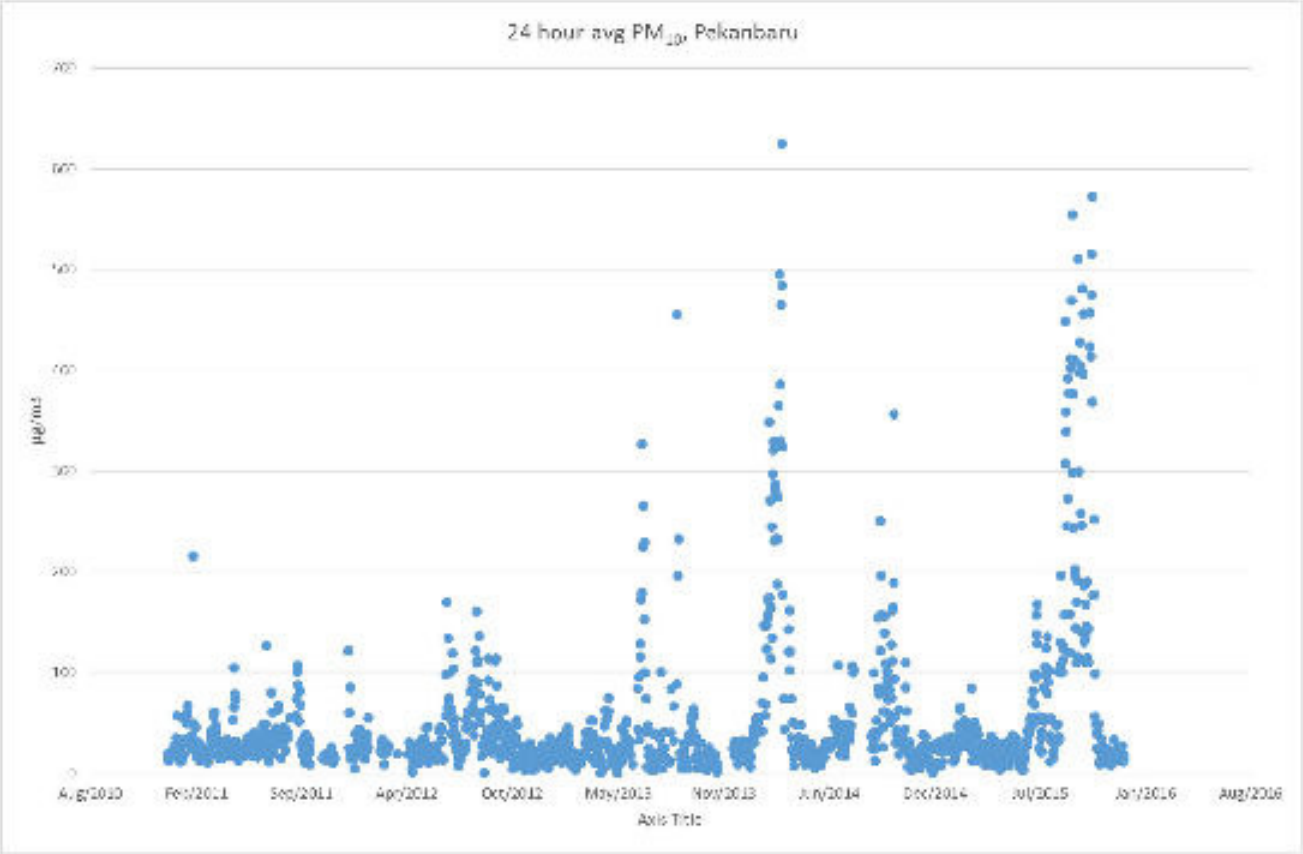


Figure 2.8 : 24-hour Average PM_{10} Concentrations as Measured at Pekanbaru, 2011-2015

Elevated concentrations of SO_2 are assumed to be the result of elevated sulphur content of fuels used for transportation and other industrial sources burning fuels containing sulphur in the area where the continuous ambient air monitoring was undertaken. Given the low level of traffic in the Project area, the concentrations of SO_2 are also expected to be much lower.

[1] Various media publications

3. Impact Assessment Methodology

3.1 Introduction

The impact assessment methodology applies to the assessment of potential environmental impacts arising from the Project. The impact assessment methodology has been developed in accordance with good industry practice and the potential impacts have been identified in the context of the Project's Area of Influence (AoI), in accordance with ADB Environmental Safeguards and IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts).

3.2 Spatial and Temporal Scope

The AoI constitutes the spatial extent of the ESIA. The AoI encompasses all areas directly and indirectly affected by Project components, which are primarily contained within the power plant site (for construction effects) and in the wider area where air discharges from the Project's operation will have an effect. Operational impacts have been considered out to a 5 km distance beyond which the impacts of the discharges are considered to be at a much lower level.

The study period is a time limit that will be used in predicting and undertaking an impact evaluation as part of the impact assessment. The period is used as a basis to determine if there are any changes to the environmental baseline resulting from the Project activities. Operational effects have been assessed using dispersion model simulations over a two-year period which is expected to encompass all likely meteorological conditions for the area.

3.3 Baseline Environmental Conditions

Baseline data collection refers to the collection of background data in support of the environmental assessment. Ideally baseline data should be collected prior to development of a project, but often this is not possible. Baseline data collection can also occur throughout the life of a project as part of ongoing monitoring of environmental and social conditions.

World Bank (1999) guidance on identification of baseline data states that it '*…describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Also takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures. The section indicates the accuracy, reliability, and sources of the data.*'

Baseline information used for this ESIA has utilised primary data collected through on-site surveys by Environmental and Social Specialists from Jacobs and their sub-consultants, NBC, in August 2017 and February 2018. Secondary data sources collected from desk-based studies and literature reviews have also been used, including ambient air monitoring data obtained from the city of Pekanbaru.

3.3.1 Adopted Background Concentrations

For the purpose of this assessment, existing baseline levels need to be estimated to determine the potential cumulative effects of contaminants discharged from the Project with existing levels in order to assess the potential for the Project to result in exceedances of the ambient air standards and guidelines. In order to provide an element of conservatism to the assessment, data from the Pekanbaru continuous ambient air monitoring station has been used, which has a statistically robust set of ambient air monitoring data. For 1-hour and 24-hour averages, the 70th percentile contaminant concentrations measured at the Pekanbaru ambient air monitoring station over the five-year period 2011-2015 have been used. This is in accordance with the Victorian

EPA recommendations (Victoria EPA, 2001) which recommends adding the 70th percentile of 1-hour average monitoring to maximum dispersion modelling results. These values are summarised in Table 3.1, and are expected to be greater than what is observed in the Project area due to the difference in land use (i.e. urban versus rural), which is confirmed by the baseline data collected in the vicinity of the Project site.

As CO is not measured at the Pekanbaru monitoring site, the highest measured 1-hour average concentration measured in the July 2017 baseline monitoring associated with the Project has been used. Similarly, $PM_{2.5}$ concentrations are not measured at Pekanbaru, and a $PM_{2.5}$:PM_{10} ratio of 50% has been assumed; this is used by the WHO Ambient Air Guidelines.

Table 3.1 : Assumed Background Concentrations of Atmospheric Contaminants in Pekanbaru

Averaging period	Background concentration (µg/m^3)					Source
	NO_2	PM_{10}	$PM_{2.5}$*	SO_2	CO**	
1-hour	14	n/a	n/a	83	1200*	70th Percentile of 1-hour averages at Pekanbaru (2011-2015)
24-hour	12	37	19	83	n/a	70th Percentile of 1-hour averages at Pekanbaru (2011-2015)
Annual	10	48	24	66	n/a	Average of all measured concentrations (2011-2015)

**Background CO concentration adopted from highest measured 1-hour average during July 2017 baseline monitoring.

Discharges of NO_X to air are a mixture of NO and NO_2, with NO gradually becoming oxidised to NO_2 by way of chemical reactions in the atmosphere. O_3 is the primary oxidising chemical in the air, and so for the purpose of predicting the conversion of NO to NO_2, the dispersion model also requires an estimation of background O_3 concentrations. O_3 concentrations measured at Pekanbaru were used (assumed at the 70th percentile of 88 µg/m^3) for the purpose of estimating NO oxidation rates.

3.4 Aspects Identification

3.4.1 Construction Phase

The construction phase of the Project is scheduled to last from late early 2018 to the end of 2020. The following stages are envisaged.

- Site clearance, levelling and general preparation;
- Construction of access road;
- Gas pipeline construction;
- Power plant and switchyard construction, including construction of water pipelines (to and from site);
- Transmission line construction; and
- Commissioning.

The construction stage includes the development of an access road which will be approximately 500 m long and run from the main road to the north of the Site. The access road will be a permanently sealed two-lane 8 m wide road. A road from the temporary jetty to the Project site may also be widened.

Construction dust arising from the dust generating activities and air emissions from construction vehicles and non-road machinery within the construction site boundary are the key concerns during construction of the Project.

3.4.2 Operational Phase

The key emission source associated with the operation of the Project is stack emissions from the combustion of natural gas during combined cycle and simple cycle operation. The main air pollutant of concern for a gas-fired combined cycle power plant is nitrogen dioxide (NO_2 while emissions of sulphur dioxide (SO_2 and particulate matter (PM) including respirable suspended particulates (PM_{10}) are likely to be minimal provided that the combustion process is optimised and efficient.

3.5 Impact Assessment

The impact assessment predicts and assesses the Project's likely positive and negative impacts, in quantitative terms to the extent possible. For each of the environmental aspects listed above, the assessment determined the sensitivity of the receiving environment and identifies impacts and assesses the magnitude and overall significance of environmental impacts. An ESIA will always contain a degree of subjectivity, as it is based on the value judgment of various specialists and ESIA practitioners. The evaluation of significance is thus contingent upon values, professional judgement, and dependent upon the environmental context. Ultimately, impact significance involves a process of determining the acceptability of a predicted impact.

3.5.1 Defining Impact

There are a number of ways that impacts may be described and quantified. An impact is essentially any change to a resource or receptor brought about by the presence of the proposed project component, project discharge or by the execution of a proposed project related activity. The assessment of the significance of impacts and determination of residual impacts takes account of any inherent mitigation measures incorporated into the Project by the nature of its design.

In broad terms, impact significance can be characterised as the product of the degree of change predicted (the magnitude of impact) and the value of the receptor/resource that is subjected to that change (sensitivity of receptor). For each impact the likely magnitude of the impact and the sensitivity of the receptor are defined. Generic criteria for the definition of magnitude and sensitivity are summarised below.

3.5.2 Direct vs Indirect Impacts

A direct impact, or first order impact, is any change to the environment, whether adverse or beneficial, wholly or partially, resulting directly from an environmental aspect related to the project. An indirect impact may affect an environmental, social or economic component through a second order impact resulting from a direct impact. For example, removal of vegetation may lead to increased soil erosion (direct impact) which causes an indirect impact on aquatic ecosystems through sedimentation (indirect impact).

3.5.3 Magnitude Criteria

The assessment of impact magnitude is undertaken by categorising identified impacts of the Project as beneficial or adverse. Then impacts are categorised as ‘major’, ‘moderate’, ‘minor’ or ‘negligible’ based on consideration of parameters such as:

- Duration of the impact – ranging from ‘well into operation’ to ‘temporary with no detectable impact’.
- Spatial extent of the impact – for instance, within the site boundary, within district, regionally, nationally, and internationally.
- Reversibility – ranging from ‘permanent thus requiring significant intervention to return to baseline’ to ‘no change’.
- Likelihood – ranging from ‘occurring regularly under typical conditions’ to ‘unlikely to occur’.

- Compliance with legal standards and established professional criteria – ranging from 'substantially exceeds national standards or international guidance' to 'meets the standards' (i.e. impacts are not predicted to exceed the relevant standards) presents generic criteria for determining impact magnitude (for adverse impacts). Each detailed assessment will define impact magnitude in relation to its environmental or social aspect.
- Any other impact characteristics of relevance.

Table 3.2 below presents generic criteria for determining impact magnitude (for adverse impacts). Each detailed assessment will define impact magnitude in relation to its environmental or social aspect.

Table 3.2 : General criteria for determining impact magnitude

Category	Description
Major	Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature and requiring significant intervention to return to baseline; would violate national standards or Good International Industry Practice (GIIP) without mitigation.
Moderate	Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change.
Minor	Detectable but small change to the specific conditions assessed.
Negligible	No perceptible change to the specific conditions assessed.

3.5.4 Sensitivity Criteria

Sensitivity is specific to each aspect and the environmental resource or population affected, with criteria developed from baseline information. Using the baseline information, the sensitivity of the receptor is determined factoring in proximity, number exposed, vulnerability and the presence of receptors on site or the surrounding area. Generic criteria for determining sensitivity of receptors are outlined in Table 3.3 below. Each detailed assessment will define sensitivity in relation to its environmental or social aspect.

Table 3.3 : General criteria for determining impact sensitivity

Category	Description
High	Receptor (human, physical or biological) with little or no capacity to absorb proposed changes
Medium	Receptor with little capacity to absorb proposed changes
Low	Receptor with some capacity to absorb proposed changes
Negligible	Receptor with good capacity to absorb proposed changes

3.5.5 Impact Evaluation

The determination of impact significance involves making a judgment about the importance of project impacts. This is typically done at two levels:

- The significance of project impacts factoring in the mitigation inherently within the design of the project; and
- The significance of project impacts following the implementation of additional mitigation measures.

The impacts are evaluated taking into account the interaction between the magnitude and sensitivity criteria as presented in the impact evaluation matrix in Table 3.4 below.

Table 3.4 : Impact matrix

		Magnitude			
		Major	**Moderate**	**Minor**	**Negligible**
Sensitivity	**High**	Major	Major	Moderate	Negligible
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

The objective of the ESIA is to identify the likely significant impacts on the environment and people of the project. In this impact assessment, impacts determined to be 'moderate' or 'major' are deemed significant. Consequently, impacts determined to be 'minor' or 'negligible' are not significant.

3.6 Assessment Criteria

Ambient air quality standards and guidelines have been developed with the primary aim to provide a basis for protecting public health from the adverse effects of air pollution and for eliminating, or reducing to a minimum, those pollutants in air that are known or likely to be hazardous to human health and wellbeing. The ambient air quality standards and guidelines provide values for evaluating the potential impact of contaminants that are commonly discharged from industrial sources.

The Indonesian Ministry of the Environment and Forestry has legislated National Ambient Air Standards that are used as one set of the evaluation criteria in determining the level of impact of the proposed power station emissions to air. The World Bank Group Environmental Health and Safety General Guidelines (WBG, 2007) and the EHS Guidelines for New Thermal Power Plants (WBG, 2008) also provide ambient air guidelines and emission limits based on those recommended by the WHO. The national and international ambient air guidelines and emission limits along with the principle of the development meeting Good International Industrial Practice (GIIP) are used to assess the potential environmental impacts on air quality from the proposed power station.

The following section sets out the emission standards and ambient air standards and guidelines applicable to this air dispersion modelling assessment.

3.6.1 Indonesian Standards

3.6.1.1 Emission Standards

For the combustion of fossil fuels, the main air quality parameters of concern are NO_X, SO_2 and PM_{10}. The proposed power plant will meet the Indonesian limit values, stipulated in Environmental Regulation No. 21 of 2008, regarding Threshold Limit of Stationary Sources. Table 3.5 sets out the emission threshold limit values for gas fired power plants.

Table 3.5 : Emission Threshold Limits for Stationary Gas-Fired Power Plants

No.	Parameter	Maximum (mg/Nm^3)
1	Sulphur Dioxide	150
2	Nitrogen Oxides as NO_2	400
3	Total Particulate	50
4	Opacity	n/a

No.	Parameter	Maximum (mg/Nm^3)

Notes:

1. The volume of gas measured in the standard state (25°C and a pressure of 1 atmosphere).

2. All parameters corrected to 3% Oxygen for gas fuel in a dry state except for opacity

3. The implementation of quality standards for 95% of emissions during normal operation time of 3 (three) months.

3.6.1.2 Ambient Air Quality Standards

The Indonesian government has promulgated the Indonesia Air Quality Standards - Government Regulation No. 41 of 1999 regarding air pollution control. This regulation sets out the ambient air quality standards for Indonesia which all developments must meet. The ambient air quality standards relevant to this assessment are presented in Table 3.6.

Table 3.6 : Indonesia Ambient Air Quality Standards, 25ºC, 1 Atmosphere

Parameter	Exposure Period	Threshold Limit (25°C)
SO_2 (Sulphur dioxide)	1 hour	900 µg/Nm^3
	24 hours	365 µg/Nm^3
	1 year	60 µg/Nm^3
NO_2 (Nitrogen dioxide)	1 hour	400 µg/Nm^3
	24 hours	150 µg/Nm^3
	1 year	100 µg/Nm^3
PM_{10} (Particulate Matter <10µm)	24 hours	150 µg/Nm^3
$PM_{2.5}$ (Particulate Matter <2.5µm)*	24 hours	65 µg/Nm^3
CO (Carbon monoxide)	1 hour	30,000 µg/Nm^3
	24 hours	10,000 µg/Nm^3
O_3 (Oxidant)	1 hour	235 µg/Nm^3
	1 year	50 µg/Nm^3
HC (Hydrocarbon)	3 hours	160 µg/Nm^3
Pb (Lead)	24 hours	2 µg/Nm^3
	1 year	1 µg/Nm^3
Dust fall	30 days	10 tonnes/km^2/month (for residential area)
		20 tonnes/km^2/month (for industrial area)

It should be noted that the local environmental agency (Badan Pengelolaan Lingkungan Hidup Daerah or BPLHD), through the AMDAL approval process, can also set stricter ambient air quality standards.

3.6.2 WHO Ambient Air Quality Guidelines

The WHO has published recommended ambient air quality guidelines for a range of pollutants found in ambient air which have the potential to adversely affect human health (WHO, 2006). These guidelines are often adopted by countries outright or are modified to reflect the countries' national requirements as legislated national ambient air quality standards. In 2005 the WHO updated their published ambient air quality guidelines and this has resulted in a significant reduction in the ambient air quality guidelines recommended for particulate matter (PM_{10}

and $PM_{2.5}$) and sulphur dioxide. Interim targets have been provided by the WHO in recognition of the need for a staged approach to achieving the recommended guidelines. The updated guidelines and interim targets are presented in Table 3.7. The WHO ambient air quality guidelines are also contained in the World Bank Group Environmental, Health and Safety General Guidelines (WBG, 2007).

The WHO ambient air quality guidelines need to be considered in assessing the impacts of the emissions from the proposed power plant in respect to demonstrating that GIIP is being achieved, and that the more stringent WHO guidelines are being achieved when compared to the Indonesian Ambient Air Standards.

Table 3.7 : Relevant WHO Ambient Air Quality Guidelines, 0ºC, 1 Atmosphere

Parameter	Exposure Period	Threshold Limit
Sulphur Dioxide (SO_2)	10 minutes	500 μg/Nm^3 not to be exceeded over an averaging period of 10 minutes
	1 hour	No guideline
	24 hours	125 μg/Nm^3 (Interim target 1) 50 μg/Nm^3 (Interim target 2) 20 μg/Nm^3 (guideline)
Nitrogen Dioxide (NO_2)	1 hour	200 μg/Nm^3
	24 hours	No guideline
	1 year	40 μg/Nm^3
Particulate matter less than 10 microns (PM_{10})	24 hour	150 μg/Nm^3 (Interim target 1) 100 μg/Nm^3 (Interim target 2) 75 μg/Nm^3 (Interim target 3) 50 μg/Nm^3 (guideline)
	annual	70 μg/Nm^3 (Interim target 1) 50 μg/Nm^3 (Interim target 2) 30 μg/Nm^3 (Interim target 3) 20 μg/Nm^3 (guideline)
Particulate matter less than 2.5 microns ($PM_{2.5}$)	24 hour	75 μg/Nm^3 (Interim target 1) 50 μg/Nm^3 (Interim target 2) 37.5 μg/Nm^3 (Interim target 3) 25 μg/Nm^3 (guideline)
	annual	35 μg/Nm^3 (Interim target 1) 25 μg/Nm^3 (Interim target 2) 15 μg/Nm^3 (Interim target 3) 10 μg/Nm^3 (guideline)
Ozone (O_3)	8 hour	100 μg/Nm^3

The WHO has no ambient air guideline values for 1-hour average SO_2 and 24-hour average NO_2. New Zealand (NZ) ambient air guidelines (MfE, 2002) have been used to provide an international benchmark to assess modelling predictions for these averaging periods in this report. The NZ ambient air guideline for SO_2 is 350 μg/Nm^3 as a 1-hour average and for SO_2 is 100 μg/Nm^3 as a 24-hour average.

3.6.3 IFC Emission Guidelines

The general approach of the WBG EHS General Guidelines is to prevent or minimise impacts from power station developments so that:

- *"Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognized sources;*
- *Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed." (WBG, 2007)*

The EHS Guidelines for Thermal Power Plants emission limits distinguish between degraded (i.e. polluted) and non-degraded airsheds. However, for gas combustion the emission limits are the same for both degraded airsheds (DAs) and non-degraded airsheds (NDAs). The IFC emission limits for combustion turbines are presented in Table 3.8.

Table 3.8 : IFC Emission Guidelines for Combustion Turbines (mg/Nm^3)

Combustion Technology/Fuel	Particulate Matter (PM)		Sulphur Dioxide (SO_2)		Nitrogen Oxides (NOx)	Dry Gas, Excess O_2 Content (%)
	NDA	DA	NDA	DA	NDA/DA	
Natural Gas (all turbine types of Unit > 50MWth)	N/A	N/A	N/A	N/A	51 (25 ppm)	15%

Ambient air monitoring data collected in the area, as discussed in Section 2 of this report, indicate that the airshed is degraded with respect to particulate matter, and non-degraded with respect to SO_2 and NO_2. Discharges from natural gas-fired power plants are primarily of concern in regard to NO_2. SO_2 and PM_{10} are discharged for the Riau CCPP at much lower levels, and are expected to have negligible impacts on the surrounding air quality.

4. Air Quality Assessment Methodology

4.1 Construction Phase

The air quality impacts during construction of the Project have been assessed in a qualitative manner following WBG EHS Guidelines and based on available information.

The production of dust from construction works such as the formation of roads and preparation of lay-down and building sites is inevitable. Modelling for dust is generally not considered appropriate for assessing construction impacts, as emission rates vary depending on a combination of the construction activity being undertaken and the meteorological conditions, which cannot be reliably predicted. For this assessment, *Guidance on the Assessment of Dust from Demolition and Construction, Version 1.1* developed by the Institute of Air Quality Management (IAQM) (2014) has been referenced.

Activities on Site and along the gas pipeline route have been divided into four types to reflect their different potential impacts. These are:

- Demolition;
- Earthworks;
- Construction; and
- Trackout.

Of these four types of activities, only earthworks, construction and trackout are relevant to the Project as very limited demolition may be required for the gas pipeline.

The IAQM method uses a five step process for assessing dust impacts from construction activities:

Step 1. Screening based on distance to nearest receptor. No further assessment is required if there are no receptors within a certain distance of the works;

Step 2. Assess the risk of dust effects from activities using:

- the scale and nature of the works, which determines the potential magnitude of dust emissions; and
- the sensitivity of the area.

Step 3. Determine site specific mitigation for remaining activities with greater than negligible effects.

Step 4. Assess significance of remaining activities after mitigation has been considered.

Step 5. Reporting.

The Step 1 screening criteria provided by the IAQM guidance suggests screening out assessment of impacts from activities where sensitive 'human receptors' will be more than 350 m from the boundary of the site, 50 m of the route used by construction vehicles, or up to 500 m from the Site entrance. Sensitive 'ecological receptors' can be screened out if they are greater than 50 m from the boundary of the site, 50 m of the route used by construction vehicles, or 500 m from the site entrance.

The Step 2 assessment determines the Dust Emission Magnitude for each of four dust generating activities; demolition, earthworks, construction, and track out. The classes are; Large, Medium, or Small, with suggested definitions for each category. The lists of suggested definitions for earthworks and construction activities are presented in Appendix A.

The class of activity is then considered in relation to the distance of the nearest receptor and a risk category determined through an assessment matrix for each of three categories:

- Sensitivity to dust soiling effects;
- Sensitivity of people to health effects from PM_{10}; and,
- Sensitivity of ecological effects.

A copy of each matrix for earthworks, construction, and track out is presented in Appendix A.

4.2 Operational Phase

Stack emissions of the power plant have been identified as key source of air pollution during operation of the Project. The Project consists of two sets of gas turbine generating unit, two sets of heat recovery steam generator (HRSG) and one steam turbine generating unit with associated auxiliary equipment. The cooling towers associated with the Project will also discharge particulate matter to air, though at very low levels. The Project will be designed to operate continuously throughout the year. The Black Start Diesel Generators will supply black power in case of a station black out and emergency power for the safe shutdown of the power plant in the event of the loss of mains supply. The Project site boundary is shown in Figure 1.1..

During combined cycle operation, the heat of exhaust gas will be admitted to the HRSG where superheated steam will be produced which will then drive the steam turbine to generate additional electrical power. Use of the HSRG will not result in additional contaminants to the air discharges.

4.2.1 Model Selection

A two stage modelling approach was taken, first using the TAPM prognostic meteorological model to provide meteorological data for the modelling period. The AERMOD dispersion model (Version 14134) was then used to predict the ground level concentrations of the pollutants discharged from the proposed site.

4.2.2 TAPM Settings

As discussed in Section 2, meteorological data collected at the Pekanbaru continuous ambient air monitoring site was determined to be influenced by nearby buildings, and so was not considered to be representative of actual surface winds in the wider area. The prognostic meteorological model TAPM has therefore been used to develop a meteorological dataset for use with the dispersion model. TAPM was developed by the CSIRO in Australia and predicts all meteorological parameters based on large-scale synoptic information, in this case for the Indonesian region. TAPM consists of two main components: a meteorological component and a pollution dispersion component. For this modelling exercise the meteorological component was used to produce upper air and surface meteorological data for use with AERMOD dispersion model.

In order to produce the meteorological data set, TAPM was configured as per CSIRO recommendations (Edwards et al, 2004) which primarily follow that used by Hibberd *et al* (2003), with:

- Four nested meteorological grids with a grid spacing of 30, 10, 3 and 1 km;
- Default vegetation, topography and soil types as supplied in the South Asia TAPM databases;
- Grid centre at 0° 32.5’ N, 101° 31’ E, with a UTM grid centre of 780581E, 59726N;
- Deep soil moisture used throughout the year was 0.15;
- 25 vertical levels;
- Prognostic turbulence scheme and hydrostatic approximation; and
- Model run for 2015 and 2016.

The AERMOD meteorological data file was extracted at a pseudo-meteorological station of the modelling domain located at the location of the proposed power plant. Two meteorological datasets – one surface air data file (**.sfc) and one upper air data file (**.pfl) were extracted from a pseudo-met station of the modelling grid located at the proposed Java 1 site for use with the AERMOD dispersion model. A windrose of the surface meteorological data is provided as Figure 4.1.

It is noted that Gaussian-plume models such as AERMOD over-predict when winds less than 0.5 m/s are used. For this reason, a minimum wind speed of 0.5 m/s has been applied to the wind speeds predicted by TAPM for use with Gaussian-plume models.

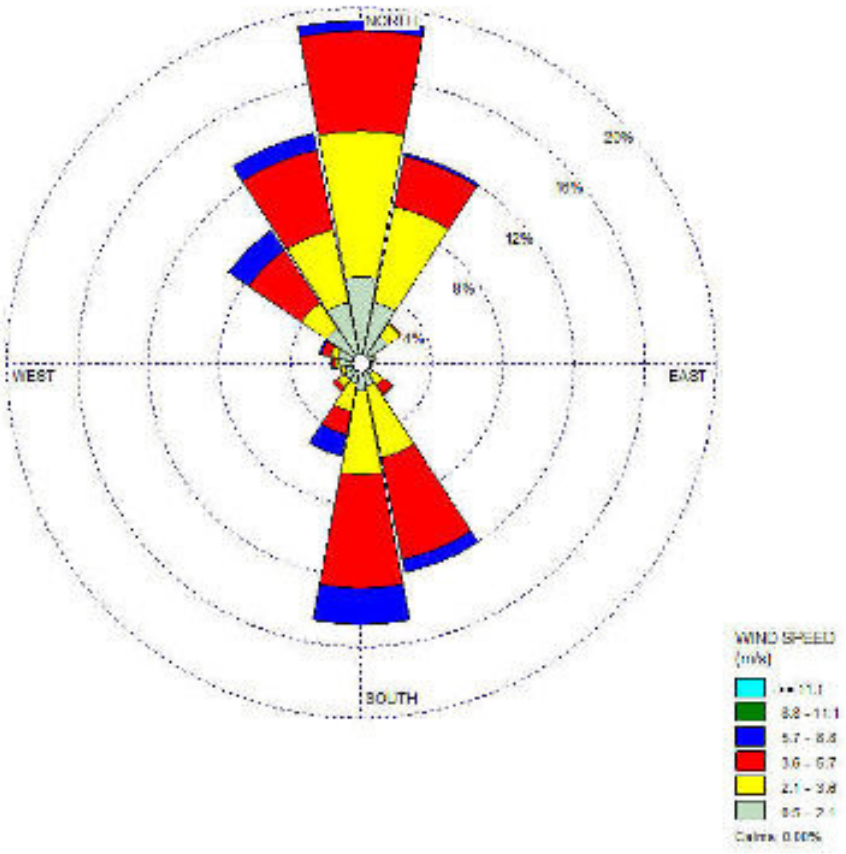


Figure 4.1 : Windrose of Modelled Meteorological Data at the Proposed CCGT Site

4.2.3 Modelling Scenarios

Modelling was conducted for the following scenarios.

- Emissions of combustion gases and particulate matter from the proposed 275 MW Riau CCPP; and
- Emissions of combustion gases and particulate matter from the proposed power plant in addition to the existing Tenayan CFPP.

Both scenarios were modelled assuming continuous operation at maximum continuous rating for the years 2015-2016.

4.2.4 Receptor Grid and Sensitive Receptors

The AERMOD model was run with a 10 km x 10 km (100 km^2) digital terrain file with 50 m grid spacing. The AERMAP module of AERMOD was run to calculate the ground elevations and representative terrain height scale for all receptors, stacks and buildings in the model from digital terrain elevation data.

4.2.5 Model Input Parameters

The input parameters used for this atmospheric dispersion modelling are summarised below. The key model assumptions to note are:

- All modelled emissions, either time-of-hour dependent or constant with time, are modelled over a one-year period;
- The Universal Trans Mercator (UTM_47N) projection was used for mapping contours;
- Meteorological data set for 2015-2016 was developed using the TAPM prognostic meteorological model to be representative of the existing meteorological conditions;
- Building downwash effects were assumed to be irrelevant for the existing and proposed power plant with the exception of the Steam Turbine Building, as per the GIIP; and
- Discharge rates for each power plant were modelled at maximum continuous rating, 7 days a week, 52 weeks a year.

4.2.6 Chimney Height and Building Downwash Effects

WBG Environmental, Health and Safety (EHS) General Guidelines recommends that the chimney height for all point source emissions, whether significant or not, be designed according to GIIP. The GIIP is based on United States 40 CFR, part 51.100 (ii), which used the following technical document, "Guideline for Determination of Good Engineering Practice Chimney Height (Technical Support Document for the Chimney Height Regulations)", EPA 450/4-80-023R, June 1985.

The Good Engineering Practice (GEP) Chimney Height is determined using the following equations

$$H_G = H + 1.5L$$

where:

HG = GEP chimney height measured from the ground level elevation at the base of the chimney

H = Height of nearby structure(s) above the base of the chimney

L = Lesser dimension, height (h) or width (w), of nearby structure(s)

“Nearby structure(s)” = Structures within/touching a radius of 5L.

A chimney located downwind, within the influence zone (the lesser of the structure’s width or height five times – 5L) of structure(s) that meets the GEP stack height will effectively place the chimney’s emissions outside the building wake height effects. However, if a building is within the influence zone and the calculation shows that is higher than the effective stack height, then its influence in terms of building downwash effects needs to be determined in the dispersion modelling undertaken.

AERMOD contains the US EPA's Building Profile Input Program (BPIP). The BPIP processor computes the maximum GEP chimney height and maximum Wake Effect Heights (WEHs) for all combinations of tiers, chimneys and wind directions. Dispersion modelling then uses the WEHs to compute the plume downwash down wind of the chimney. The GEP calculation was undertaken for all buildings and structure within a radius of 5 x L (5 x stack height of 45 m). Only the Steam Turbine Building was found to be of a size that it could potentially result in building downwash effects on the discharged plume. This building (25 m high, and 24 m wide) and has therefore been included in the AERMOD dispersion modelling with BPIP processor switched on.

4.2.7 Stack Discharge Parameters

A number of sources have been identified as potentially discharging pollutants to the atmosphere. They include two point sources corresponding to the locations of the CCPP stacks as shown in design drawings. Locations of stacks at the existing Tenayan CFPP obtained from aerial imagery. Contaminant discharge rates have been derived from design criteria where available, as well as US EPA AP-42 emission factors[2].

Table 4.1 presents the physical parameters of the discharge sources as used in the dispersion model. All PM_{10} has been assumed to be $PM_{2.5}$.

Table 4.1 : Source Characteristics and Discharge Rates Used in Dispersion Model

Source ID	Stack Height (m)	Stack Diameter (m)	Efflux Velocity (m/s)	Exit Temperature (°C)	Discharge Rate (g/s)			
					NO_X	PM_{10}	SO_2	CO
Riau CCGT (Stack 1)	45	3.8	20	82	12.1*	1.56	0.47*	1.95
Riau CCGT (Stack 2)	45	3.8	20	82	12.1*	1.56	0.47*	1.95
Tenayan CFPP	150	5	10	120	70	11.2	1283	3.1

Note: *guaranteed emission rates

4.2.8 Cooling Tower Emissions

Cooling tower PM_{10} emission rates were calculated from the evaporative loss of the towers as supplied by the EPC Contractor. The dimensions of the cooling towers are provided in Table 4.2

Table 4.2 : Cooling tower condition details

Parameter	Value
Exhaust temperature	35.8°C
Exhaust flow	3,800 kg/s
Volumetric flow rate	3,500 m^3/s
Exhaust velocity	10.4 m/s
Geometry of cooling tower	73 m long x 18 m wide x 10.1 m high (top deck)
Discharge height	13 m
Drift	Less than 1 kg/s
Total dissolved solids	100 mg/L

[2]

Parameter	Value
Particulate Matter discharge rate	0.1 g/s

4.2.9 Emergency Grid Failure

The CCPP will have an emergency black start facility, comprising 4 x 1.2 MWe containerised diesel generator sets (DGs). This facility is required by the Power Purchase Agreement (PPA) and will enable the plant to start independently and reenergise the grid without any external source of power in the unlikely event of a PLN grid failure or black-out. The failure could be local to Riau or affect the whole of the Sumatra Grid.

During a normal start, power to start the GTs is imported from the grid via the generator step-up transformer. When there is a grid failure (or a "black-out" or "black grid"), no power is available from the grid and so, without black start capability, the plant would not be able to start until the grid is energised by some other power station. With the black start facility, the plant will be able to start on its own and help restore power to consumers.

When there is a black-out, power stations disconnect from the grid as there is no actual demand. In order to re-energise the grid, stations with black-start capability must be able to start without any power from the grid. Typically, the power is provided by diesel generators. At the Riau plant, four 1.2 MWe DGs will be used for this purpose.

Under a black start scenario, the DGs would provide the power to start one of the gas turbines. The DGs will run for, perhaps, an hour or so while the plant is being readied for the start. Then, one GT would be started and synchronised to the DG sets forming an "island" grid. Then, the generator of the gas turbine set would take over the supply of the auxiliary loads and the DG sets can be shut down. The GT would run at low load in parallel with the DGT sets for approximately 30 minutes.

It is anticipated that this scenario would occur no more than once per year. In addition, each DG unit would be subject to a monthly test run to ensure they are functioning properly for a period of 15 to 30 minutes. The units would be fired up separately when conducting the monthly test runs.

Each diesel generator set will be installed in a steel container with its own chimney stack. Table 4.3 presents the estimated emission parameters of the BSDGs using the US EPA AP-42.

Due to the infrequent nature of the running of the BSDGs in an emergency situation and the short duration for which these units will operate for, these units have not been included in the dispersion modelling conducted. The impacts of emissions to air from the BSDGs will be negligible.

Table 4.3 : Estimated Black Start Diesel Generator Emissions per Unit

Parameter	Unit	Value
Stack height	m	5
Stack diameter	m	0.2
Exit velocity	m/s	30
Fuel consumption	kg/hr	327
Volume flow rate	m^3/s	5
Exit temperature	K	673
Power Output	MWe	1.2
Thermal Input	MWth	4.1
NOx emission rate	g/s	5.6

Parameter	Unit	Value
PM emission rate	g/s	0.17
CO emission rate	g/s	1.48
SO_2 emission rate (0.05% sulphur content of fuel)	g/s	0.09
SO_2 emission rate (0.3% sulphur content of fuel)	g/s	0.5

Note: US EPA AP-42 emission factors for large units have been used to generate emission rates

4.2.10 Conversion of NO to NO_2

Emission factors and modelling outputs for NO_X are typically reported in terms of NO_X as NO_2. This approach presents predicted concentrations of the principal oxides of nitrogen (NO + NO_2) based on the assumption that all nitric oxide in the plume fully oxidises to nitrogen dioxide. In reality, only a portion of the NO_X emitted from the combustion sources is NO_2, with typically less than 5% to 10% of the total NO_X discharge consisting of NO_2, and additional NO_2 being generated by oxidation of NO in the plume as it disperses downwind.

The US EPA (Appendix W to Code of Federal Regulations 40 Part 51, 2017) recommends a three tiered approach to converting NO to NO_X, as follows:

- Tier 1: Assume total conversion of NO to NO_2.
- Tier 2: Assume 80% conversion of NO to NO_2 for 1-hour averages, and 75% conversion for annual average concentrations.
- Tier 3: Undertake detailed conversion methodology on a case by case basis. Conversion methodologies include the Plume Volume Molar Ratio Method (PVMRM) or Ozone Limiting Method (OLM).

Methods of modelling conversion of NO to NO_2 can be complex, and are therefore not normally undertaken if more conservative assumptions can be used that show adverse effects of pollutants are likely to be avoided. Given the size of the proposed power plant, a Tier 3 approach using the PVMRM has been followed.

The Plume Volume Molar Ratio Method (PVMRM) calculates the ratio of ozone moles to NOx moles in an effluent plume segment volume at downwind distance receptor locations (Hanrahan, 1999). This molar ratio is multiplied by the NOx concentrations estimated by AERMOD to calculate the NO_2 concentrations in the plume. The PVMRM includes a method to simulate multiple NO_X sources by accounting for how the plumes merge and combine. Similar to the Ozone Limiting Method (OLM), the PVMRM does not account for the gradual entrainment and mixing of ambient O_3 in the plume, and fresh ozone is assumed to be uniformly mixed across the plume cross section.

The main characteristic that affects NO_2 conversion using the PVMRM is background O_3 concentrations. A background concentration of 88 µg/m^3 has been assumed, which is the measured 1-hour average concentration at the 70th percentile as measured at the PEF-2 ambient air monitoring site in Pekanbaru. An in-stack ratio of NO_2:NO_X has been assumed to be 0.1, or 10% NO_2.

4.2.11 Use of 99.9 Percentile Levels for Evaluations

The use of percentiles when analysing dispersion modelling predictions for 1-hour averages, subject to certain criteria, is a statistical method widely accepted and used. For example, the Ministry for the Environment's (New Zealand) *Good Practice Guide for Atmospheric Dispersion Modelling* (2004) recommends (Section 6) for the purpose of comparing modelling results to evaluation criteria, that the 99.9th percentile value of the predicted ground level of the highest maximum ground level concentration likely to occur is used (MfE, 2004). The use of

percentiles is linked to the inherent uncertainty (accuracy) of modelling predictions even when input data is appropriate. It has been found generally that short-term (for example, 1-hour average) modelling predictions at the 99.9th percentile more closely approximate empirical data than do peak predictions. The use of percentiles for analysing dispersion modelling data (and monitoring data) becomes increasingly less relevant as averaging times increase and as a result the highest maximum ground level concentrations should be used (for example, 24-hour averages).

Percentile limits should only be applied when there is a large amount of data. Consequently, the use of percentiles is particularly relevant to dispersion modelling outputs where, for example, the predicted hourly averages for 12 months (8,760 hours) or more of meteorological data are available for interpretation. This approach has been used in evaluating the 1-hour average results from the dispersion modelling undertaken.

4.3 Cumulative Impacts

The assessment of cumulative impacts will identify where particular resources or receptors would experience significant adverse or beneficial impacts as a result of a combination of projects (inter-project cumulative impacts). In order to determine the full combined impact of the development, potential impacts during construction and operational phases have been assessed where relevant.

There are no relevant cumulative impacts that need to be considered for the construction phase of the Project. The main existing industrial discharge in the Project area is the Tenayan CFPP located to the north of the Project. Cumulative effects of the operational phase of the Project with the Tenayan CFPP have been assessed by dispersion modelling both sources.

5. Assessment of Potential Impacts

5.1 Construction Phase

5.1.1 Dust

The construction phase of the project will involve land preparation including site clearance, backfilling and land drainage followed by construction of the power plant and associated gas pipeline and transmission line. Potential dust discharges will be associated principally with the site clearance and levelling activities, which will involve movement of earth.

Power Plant

The site area for the power plant and switchyard will need to be cleared of vegetation and any debris prior to levelling. Site clearance works will include felling, trimming, and cutting trees, and disposing of vegetation and debris off-site. Voids and water ponds will be dried and filled with suitable material.

Topsoil will be stripped from the surface. Excavated topsoil will be transported to and stockpiled in designated topsoil storage areas. Prior to being filled, any sub-grade surfaces will be freed of standing water and unsatisfactory soil materials will be removed. All unnecessary excavated materials will be transported and deposited off-site at an approved facility.

The site will then be levelled. Ideally, the cut and fill will be balanced, to minimise the need to import or export material from the site area. Based on the site topography, preliminary estimates show that if the site elevation is set at 28 m, then the cut and fill / backfilling volumes will be reasonably well balanced at approximately 165,000 m^3 each.

Notwithstanding this, it is likely that approximately 45,000 m^3 of soil will need to be disposed of offsite. At 20 m^3 per truck, this will require 2,250 truck movements over approximately 3 months. Access roads will be used to convey soil and other material for offsite disposal.

Due to the volume of earth movement required (165,000 m^3 of cut and fill), the dust emission magnitude of earthworks activities which may be associated with the power plant would be classified as “Large”, following the IAQM assessment definition in Appendix A:

> *‘Total site area <10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active and any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes;’*

The dust emission magnitude of construction activities, which includes on site concrete batching, associated with the power plant would be classified as “Medium”, following the IAQM assessment definition:

> *‘Total building volume 25,000 m^3 – 100,000 m^3, potentially dusty construction material (e.g. concrete), on site concrete batching;’*

The dust emission magnitude of trackout activities associated with the power plant, which includes a range of 50-60 heavy vehicles per day, would fall under the “Large” classification following the IAQM assessment definition:

> *‘Large: >50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m’*

While the potential magnitude of dust emissions are classified as “Medium” to “Large”, based on the nature or scale of the power plant construction activities, a survey of aerial imagery and review of baseline site assessment information indicates that there are no residential or other sensitive receptors within 350 m of the construction works associated with the power plant site.

Pipeline

Construction of the gas pipeline involves clearing of vegetation and grading of the immediate area, transporting the pipe sections to the relevant area, digging and preparation of trenches, backfilling the trenches using the excavated material and compaction of trench material.

It is understood that the open gas pipeline trenches will be a maximum of 500 m at any one time and will be no more than 2 m deep by 1 m wide. The time that each section of trench is excavated and open is likely to be for around one week therefore gas pipeline construction activities are expected to be limited in terms of spatial extent and therefore in terms of the potential exposure period to dust. On this basis the dust emission magnitude of the pipeline earthworks activities is expected to fall into the ‘Small’ classification, following the IAQM assessment definition in Appendix A.

Based on the variety of construction equipment required for the pipeline excavators (bulldozers, dump trucks, cranes, welding machines and water pumps), the dust emission magnitude of the pipeline trackout activities has been conservatively assigned to the ‘Medium’ classification, following the IAQM assessment definition in Appendix A.

The construction of the gas pipeline will also occur through largely uninhabited areas, with the land use consisting primarily of palm oil plantations. There are a few residential properties which are located within 350 m of the pipeline route and therefore within a distance to be impacted by construction dust. Due to the nature of the works area (i.e. a maximum of 500 m of open trench at any one time), with reference to the IAQM assessment definitions in Appendix A, there are:

- approximately 1-10 highly sensitive receptors anticipated to be within 50 m of the pipeline construction activities, on a worst-case basis; and
- located in an area with an annual mean PM_{10} above 32 $\mu g/m^3$ (background PM_{10} has been understood to be 48 $\mu g/m^3$ as in Table 3.1).

This would therefore classify the sensitivity of the area to dust soiling effects on people and property as ‘Low’, and the sensitivity of the area to human health impacts as ‘Medium’ with reference to the IAQM definitions in Appendix A.

Summary

Table 5.1 summarises the dust emission magnitude of the Project construction phase of the power plant and pipeline, determined with reference to the IAQM guidance. With reference to the magnitude criteria for the ESIA in Table 3.2, this would be categorised as ‘Moderate’ to ‘Major’ magnitude of impact for the power plant, and ‘Minor’ to ‘Moderate’ for the pipeline.

Table 5.1 : Construction Dust Emission Magnitude

Activity	Dust Emission Magnitude	
	As per IAQM (2014) Guidance	ESIA Classification
Power Plant		
Earthworks	Large	Major

Activity	Dust Emission Magnitude	
	As per IAQM (2014) Guidance	ESIA Classification
Construction	Medium	Moderate
Trackout	Large	Major
Gas Pipeline		
Earthworks	Small	Minor
Construction	N/A	N/A
Trackout	Medium	Moderate

The impact assessment results using the dust emission magnitude classification, and the sensitivity of the area is presented in Table 5.22.

Given the absence of sensitive receptors within 350 m of the power plant, in combination with the relatively short duration of the construction period it is considered that there will be a 'Negligible' impact from the power plant construction.

As the magnitude classification of dust emissions from the pipeline construction activities is 'Small' to 'Medium', when this is considered with the 'Low' sensitivity to dust soiling, and 'Medium' sensitivity to human health, a 'Low' risk of impact from dust emissions is concluded, with reference to the IAQM assessment definitions in Appendix A. This translates to a 'Minor' impact as per the ESIA impact matrix in Table 3.4.

Table 5.2 : Risk of Dust Impacts and Significance

Activity	Impact Classification	Significant
Power Plant		
Earthworks	Negligible	Not significant
Construction	Negligible	Not significant
Trackout	Negligible	Not significant
Pipeline		
Earthworks	Minor	Not significant
Construction	N/A	N/A
Trackout	Minor	Not significant

The objective of the ESIA is to identify the likely significant impacts on the environment and people of the project. In this impact assessment, impacts determined to be 'moderate' or 'major' are deemed significant. Consequently, impacts determined to be 'minor' or 'negligible' are not significant. On this basis, the construction dust effects of the power plant and gas pipeline are considered to be not significant.

5.1.2 Combustion Gases

Ambient air monitoring undertaken during the baseline monitoring described in Section 2.1.3 indicate that overall air quality is good with respect to combustion gases, although there is the potential for cumulative impacts of SO_2 and particulate matter. However, combustion emissions associated with construction activities will be more than 350 m from the main residential areas and emissions from the main source will occur over a relatively short

duration. As such, it is considered that the potential impact on people living and working in the surrounding area from construction phase combustion gas emissions will be 'Negligible'.

5.2 Operational Phase

5.2.1 Assessing the Impacts of Discharges to Air from Operation of the Project

Atmospheric dispersion modelling was undertaken to predict the likely impact emissions from the power station on air quality of the surrounding area and to assess the potential impacts on the environment. The results of the modelling are evaluated in the following sections.

Atmospheric dispersion modelling was used to predict the highest one-hour (99.9th percentile) and 24-hour and annual average maximum ground level concentrations (MGLCs) for NO_2 and SO_2, 24-hour and annual average MGLCs for PM_{10}, and 1-hour averages for CO. The modelling assumes that the CCPP plant was operating simultaneously on a continuous basis over the course of the 2-year modelling period. The modelling also included discharges of PM_{10} from the cooling towers associated with the CCPP.

Relevant isopleth diagrams are presented in the following sections. The location of the highest concentration predicted by the modelling is indicated by an arrow on each isopleth diagram.

5.3 Proposed CCPP Plant Model Results

The highest maximum ground level concentrations (MGLCs) predicted by the AERMOD dispersion model for the proposed power plant are presented in Table 5.33 below. The relevant international air quality standards and guidelines are provided for comparison. Maximum predicted concentrations including the existing background concentrations as derived from the Pekanbaru monitoring data are also provided. As discussed previously the background data is obtained in a more urban environment than the Project area, where ambient air concentrations are likely to be higher. Using this data to represent existing baseline conditions for the assessment of the effects of discharges from the proposed CCPP plant will therefore provide a conservative assessment.

Table 5.3 : Highest MGLCs Proposed Power Plant at for Comparison with International and Indonesian Guidelines

Pollutant and Averaging Period	Highest Predicted MGLCs (µg/m^3)		International Guidelines (µg/m^3)	Indonesian Ambient Air Standard (µg/m^3)
	Excluding Background	Including Background		
CO (1-hour highest 99.9th percentile)	10.2	1210.2	30,000 (NZ)	30,000
CO (24-hour)	2.5	602.5	10,000 (WHO)	10,000
NO_2 (1-hour highest 99.9th percentile)	41.4	55.4	200 (WHO)	400
NO_2 (as NO_2, 24-hour average)	12.8	24.8	100 (NZ)	150
NO_2 (as NO_2, annual average)	3.2	13.2	40 (WHO)	100

Pollutant and Averaging Period	Highest Predicted MGLCs (µg/m³)		International Guidelines (µg/m³)	Indonesian Ambient Air Standard (µg/m³)
	Excluding Background	Including Background		
PM_{10} (24-hour average)	2	39	150 (WHO Interim target 1); 100 (WHO Interim target 2); 75 (WHO Interim target 3); 50 (WHO)	150
PM_{10} (annual average)	0.6	48.6	70 (WHO Interim target 1); 50 (WHO Interim target 2); 30 (WHO Interim target 3); 20 (WHO)	n/a
$PM_{2.5}$ (24-hour average)	2	21	75 (WHO Interim target 1); 50(WHO Interim target 2); 37.5 (WHO Interim target 3); 25 (WHO)	65
$PM_{2.5}$ (annual average)	0.6	24.6	35 (WHO Interim target 1); 25 (WHO Interim target 2); 15 (WHO Interim target 3); 10 (WHO)	n/a
SO_2 (1-hour highest 99.9th percentile)	2.5	85.5	350 (NZ)	900
SO_2 (24-hour average)	0.6	83.6	125 (WHO Interim target 1); 50 (WHO Interim target 2): 20	365
SO_2 (annual average)	0.2	66.2	10 – 30 (NZ)	60

Isopleth diagrams of predicted NO_2 from the Project are provided as Figure 5.1, Figure 5.2and Figure 5.3 below.

The highest predicted MGLC of NO_2 as a 1-hour average (99.9th percentile) from the Project is 41.4 µg/m³, which is approximately 21% of the WHO guideline, and 18% of the Indonesian Standard value. This concentration is predicted to occur very close to the proposed power plant, just beyond the western boundary of the plant. If the assumed background value of 14 µg/m³ is added, the WHO and Indonesian guidelines and standards for NO_2 are still met. The highest predicted concentrations occur at the site boundary, and decrease with distance from the source.

Predicted MGLCs of NO_2 as 24-hour averages are similarly well below the Indonesian and international guidelines and standards, being less than 13% of the 100 µg/m³ International Guideline value, and 9% of the 150 µg/m³ Indonesian Standard. The highest predicted 24-hour average MGLCs are shown to occur approximately 1.5 km to the southwest of the power plant site boundary. As the airshed is shown to be relatively non-degraded with respect to NO_2, with the assumed background concentration assumed as being 12 µg/m³, both the International Guideline and Indonesian Standard values are predicted to be complied with.

Predicted MGLCs of NO_2 as annual averages (including background) is well below the 40 µg/m³ WHO Guideline, and the 100 µg/m³ Indonesian Standard.

The airshed in Pekanbaru has been shown to be degraded with respect to particulate matter and SO_2, with exceedances being observed at the Pekanbaru monitoring station. This is primarily due to the large scale agricultural burning and forest fires (for PM_{10}) and the use of high sulphur fuel for transport (for SO_2). These sources of air pollution are expected to decrease in the coming years as government regulations limit the spread of fires for agricultural land clearing, and the implementation of lower sulphur content of fuels. Regardless, the incremental increase in ambient concentrations of CO, PM_{10} and SO_2 resulting from the Project's air discharges, which include both stack and cooling tower discharges, are predicted to be at a very low level as shown in Table 5.33 above, with respect to the ambient air guidelines. Considering the low emission rates of these contaminants, the incremental effect on the airshed may be assumed to be minor and will not significantly contribute to further airshed degradation.

Emissions of particulate matter from the cooling towers were shown to have a small contribution to overall particulate matter concentrations, with the maximum predicted concentrations resulting from the cooling towers in isolation being less than 0.2 $\mu g/m^3$ as a 24-hour average. The maximum concentrations occur at the site boundary, and quickly disperse to negligible levels with distance from the site. The cooling tower discharges are therefore expected to have a negligible impact on the surrounding environment.

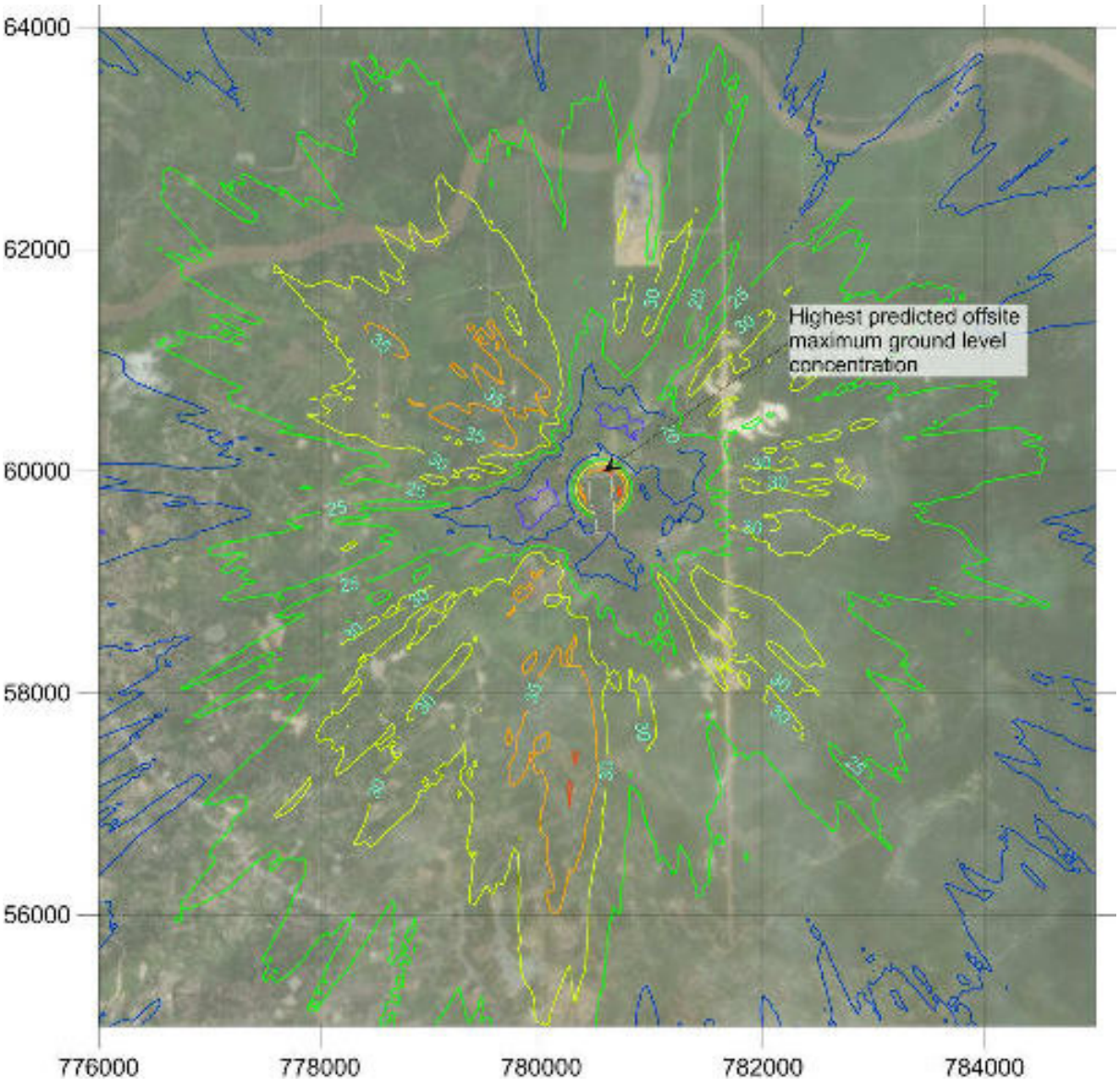


Figure 5.1 : Highest Predicted Maximum Ground Level Concentrations (1-hour average, 99.9th percentile) of NO_2 ($\mu g/m^3$) from discharges from the proposed power plant (excluding background)

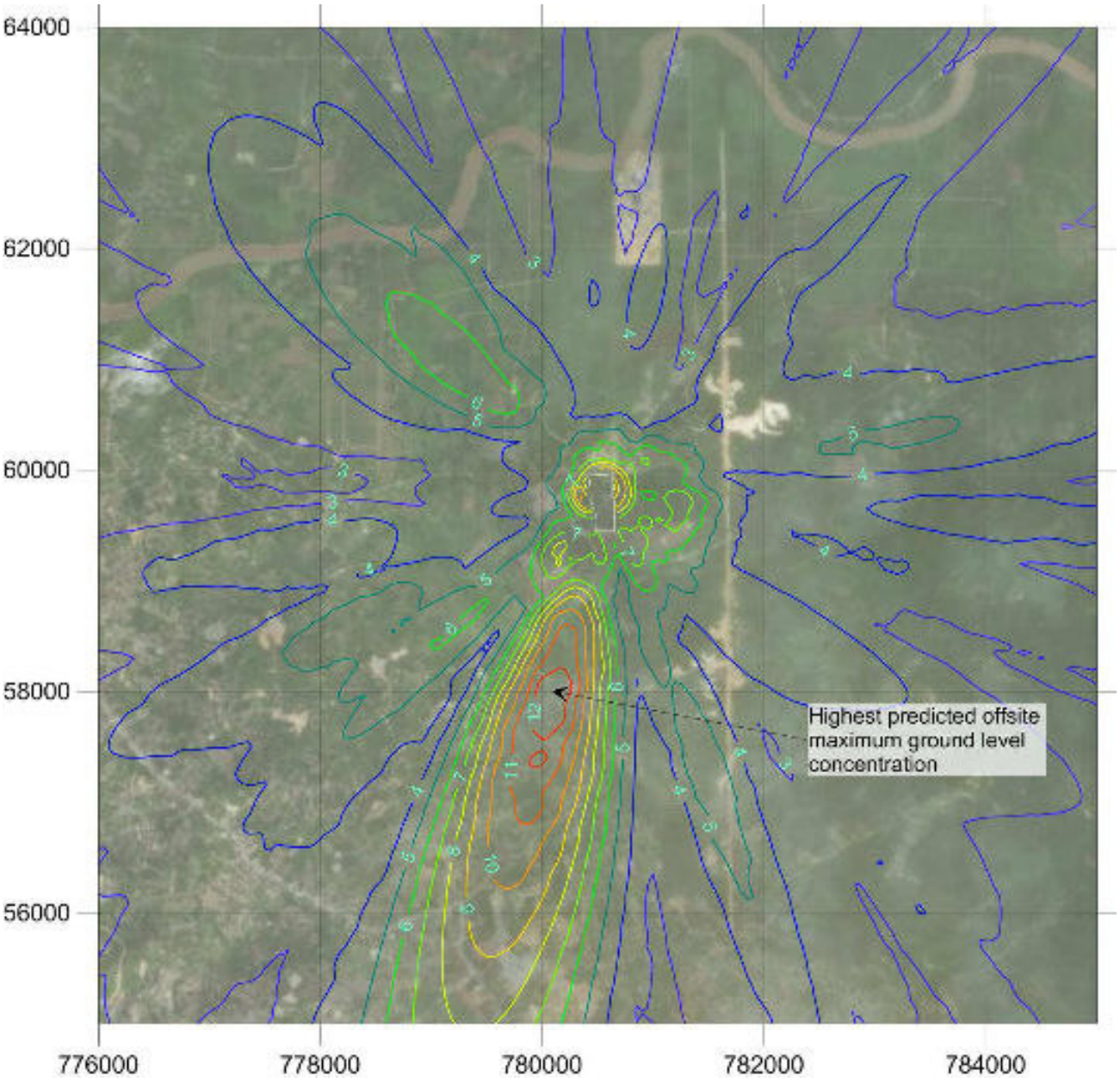


Figure 5.2 : Highest Predicted Maximum Ground Level Concentrations (24-hour average) of NO_2 ($\mu g/m^3$) from discharges from the proposed power plant (excluding background)

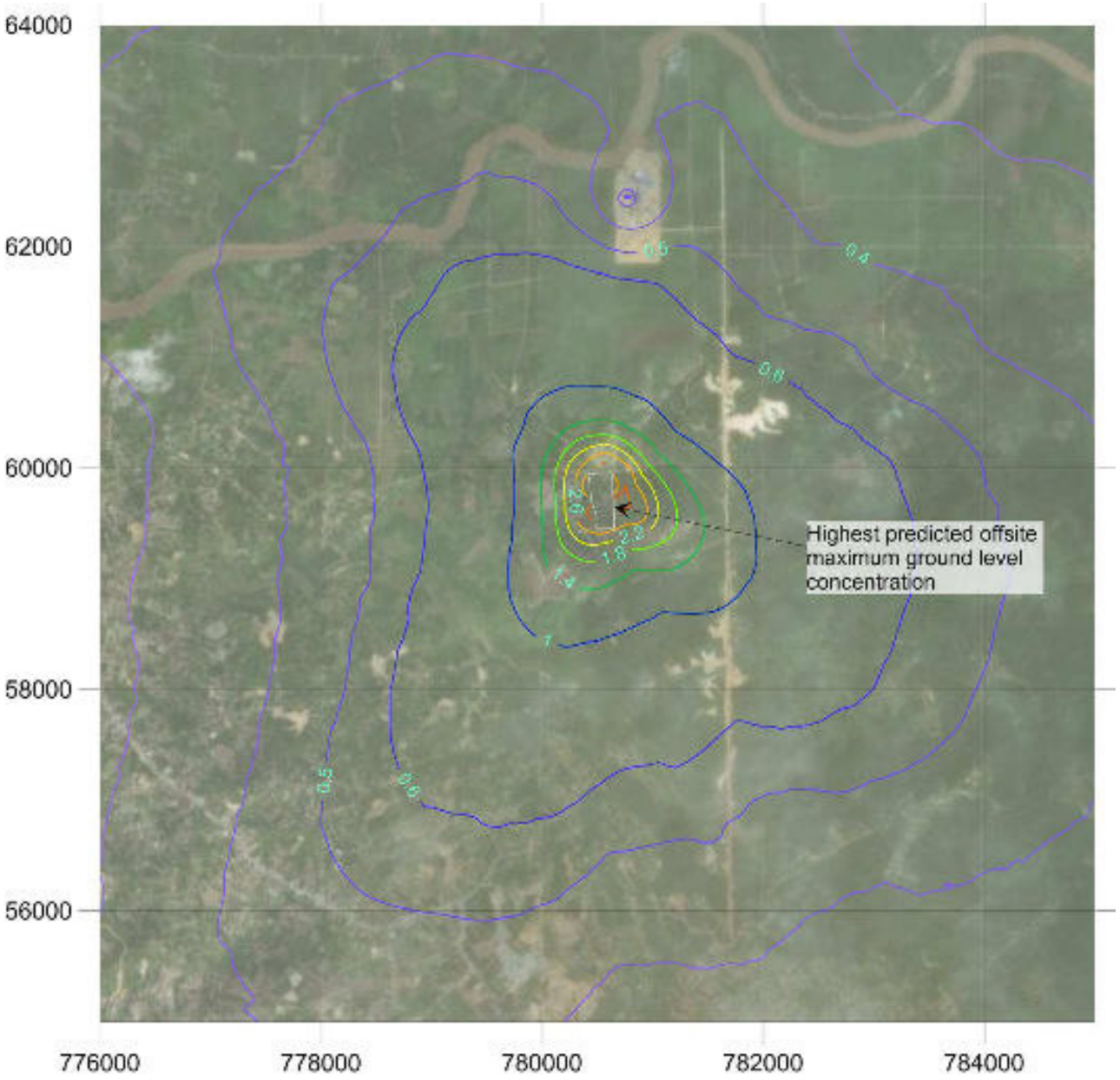


Figure 5.3 : Highest Predicted Maximum Ground Level Concentrations (annual average) of NO_2 ($\mu g/m^3$) from discharges from the proposed power plant (excluding background)

5.3.1 Black Start Emergency Situation

Due to the infrequent nature of the running of the BSDGs in an emergency situation and the short duration for which these units will operate impact of emissions to air on the surrounding air quality will be negligible.

5.4 Cumulative Impacts

The highest MGLCs predicted by the AERMOD dispersion model for the combined Riau CCPP and Tenayan CFPP are presented in Table 5.44 below.

The relevant international air quality standards and guidelines are provided for comparison. Isopleths of predicted MGLCs of NO_2 are provided as 1-hour averages (99.9th percentile) in Figure 5.4, 24-hour averages in Figure 5.5 and as an annual average in Figure 5.6. Maximum concentrations including existing background concentrations are also provided. As previously discussed, the background concentrations are adopted from monitoring undertaken in Pekanbaru, and are expected to be higher than what would be observed in the Project area. It is also noted that the existing Tenayan CFPP has been included in the modelling assessment, which will account for discharges that may not be observed (or would be observed at a lower level) at the Pekanbaru ambient air monitoring station.

Table 5.4: Highest MGLCs from Cumulative Discharges (Proposed Riau CCPP and Existing Tenayan CFPP), for Comparison with International and Indonesian Guidelines

Pollutant and Averaging Period	Highest Predicted MGLCs (µg/m^3)		International Guidelines (µg/m^3)	Indonesian Ambient Air Standards (µg/m^3)
	Excluding Background	Including Background		
CO (1-hour highest 99.9th percentile)	10.5	1210.5	30,000 (NZ)	30,000
CO (24-hour)	2.6	602.6	10,000 (WHO)	10,000
NO_2 (1-hour highest 99.9th percentile)	53.4	67.4	200 (WHO)	400
NO_2 (as NO_2, 24-hour average)	15.7	27.7	100 (NZ)	150
NO_2 (as NO_2, annual average)	4.4	14.4	40 (WHO)	100
PM_{10} (24-hour average)	2.7	39.7	150 (WHO Interim target 1); 100 (WHO Interim target 2); 75 (WHO Interim target 3); 50 (WHO)	150
PM_{10} (annual average)	0.8	48.8	70 (WHO Interim target 1); 50 (WHO Interim target 2); 30 (WHO Interim target 3); 20 (WHO)	n/a
$PM_{2.5}$ (24-hour average)	2.7	21.7	75 (WHO Interim target 1); 50(WHO Interim target 2); 37.5 (WHO Interim target 3); 25 (WHO)	65
$PM_{2.5}$ (annual average)	0.8	24.8	35 (WHO Interim target 1); 25 (WHO Interim target 2); 15 (WHO Interim target 3); 10 (WHO)	n/a
SO_2 (1-hour highest 99.9th percentile)	141.9	224.9	350 (NZ)	900
SO_2 (24-hour average)	29.1	112.1	125 (WHO Interim target 1); 50 (WHO Interim target 2); 20	365

Pollutant and Averaging Period	Highest Predicted MGLCs (µg/m³)		International Guidelines (µg/m³)	Indonesian Ambient Air Standards (µg/m³)
	Excluding Background	Including Background		
SO_2 (annual average)	6.4	72.4	10 – 30 (NZ)	60

Isopleth diagrams showing the highest predicted concentrations of NO_2 resulting from the combined discharges from the Project and the existing Tenayan CFPP are provided as Figure 5.4 (1-hour averages), Figure 5.5 (24-hour averages), and Figure 5.6 (annual averages) below. The highest predicted MGLC of NO_2 as a 1-hour average (99.9 percentile) from the cumulative discharges is 53 µg/m³ (67 µg/m³ including the assumed background NO_2 concentration), which is well below the WHO one-hour average guideline value of 200 µg/m³, and the Indonesian Standard of 400 µg/m³. The highest predicted concentrations occur at the site boundary of the Project. There is little overlap in the plumes in NO_2 concentrations between the Project and the existing Tenayan CFPP. This is likely due to the distance between the two power plants as well as the differences in emission heights of the two sources.

Predicted MGLCs of NO_2 as 24-hour averages are similarly well below the 100 µg/m³ International guideline value, and the 150 µg/m³ Indonesian Standard. The highest predicted MGLCs are shown to occur approximately 1.5 km to the south-west of the Project site.

Predicted MGLCs of NO_2 as annual averages (including background) are also low, being less than 40% of the 40 µg/m³ WHO Guideline, but are less than 15% of the 100 µg/m³ Indonesian Standard.

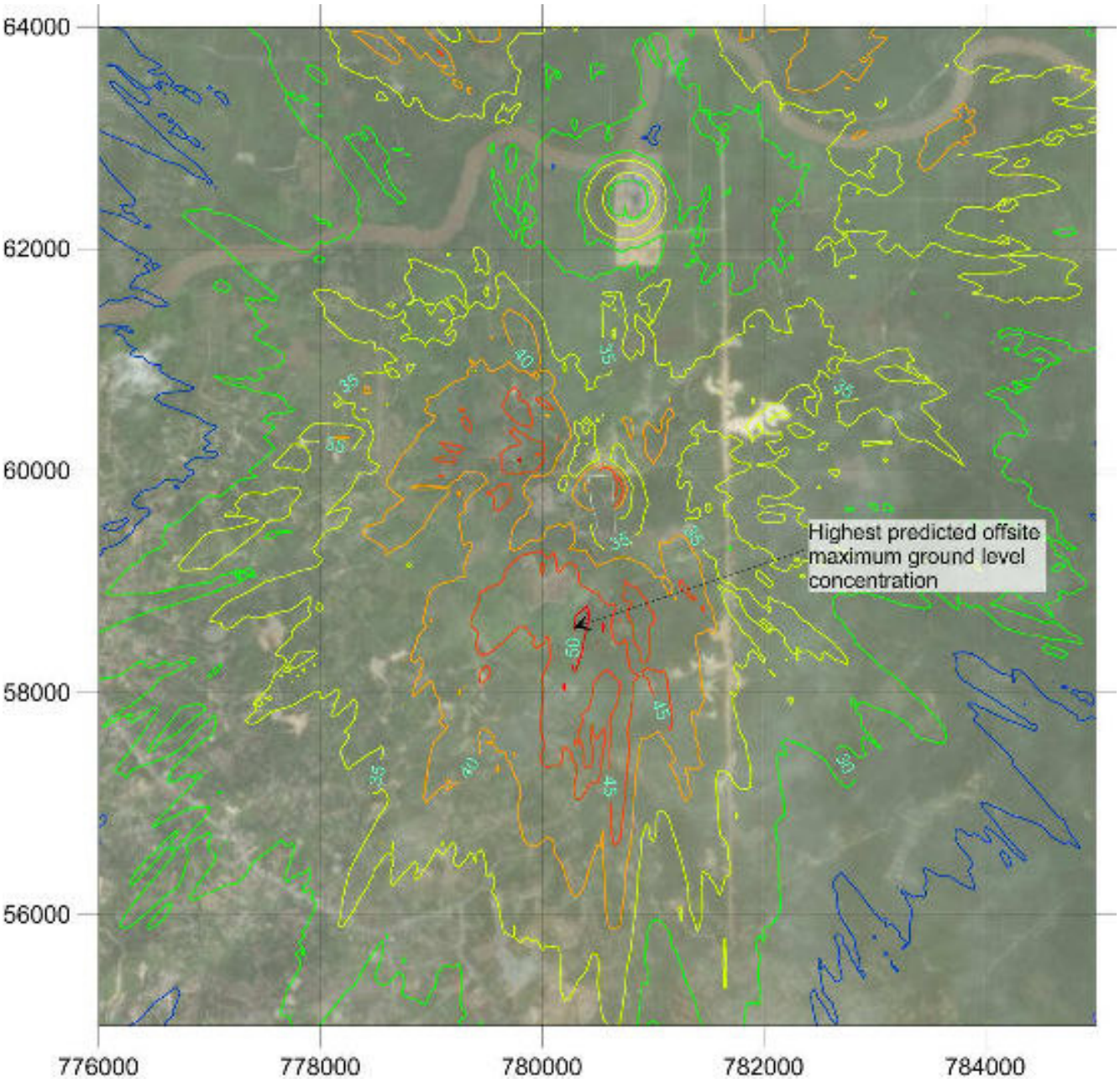


Figure 5.4 : Highest Predicted Maximum Ground Level Concentrations (1-hour average, 99.9th percentile) of NO_2 ($\mu g/m^3$) from discharges from the existing and proposed power complexes (excluding background)

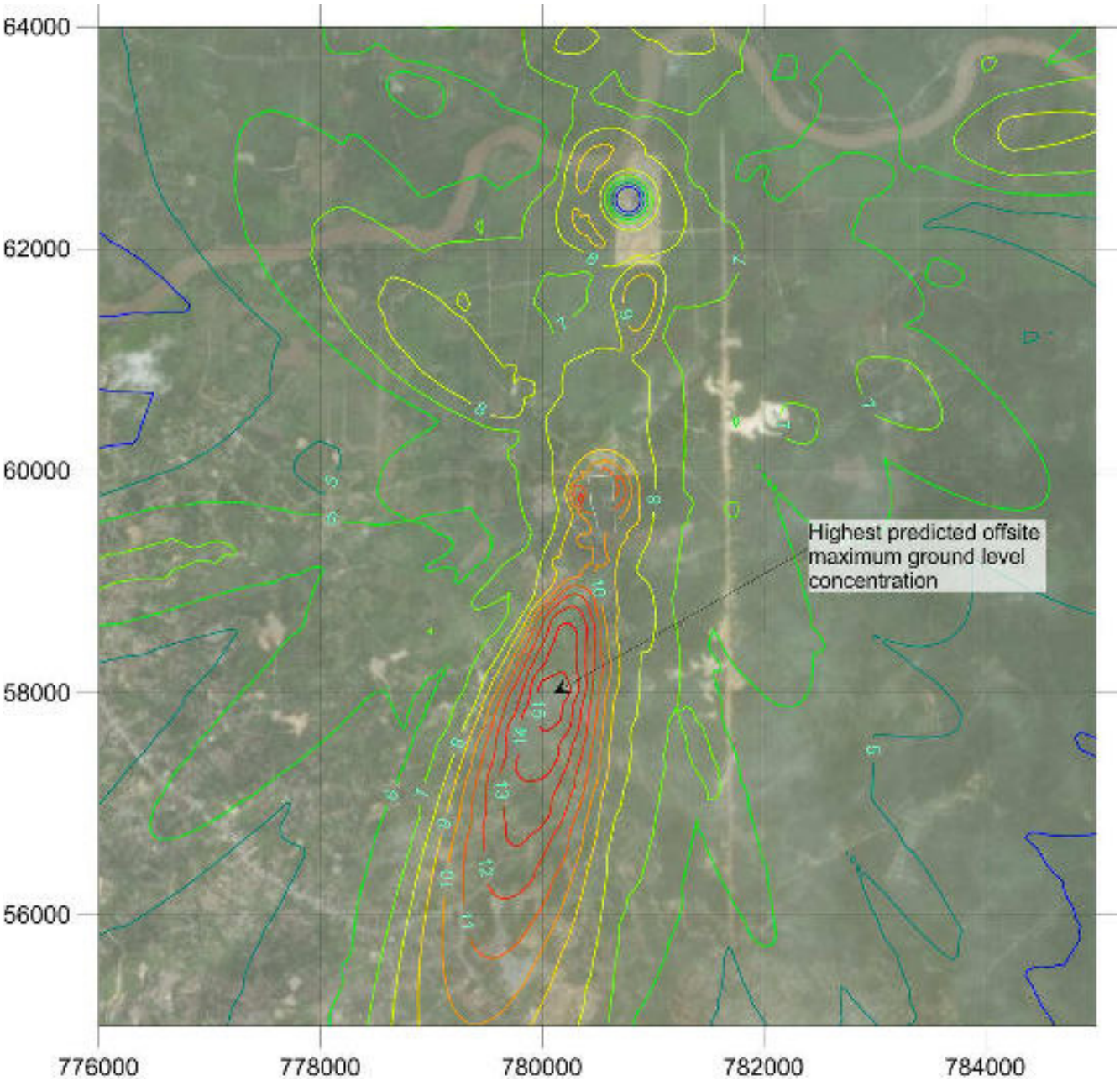


Figure 5.5 : Highest Predicted Maximum Ground Level Concentrations (24-hour average) of NO_2 ($\mu g/m^3$) from discharges from the existing and proposed power complexes (excluding background)

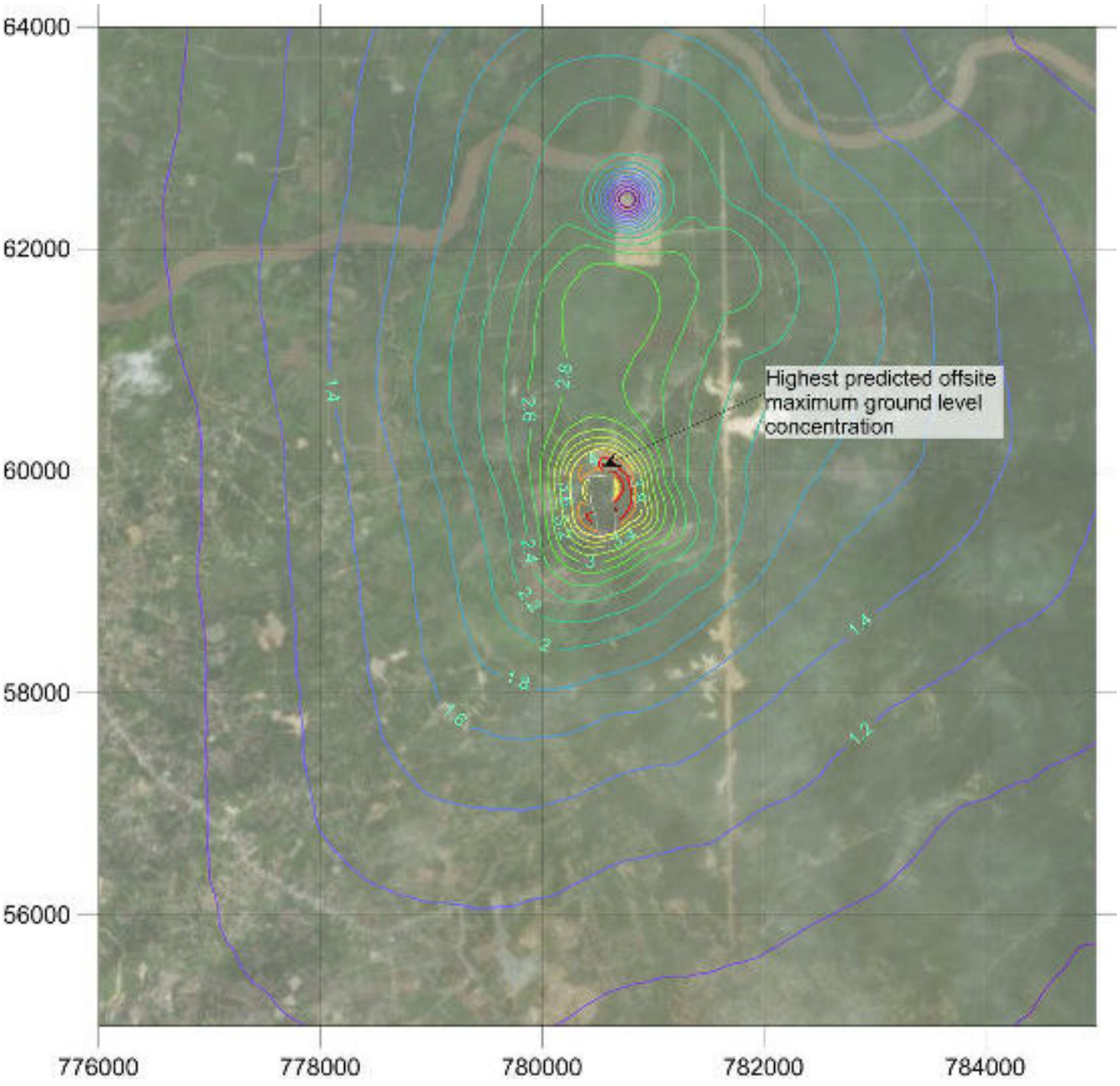


Figure 5.6 : Highest Predicted Maximum Ground Level Concentrations (annual average) of NO_2 ($\mu g/m^3$) from discharges from the existing and proposed power complexes (excluding background)

The Tenayan CFPP discharges contaminants to air at a greater rate than the Project due to the nature of coal-fired power plants, and consequently the model predictions are higher for the cumulative assessment. It is noted that the existing background concentrations as measured at both Pekanbaru and at the baseline monitoring sites would include the Tenayan CFPP discharges, and so adding the background concentrations to the model predictions could be seen as 'double counting'.

Regardless, the incremental increase in ambient concentrations of CO, PM_{10} and SO_2 resulting from the combined Tenayan CFPP and the Project's air discharges are well below the ambient air guidelines. It is also noted that the very low discharge rates of these contaminants from the Project mean that the contribution to the

ambient concentrations in the region are relatively minor and will not result in significant increases in ambient air concentrations.

Based on the above assessment, the impact magnitude as per the matrix provided in Table 3.2 of the operation of the Project is expected to be 'Moderate', in that there will be a permanent and detectable change to the contaminant concentrations (principally NO_X) in the surrounding environment.

The sensitivity of the receiving environment, as per the matrix provided in Table 3.3, is considered to be 'Low', in that the dispersion modelling assessment indicates that the surrounding area has some capacity to absorb the change to the increase in the air contaminants without resulting in significant degradation of air quality.

The impact significance on air quality from the operation of the Project (i.e. an activity with a 'Moderate' impact upon a 'Low' sensitivity receiving environment) as therefore assessed as being 'Minor' as determined by the matrix provided in Table 3.4.

6. Mitigation and Monitoring

6.1 Construction Phase

6.1.1 Mitigation

Although the unmitigated impacts of nuisance dust are not considered to be significant in the wider context of the Project, there could be individual residences within closer proximity to construction sites, as well as local use of near-by farming areas. The Project will apply good working practices to minimise potential impacts through mitigation techniques such as:

- Water spraying of or covering all exposed areas and stockpiles;
- Covering or enclosed storage of aggregates (including topsoil and sand) where practical;
- Minimizing the size of exposed areas and material stockpiles and the periods of their existence;
- Covering the construction materials transported by trucks or vehicles to prevent dust emissions;
- Limiting dust generation activities in high winds or specific wind directions, if required;
- Cleaning wheels and the lower body parts of trucks at all exits of the construction site;
- Cleaning the entire construction work sites at least once per week; and,
- Maintaining and checking the construction equipment regularly.

6.1.1 Monitoring

As part of good working practice the construction manager for the construction phase of the Project will complete routine checks on dust generation from construction activities, and confirm that dust suppression and appropriate storage is being used where required. In addition, a mechanism for complaints regarding dust will be available to locals, and due regard given to any issues raised.

6.2 Operational Phase

6.2.1 Mitigation

Mitigation of discharges from the operational phase of the project has occurred in the Project design stage, and includes high efficiency burners and low design concentration of contaminants from natural gas combustion. Drift eliminators on the cooling towers also limit particulate matter discharges from the site.

As discussed in 4.2 and 4.3, the predicted maximum contribution of air pollutants to the airshed resulting from the operation of the Project is low, at less than 25% of the relevant air quality standards for all contaminants. Since the Project is located in a non-degraded airshed with respect to the main contaminant discharged (NO_2), and the maximum Project contribution is predicted to be less than 25% of the relevant air quality standards, the cumulative impact significance is also considered minor during the operation of the Project. No additional mitigation measure associated with the operation of the Project is therefore required.

6.2.2 Monitoring

The Project will include an environmental monitoring programme, which will include a Continuous Emissions Monitoring System (CEMS) for continuous monitoring of gases discharged from both stacks, including measurements of oxygen, carbon dioxide, nitrogen oxides and temperature.

It is recommended that ambient air monitoring for NO_2 is undertaken in the area surrounding the power plant at two locations, with sampling carried out using passive and manual methods on a monthly basis. Alternatively, a permanent continuous ambient air monitoring unit for NO_2 which utilises electro chemical cell non-reference method could be installed at one location where the highest concentration of NO_2 as a 24-hour average is predicted to occur, subject to land acquisition and security arrangements.

7. Assessment of Residual Impacts

7.1 Construction Phase

The assessment indicates that the air quality associated with the construction will be controlled to minor; no adverse air quality impact during construction phase will be anticipated provided all recommended air mitigation measures will be implemented.

7.2 Operational Phase

The potential air quality impacts arising from the Project during the operational phase have been predicted to be small relative to the relevant WHO Ambient Air Quality Guidelines as recommended in the IFC Guidelines. Incremental impacts in the degraded air shed should therefore be minimised by NO_X emissions being less than 25% of the WHO guideline, and will be significantly less than this at the nearest residential areas. Incremental impacts of other contaminants, including SO_2 and particulate matter, are significantly lower than those of NO_2. The significance of impact during the operation phase of the Project is therefore considered minor.

8. References

Edwards M, Hurley P, and Physick B, 2004. *Verification of TAPM meteorological predictions using sodar data in the Kalgoorlie region*, CSIRO.

Hanrahan, P. L. 1999. The Plume Volume Molar Ratio Method for Determining NO2/NO*x* Ratios in Modelling-Part I: Methodology. J. Air & Waste Manage. Assoc. 49:1324-1331. 1999.

Hibberd M, Physick B, and Park G, 2003. *Verifications of several aspects of TAPM against multi-year monitoring data at Collie.*, Proceedings of the 17th International Clean Air Conference, 2003.

Institute of Air Quality Management (IAQM), 2014. *IAQM Guidance on the assessment of dust from demolition and construction*, Institute of Air Quality Management, London. Available at: http://iaqm.co.uk/wp-content/uploads/guidance/iaqm_guidance_report_draft1.4.pdf [Accessed March 2018].

Ministry for the Environment, 2002. *Ambient Air Quality Guidelines, 2002 update,* NZ Ministry for the Environment. Available at: http://www.mfe.govt.nz/sites/default/files/ambient-guide-may02.pdf [Accessed December 2017].

Ministry for the Environment, 2004. *Good practice guide for atmospheric dispersion modelling*. Available at: http://www.mfe.govt.nz/publications/air/atmospheric-dispersion-modelling-jun04/atmospheric-dispersion-modelling-jun04.pdf [Accessed March 2018].

United Kingdom Environment Agency, 2015. *Air Modeling Guidelines on Conversion Ratios for NOx and NO_2*. Available at: http://www.environmentagency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf [Accessed March 2018].

United States Environmental Protection Authority, 2000. *AP 42 Section 3.1 Stationary Gas Turbines*. Available at: https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf [Accessed March 2018].

United States Environmental Protection Authority, 2017. *CFR 40 Part 51—Guideline on Air Quality Models, Appendix W, 2017*. Available at: https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf [Accessed February 2018].

Victorian Environmental Protection Authority, *Victoria Government Gazette*, 21 December 2001.

World Bank Indonesia office, 2003. *Indonesia Environment Monitor 2003, Special Focus Reducing Pollution*

World Bank Group, 2007. *Environmental Health and Safety Guidelines: General EHS Guidelines: Environmental: Air emissions and ambient air quality.* Available at: http://www.ifc.org/wps/wcm/connect/532ff4804886583ab4d6f66a6515bb18/1-1%2BAir%2BEmissions%2Band%2BAmbient%2BAir%2BQuality.pdf?MOD=AJPERES [Accessed March 2018].

World Bank Group, 2008. *Environmental Health and Safety Guidelines: Environmental, Health, and Safety Guidelines for Thermal Power Plants*. Available at: http://www.ifc.org/wps/wcm/connect/dfb6a60048855a21852cd76a6515bb18/FINAL_Thermal%2BPower.pdf?MOD=AJPERES&id=1323162579734 [Accessed March 2018].

World Health Organisation (WHO), 2006. *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide - Global update 2005 - Summary of Risk Assessment*, World Health Organisation, Geneva.

Available at: http://apps.who.int/iris/bitstream/10665/69477/1/WHO_SDE_PHE_OEH_06.02_eng.pdf [Accessed August 2017].

Appendix A. Assessment Criteria

The assessment criteria below have been summarised from the *Guidance on the Assessment of Dust from Demolition and Construction* developed by the Institute of Air Quality Management (IAQM) (2014).

A.1 Dust Emission Magnitude

Earthworks

Earthworks will primarily involve excavating material, haulage, tipping and stockpiling. This may also involve levelling the site and landscaping. Every site is different in terms of timing (seasonality), geology, topography and duration and therefore professional judgement must be applied when classifying the earthworks' activities.

The following are examples of the potential dust emission classes (note that not all the criteria need to be met for a particular class); other criteria may be used if justified in the assessment:

- Large: Total site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry to due small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8m in height, total material moved >100,000 tonne;
- Medium: Total site area 2,500m^2 – 10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m – 8 m in height, total material moved 20,000 tonne – 100,000 tonne; and
- Small: Total site area <2,500 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <10,000 tonne, earthworks during wetter months.

Construction

The key issues when determining the potential dust emission class during the construction phase include the size of the building(s)/infrastructure, method of construction, construction materials, and duration of build. Every site is different in terms of timing (seasonality), building type, duration, scale (volume and height) and therefore professional judgement must be applied when classifying the construction activities into one of the 3 magnitude classes.

The following are examples of the potential dust emission classes (note that not all the criteria need to be met for a particular class); other criteria may be used if justified in the assessment:

Large: Total building volume >100,000m^3, piling, on site concrete batching; sandblasting

Medium: Total building volume 25,000m^3 – 100,000m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching; and

Small: Total building volume <25,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber).

Trackout

Factors which determine the dust emission magnitude are vehicle size, vehicle speed, vehicle numbers, geology and duration. As with all other potential sources, professional judgement must be applied when classifying trackout into one of the dust emission magnitude categories.

Example definitions for trackout are:

Large: >50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m;

Medium: 10-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m; and

Small: 3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length.

These numbers are for vehicles that leave the site after moving over unpaved ground, where they will accumulate mud and dirt that can be tracked out onto the public highway.

A.2 Area Sensitivity

The dust emission magnitudes for both earthworks and construction activities should then be used in the matrix in Table A1 to determine the earthworks risk category for dust soiling effects with no mitigation applied. Similarly, the dust emission classes should be used in the matrix provided in Table A2 to assess risk to human health, and Table A3 for assessing ecological risk.

Table A1: Sensitivity of the area to Dust Soiling Effects on People and Property

Receptor Sensitivity	Number of Receptors	Distance from Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table A2: Sensitivity of the area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM_{10} Concentration	Number of Receptors	Distance from Source (m)				
			<20	<50	<100	<200	<350
High	>32 µg/m^3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32 µg/m^3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28 µg/m^3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24µg/m^3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32 µg/m^3	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32 µg/m^3	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	24-28 µg/m^3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24µg/m^3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table A3: Sensitivity of the area to Ecological Impacts

Receptor Sensitivity	Distance from Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

A.3 Risk of Dust Impacts

The dust emission magnitude determined for construction and earthworks activities (i.e. small, medium or large) should be combined with the sensitivity of the area determined by the matrices in Tables A1, A2 and A3) to determine the risk of impacts with no mitigation applied. The matrix in Table A4 provides a method of assigning the level of risk for each activity. This should be used to determining the level of mitigation that must be applied. For those cases where the risk category is 'Negligible', no mitigation measures beyond those required by legislation will be required.

Table A4: Risk of Dust Impacts

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Appendix F. Technical Report – Noise Impact Assessment

Riau 275 MW Gas Combine Cycle Power Plant IPP - ESIA

Medco Ratch Power Riau

Technical Report – Noise Assessment

AM039100-400-GN-RPT-1009 | V1

May 2018

Document history and status

Revision	Date	Description	By	Review	Approved
Draft A	14/12/2017	Initial draft	B Ison	L Spencer	B Ison
Draft B	11/01/2018	Updated to address additional input information	L Spencer	D Borella	L Spencer
Draft C	01/03/2018	Change to various project design features	B Ison	L Spencer	B Clarke
Draft D	19/03/2018	Project manager review	B Ison	B Clarke	B Ison
V0	19/04/2018	Final Draft for Issue	A Kubale	B Clarke	B Clarke
V1	18/05/2018	Final Draft for Disclosure	A Kubale	B Clarke	B Clarke

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
D	PM approved	23/3/2018	MRPR for client review	
V0	Final Draft	19/04/2018	Final Draft for Issue	
V1	Final for Discl	18/05/2018	Final Draft for Disclosure	

Riau 275 MW Gas Combine Cycle Power Plant IPP - ESIA

Project No:	AM039100
Document Title:	Technical Report -INSERT REPORT TITLE
Document No.:	AM039100-400-GN-RPT-1009
Revision:	V1
Date:	May 2018
Client Name:	Medco Ratch Power Riau
Project Manager:	Eamonn Morrissey
Author:	Ben Ison
File Name:	I:\AENVW\Projects\AM039100 Riau\Deliverables\ESIA\Technical Assessments\Noise\AM39100_Riau ESIA_Noise Assessment_V1_Final Draft for Disclosure.docx

Jacobs New Zealand Limited

Level 3, 86 Customhouse Quay,
PO Box 10-283
Wellington, New Zealand
T +64 4 473 4265
F +64 4 473 3369
www.jacobs.com

Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs New Zealand Limited (Jacobs) is to describe potential noise impacts for Riau IPP Project Environmental and Social Impact Assessment (ESIA), in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Acronyms

AMDAL	Analisis Mengenai Dampak Lingkungan
ADB	Asian Development Bank
CEMP	Construction Environmental Management Plan
CEMS	Continuous Environmental Monitoring Station
CCPP	Combined cycle power plant
CFPS	Coal fired power plant
CPI	Corrugated plate interceptor
EHS	Environmental, Health and Safety
EPFI	Equator Principle Financial Institution
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
GT	Gas turbine
H&SP	Health and Safety Plant
ha	Hectare
HHV	High Heating Value
HP	High pressure
HRSG	Heat recovery steam generator
IP	Intermediate pressure
km	Kilometres
m	Metres
aMSL	Above mean sea level
MRPR	Medco Ratch Power Riau
MW	Megawatt
NO_x	Oxides of Nitrogen
OHL	Overhead Line
OPGW	Optical Ground Wire
PPA	Power Purchase Agreement
RoW	Right of way
SAP	Survey Action Plan
SEP	Stakeholder Engagement Plan
ST	Steam turbine
T	Tonnes

1. Introduction

1.1 Purpose

This Technical Report provides an assessment of the noise impacts associated with the construction and operation of the Riau 275 MW Combined Cycle Gas Fired Power Plant IPP Project (Riau 275MW CCPP). The project consists of a 275 MW combined cycle power plant and ancillary facilities, a 40 km long 12-inch gas pipeline, and a switchyard and 150 kV transmission line - collectively comprising the "Project".

This report provides a brief description of the location and environmental setting, followed by key details of the proposed design in respect to construction and operation of the Project. This report is one of several technical reports prepared for the Environmental and Social Impacts Assessment (ESIA) and other permitting work associated with the Project. It is based on preliminary engineering work, including the EPC Contractor's (Lotte E&C) preliminary design of the power plant.

1.2 Background

The Riau 275 MW CCPP will be a new, greenfield power station. The Project Sponsors (being PT Medco Power Indonesia (MEDCO) and Ratchaburi Electricity Generating Holding PCL (RATCH), have formed PT Medco Ratch Power Riau (MRPR) to build, own and operate the plant under the terms of the Power Purchase Agreement (PPA) which has been agreed with PLN.

The key components of the Project include a 275 MW combined cycle power plant (CCPP), a 40 km long gas supply pipeline which will bring fuel to the site, a 150 kV switchyard, and an approximately 750 m long transmission line to connect the power plant to the PLN grid. Once constructed, ownership of the switchyard and transmission line collectively known as the Special Facilities will be transferred to PLN. At the end of the 20-year term of the PPA, PLN will take ownership of the power plant and gas supply pipeline.

The Project will be located approximately 10 km due east of Pekanbaru City, approximately three km south of the Siak River. The power plant and switchyard well be comfortably accommodated inside the 9 ha of land being procured by MRPR. The power plant is a 2 x 1 combined cycle plant, designed to deliver up to 275 MW over the 20-year term of the PPA. It will burn gas fuel only. It will consist of:

- 2 x GE 6F.03 gas turbine (GT) generator sets;
- 2 x supplementary fired heat recovery steam generators (HRSGs);
- 1 x steam turbine (ST) generator set;
- A wet mechanical draft cooling tower;
- Gas reception area; and
- All normal balance of plant systems.

In addition, there will be:

- a 150 kV switchyard at the plant, with an approximately 750 m double-phi connection to intercept the Tenayan – Pasir Putih 150 kV transmission line;
- A 40 km gas pipeline running from the gas connection point at an offtake location known as SV1401 on the main Grissik-Duri gas pipeline; and
- Water supply and discharge pipelines to and from the Siak River.

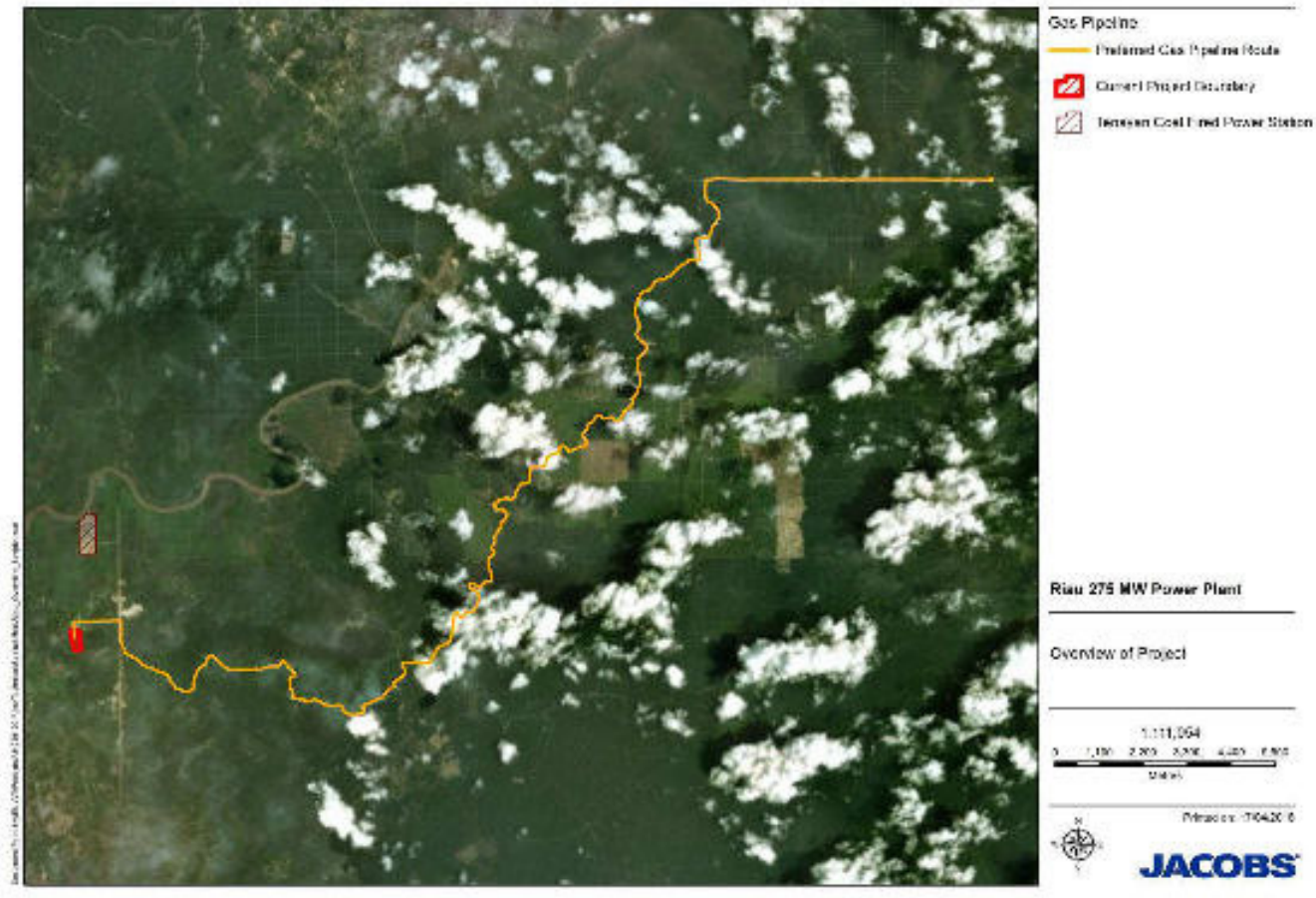


Figure 1.1 : Outline of Project Area

1.3 Purpose

The purpose of this report is to provide an assessment of the noise impacts for the operation and construction of the Project.

The objectives of this study were to:

1) Establish operational and construction noise criteria for environmental noise emissions at potentially noise affected sensitive receivers surrounding the site;
2) Determine all acoustically significant plant required for the construction of the Project and to predict noise at the nearest potentially affected noise sensitive receivers within the vicinity of the works;
3) From results of the noise predictions, assess noise levels from proposed construction relative to the noise criteria at the nearest potentially affected receivers;
4) Determine all acoustically significant plant required during the operation of the project and to predict noise at the nearest potentially affected noise sensitive receivers within the vicinity of the power station;
5) From results of the noise predictions, assess noise levels from proposed site operations relative to the noise criteria at the nearest potentially affected receivers; and
6) Recommend construction and operational noise impact mitigation and management measures if required.

Specific acoustic terminology is used within this report. An explanation of common terms is included in Appendix A.

2. Baseline Existing Environment

The current land uses at the proposed power plant site are predominantly palm oil plantations and low density rural residential properties. The photograph in Figure 2.1 provides an indication of the terrain and topography immediately surrounding the site and in Figure 2.1: View of proposed CCPP site an indication of typical rural residential development south-east of the proposal.

Figure 2.1 : View of Proposed CCGP Site

Figure 2.2 : View Towards Existing Tenayan CFPP Over Rural Residential Area

Further afield, the eastern outskirts of Pekanbaru City are located approximately 3 to 4 km towards the west and south.

2.1 Acoustic Character of Surrounding Area

Noise levels were measured at locations representative of the nearest built up areas over several days during September and October 2017. The ambient noise levels were recorded continuously for a one-hour period during representative time intervals and comments against identifiable noise influences were noted during the noise survey. Typically, the noise sources in the area were as follows:

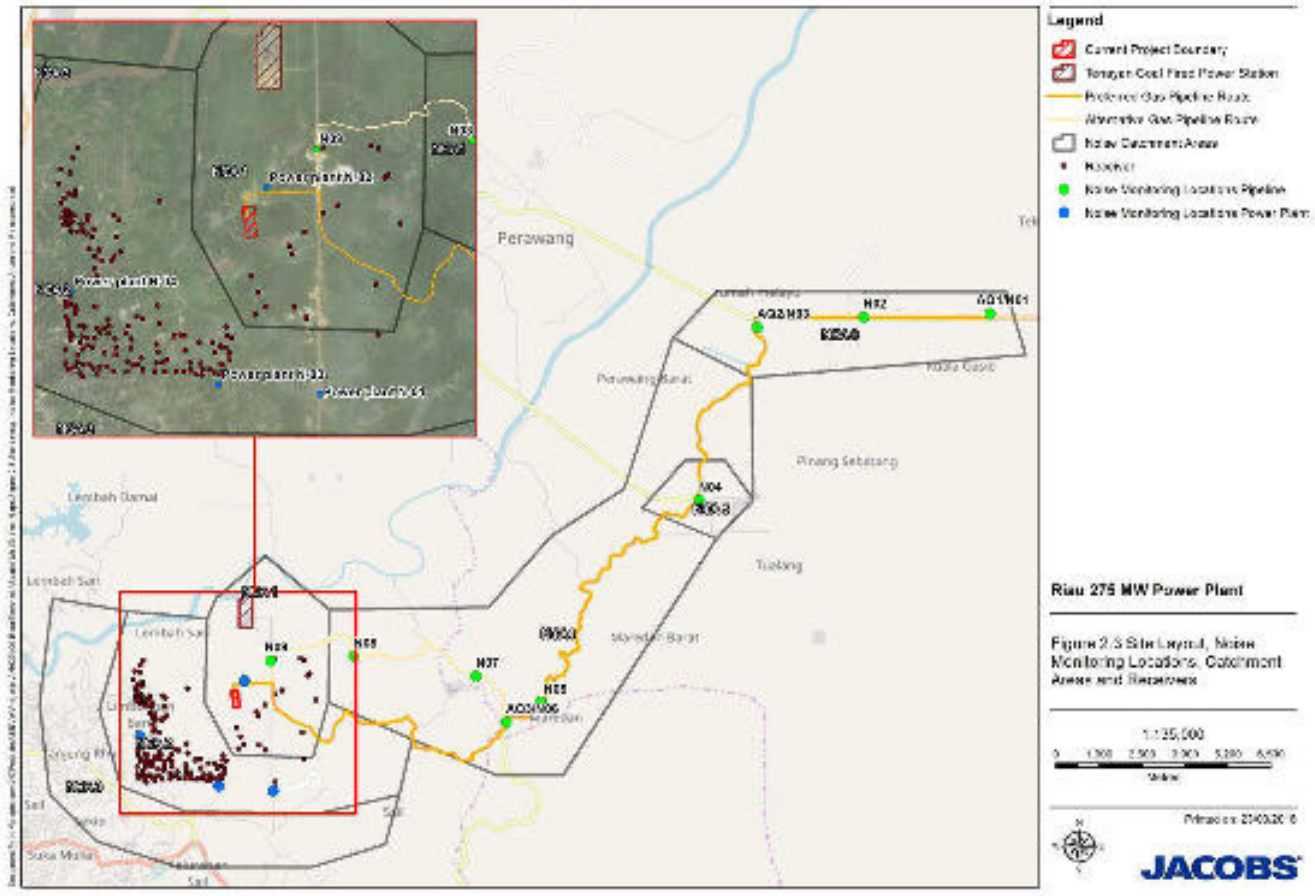
Day time – residential areas

- Noise from traffic activity
- Residential noise (children, talking, televisions, radios)
- Birds
- Dogs.

Night time – residential areas

- Noise from traffic activity
- Dominant noise from crickets and other nocturnal insects
- Generators
- Crickets
- Occasional birds.

Monitoring locations are presented visually in Figure 2.3



, and the results of monitoring are provided in Table 2.2.

2.1.1 Noise catchment areas

The area surrounding the proposed Riau CCPP has been divided into Noise Catchment Areas (NCAs). These areas have been presented in Table 2.1 and graphically in Figure 2.3 and have been defined according to the likely noise environment in the area.

Table 2.1 : Description of NCAs

Noise Catchment Area	Description
NCA 1	The immediate vicinity of the Riau CCPP
NCA 2	Semi-rural receivers on the eastern outskirts of Pekanbaru
NCA 3	Suburban receivers in eastern Pekanbaru
NCA 4	Palm oil plantations
NCA 5	Township near the intersection of JI Baru Bakal and JI Pemda
NCA 6	Properties along JI Ferry Pinang Sebatang

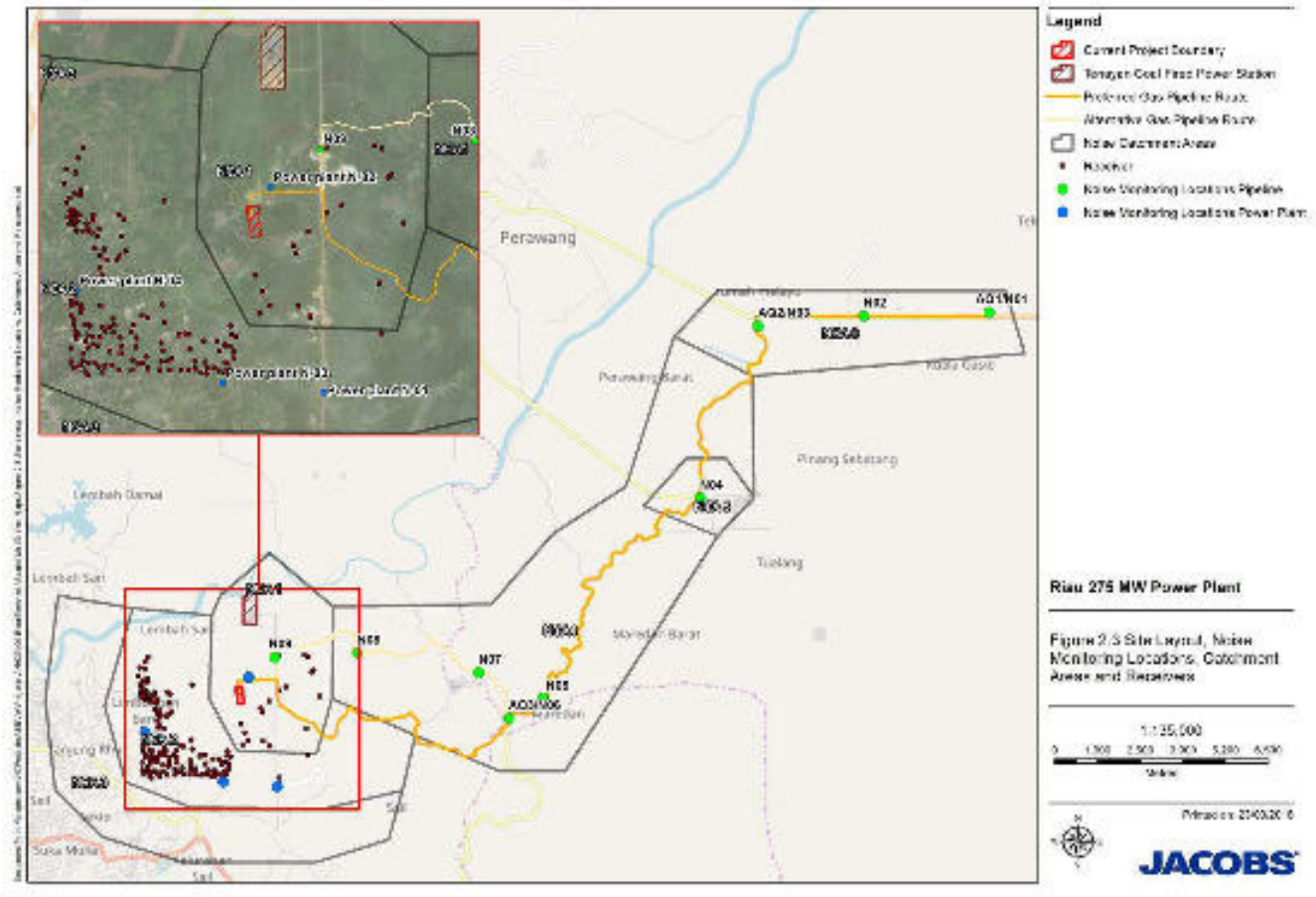


Figure 2.3 : Site Layout, Noise Monitoring Locations and Catchment Areas

2.1.2 Monitoring results

The results of monitoring at each location are summarised in Table 2.2. Noise monitoring was carried out at each site during periods where noise impacts may be experienced. For the pipeline route, noise impacts may be associated with daytime construction work only, while at for receivers potentially affected by power station noise, results are presented for each time interval of the 24-hour monitoring period and for the overall Ls (Daytime), Lm (Night time) and Lsm (24 hour) periods.

Table 2.2 : Noise Monitoring Results

Study area	Location	NCA	Monitored noise level (L_{Aeq} period)							Overall noise level			World Bank Parameters	
			L1	L2	L3	L4	L5	L6	L7	Ls	Lm	Lsm	Day	Night
			6am-9am	9am-11am	2pm-5pm	5pm-10pm	10pm-12am	12am-3am	3am-6am				(7:00 to 22:00)	(22:00 to 7:00)
Pipeline	PL01	6	-	57	-	-	-	-	-	-	-	-	-	-
	PL 02	6	-	62	-	-	-	-	-	-	-	-	-	-
	PL03	6	-	71	-	-	-	-	-	-	-	-	-	-
	PL 04	5	-	67	-	-	-	-	-	-	-	-	-	-
	PL 05	4	-	72*	-	-	-	-	-	-	-	-	-	-
	PL06	4	-	62	-	-	-	-	-	-	-	-	-	-

Study area	Location	NCA	Monitored noise level (L_{Aeq} period)							Overall noise level			World Bank Parameters	
			L1	L2	L3	L4	L5	L6	L7	Ls	Lm	Lsm	Day	Night
			6am-9am	9am-11am	2pm-5pm	5pm-10pm	10pm-12am	12am-3am	3am-6am				(7:00 to 22:00)	(22:00 to 7:00)
	PL 07	4	-	53	-	-	-	-	-	-	-	-	-	-
	PL 08	4	-	37	-	-	-	-	-	-	-	-	-	-
	PL 09	1	-	45	-	-	-	-	-	-	-	-	-	-
Power station	PS 01	2	61	50	58	49	52	47	44	56	49	55	54	55
	PS 02	1	61	53	62	57	59	62	61	59	61*	59	60	59
	PS 03	2	58	57	60	62	59	56	51	59	56	58	58	58
	PS 04	2	54	57	56	43	46	41	46	53	45	51	49	51

** These results appear to be unrealistically high and may indicate interference from a localised noise source.*

Audio recording at proposed power plant sites indicated that existing background noise levels were influenced by birds, local traffic and residential noise (including diesel generators) during daytime and evening hours and crickets during night time hours. Background noise levels along the pipeline route are controlled by the proximity of the monitoring site to local roads and the local density of residential properties.

2.2 Topography

The local topography and terrain is important in the consideration of noise propagation to other locations adjacent to the site. In the area of interest around the proposed power plant, the land is generally flat, with regular, low rolling hills.

The terrain is typically thickly vegetated with palm oil plantations and interspersed with small dirt roads. Over these large distances, acoustic absorption through these plantations may be significant and land usage has been accounted for in the modelling of noise impacts for the proposal.

2.3 Meteorology

The air quality assessment (Jacobs, 2018) has identified meteorological conditions typically associated with the proposed location of the Project. The prevailing weather patterns affect how noise propagates from the source to the receiver locations and provide potential for noise enhancing conditions to be present. Similarly, local weather conditions can also reduce noise impacts where wind directions are generally directed from receiver to the source (i.e. sound propagation towards sensitive receivers is hindered).

Wind is generally light, but the area is subject to monsoonal weather with high winds during the wet months. The predominant wind direction varies throughout the year, with southerly winds occurring primarily during the dry season and northerly winds during the rainy season. The average wind speed is less than 3 m/s.

The wind rose shown in Figure 2.4 has been generated from data collected at an ambient air monitoring site in Pekanbaru for 2010 to 2015. The data shows monitoring station is influenced by local buildings and terrain, with the general area affected by winds predominantly from the north-western and north-eastern sectors, and from the south-southeast. Calm conditions, which are a wind speed of less than 0.5m/s, are predicted to occur for 26.8% of the time and the average wind speed for the data period is 0.54 m/s. The very low wind speeds as well as the absence of winds from the north suggest that that winds at this location are measured at a low height above ground level, and are affected by local structures, trees, etc. Given the very low wind speeds observed, we consider the wind data to not be representative of meteorological conditions in the wider area which the Project is located.

As such the operational noise assessment has considered absolute worst case noise transmission, rather than typical indicative conditions. Under the modelled scenarios, wind has been assumed to be blowing at 2 m/s from each source to each receiver.

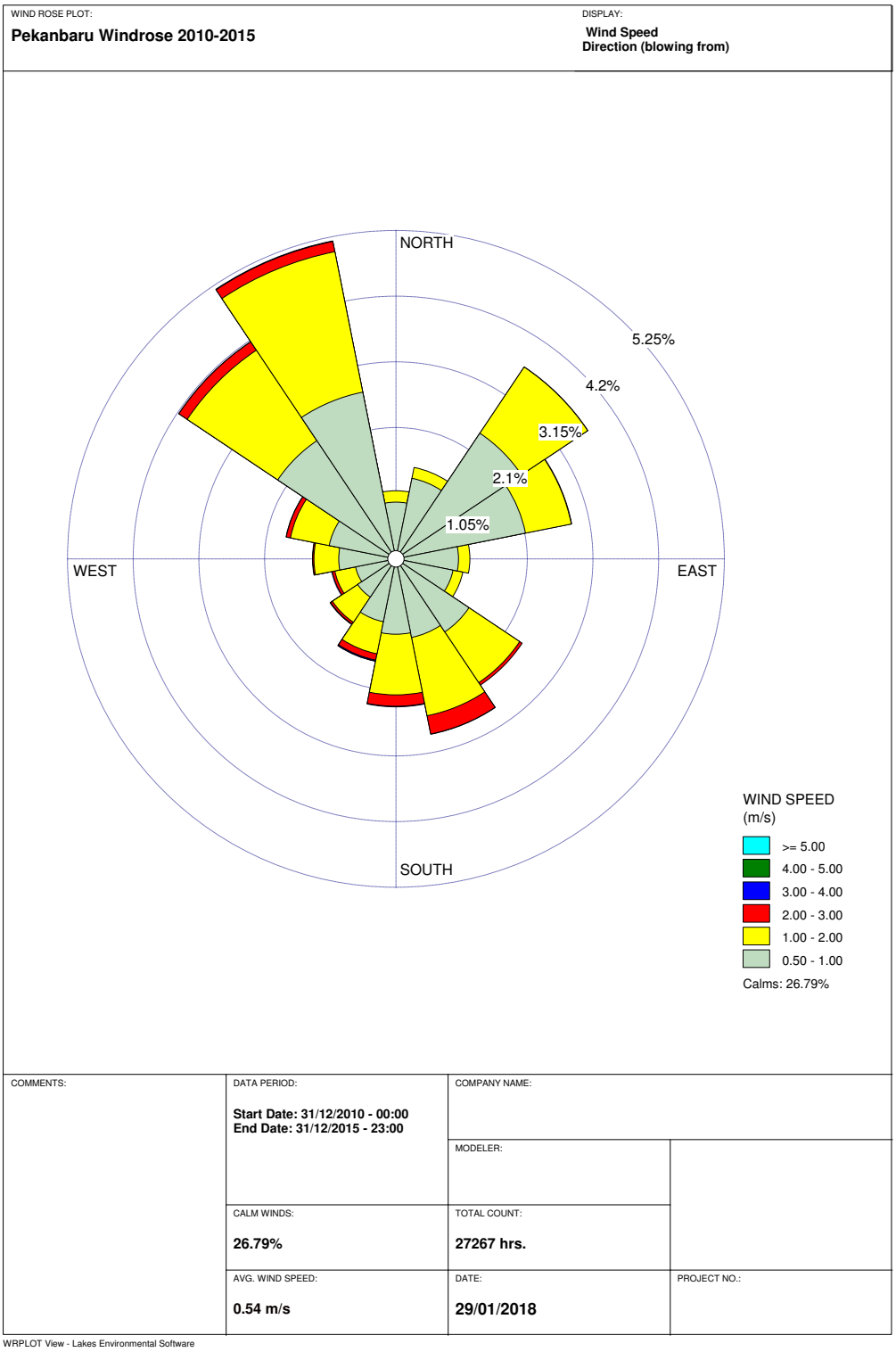


Figure 2.4 : Windrose of Data Collected at Pekanbaru (Years 2010 – 2015)

3. Standards and Guidelines

3.1 Overview

Noise limits provide a benchmark for assessing the potential for noise emissions from the power plant to impact on nearby residential locations. The noise limits applicable to this type of development are determined by the approval authorities for the Project. In this instance the Indonesian Ministry of Environment has a local approval role, referencing Indonesian environmental ambient noise standards as part of the AMDAL process. Other parties to the project include financing bodies such as the Asian Development Bank and International Finance Corporation (IFC), which also have noise criteria to be considered as part of the governance process.

An assessment of the power plant noise emissions is made using available information and compared to the most stringent of the proposed noise standards and guidelines for the daytime and night time periods. Because the power plant is expected to run 24 hours per day, consideration of the night time noise levels will be the limiting case for the majority of the considered criteria.

Where the noise limits indicate the potential for an exceedance of these goals, mitigation measures should be considered to reduce the predicted noise levels to acceptable values wherever possible.

3.2 Construction and Operational Noise

3.2.1 Indonesian Standards

The State Minister of Environment Decree No 48 identifies noise limits relevant to the project in Subsection 4.2 as follows:

*"**4.2 Minimum Noise Threshold** - Decision of Environmental Minister No KEP-48/MENLH/11/96 establish standard noise levels for specific areas shown in Table 3.1. The standard level of noise is based on an A weighted equivalent noise level, L_{Aeq} over a 1 hour period."*

Table 3.1 : presents the relevant Indonesian noise criteria for the project, which has in turn been reproduced from Table 1 of *KEP-48/MENLH/11/96*.

Table 3.1 : Indonesian SME Noise Limits for the Proposal

Appropriation Region - environmental Activities			Noise level dB(A)
a.	Appropriation Region		
	1	Housing and Settlements	55
	2	Trade and Services	70
	3	Office and Commerce	65
	4	Green open space	50
	5	Industry	70
	6	Government and Public Facilities	60
	7	Recreation	70
	8	Special:	
		Seaports	70
		Cultural heritage	60
b.	Environmental Activities		

Appropriation Region - environmental Activities			Noise level dB(A)
	1	Hospital or the like	55
	2	Schools or the like	55
	3	Places of worship or the like	55

The relevant criterion for residential noise sensitive receivers (housing and settlement) is taken to be an L_{Aeq} (1 hour) 55 dB(A). As there is no distinction for different times of the day, this criterion would be applicable for both the day and night time periods.

Other locations for consideration include industrial sites, which have an $L_{Aeq\ 1\ hour}$ 70 dB(A) criterion for both day and night. Typically, the 70 dB(A) noise limit is applied at the boundary of the facility under assessment.

School, hospitals and places of worship have the same limits as the residential criterion and it is expected that these values represent predicted external noise levels.

3.2.2 World Bank Criteria

3.2.3 WBG EHS Guidelines

The WBG recommends noise limits for residential locations in accordance with its EHS Guidelines. These guidelines have been adopted from Guidelines for Community Noise, World Health Organization, 1999 and are values for noise levels measured outside a dwelling. The noise level guidelines from the IFC have been reproduced in Table 3.2 :

Table 3.2 : IFC Noise Guidelines for Noise Sensitive Locations

Receptor	Day 07:00-22:00	Night-time 22:00-07:00
	$L_{Aeq1\ hr}$	$L_{Aeq1\ hr}$
Residential, Institutional Educational	55 dB(A)	45 dB(A)
Industrial, Commercial	70 dB(A)	70 dB(A)

The guidelines state:

"Noise impacts should not exceed the levels presented in Table 3.2 or result in a maximum increase in background levels of 3 dB at the nearest receptor location – off site"

The additional criteria of background plus 3 dB(A) is referred to as a maximum increase in noise levels and is only to be adopted where the guideline levels in the table are already exceeded.

Table 3.3 : World Bank Noise Guidelines for Power Stations

NCA (Residential, Institutional Educational receptors)	Initial noise limits dB(A)		Existing dB(A)*		Final noise limits dB(A)	
	Daytime 07:00-22:00	Night-time 22:00-07:00	Daytime 07:00-22:00	Night-time 22:00-07:00	Daytime 07:00-22:00	Night-time 22:00-07:00
	$L_{Aeq1\ hr}$	$L_{Aeq1\ hr}$	$L_{Aeq\ period}$	$L_{Aeq\ period}$	$L_{Aeq1\ hr}$	$L_{Aeq1\ hr}$
1****	55	45	59	61**	62	45
2			53	45	56	48
3***			53	45	56	48
4****			53	-	56	45

NCA (Residential, Institutional Educational receptors)	Initial noise limits dB(A)		Existing dB(A)*		Final noise limits dB(A)	
	Daytime 07:00-22:00	Night-time 22:00-07:00	Daytime 07:00-22:00	Night-time 22:00-07:00	Daytime 07:00-22:00	Night-time 22:00-07:00
	$L_{Aeq1\ hr}$	$L_{Aeq1\ hr}$	$L_{Aeq\ period}$	$L_{Aeq\ period}$	$L_{Aeq1\ hr}$	$L_{Aeq1\ hr}$
5			67	-	70	45
6			62	-	65	45

** A representative single monitoring result has been selected from each NCA*

*** As outlined in Section 0, this noise result is unrealistically high. As such the WBG EHS L_{Aeq} criterion of 55dB(A) has been applied.*

**** It is noted that noise monitoring was not conducted in NCA 3, and as such the noise levels from nearby NCA 2 have been applied. In reality this is a conservative approach as NCA 2 assesses semi-rural receivers on the eastern outskirts of Pekanbaru, whereas NCA 3 is located in the noisier suburban areas.*

***** Representative median values have been selected where multiple measurements have been obtained in these NCAs.*

Given that noise monitoring was not conducted during night time hours in NCAs 4, 5 and 6, the WBG EHS noise guidelines have been applied during these periods. In NCAs 1, 2 and 3 the existing noise level is greater than the guidelines and as such the alternative 'background plus 3 dB(A)' criterion has been applied at these locations.

Given that power plant noise is generally steady in nature, showing little variation throughout the day and night time period, the lowest noise criterion (night time) at each location will be applied.

4. Impact Assessment Methodology

4.1 Introduction

The impact assessment methodology has been developed in accordance with good industry practice and the potential impacts have been identified in the context of the Project's Area of Influence (AoI), in accordance with ADB Environmental Safeguards and IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts).

4.2 Modelling Methodology

Noise modelling for the project utilised the SoundPLAN modelling software implementing the CONCAWE method of calculation.

Calculations have been provided for both neutral and unfavourable weather conditions. The following meteorological conditions are accounted for in the modelling:

- Neutral meteorological conditions: zero wind speed, 'D class' Pasquill category; and
- Adverse meteorological conditions: 2 m/s wind speed with the wind blowing from source to receiver, 'F class' Pasquill category

As well as consideration of meteorological conditions, the standard also considers the following acoustic elements:

- Source directivity and size;
- Geometrical spreading;
- Air absorption;
- Ground absorption;
- Reflections; and
- Screening from terrain and major structures

4.2.1 Modelling parameters and scenarios

Noise contours for the site were generated based on the following modelling parameters:

- Receiver height above ground of 1.5 m;
- Ground absorption = 0.75 (soft surface);
- Contour grid size of 20 m; and
- Reflection order of 3.

Modelling was conducted for the following operational scenarios:

- 24 hour emissions from Riau 275 MW CCPP; and
- 24 hour emissions from both Riau CCPP and Tenayan CFPS (cumulative impact).

4.2.2 Meteorological influences

Given the that the wind measurements at Pekanbaru (refer Section 2.3) have been influenced by buildings and local topography, typical meteorological conditions have not been assessed, instead the operational noise assessment has considered absolute worst case noise transmission. Under the modelled scenarios, wind has been assumed to be blowing at 2 m/s from each source to each receiver. Predictions have been provided for these adverse and neutral meteorological conditions.

Where the dominant wind direction is from receiver to the noise source, noise levels will be lower than the levels predicted in this assessment.

4.2.3 Magnitude Criteria

The assessment of impact magnitude is undertaken by categorising identified impacts of the Project as beneficial or adverse. Then impacts are categorised as 'major', 'moderate', 'minor' or 'negligible' based on consideration of parameters such as:

- Duration of the impact – ranging from 'well into operation' to 'temporary with no detectable impact'.
- Spatial extent of the impact – for instance, within the site boundary, within district, regionally, nationally, and internationally.
- Reversibility – ranging from 'permanent thus requiring significant intervention to return to baseline' to 'no change'.
- Likelihood – ranging from 'occurring regularly under typical conditions' to 'unlikely to occur'.
- Compliance with legal standards and established professional criteria – ranging from 'substantially exceeds national standards or international guidance' to 'meets the standards' (i.e. impacts are not predicted to exceed the relevant standards) presents generic criteria for determining impact magnitude (for adverse impacts). Each detailed assessment will define impact magnitude in relation to its environmental or social aspect.
- Any other impact characteristics of relevance.

Table 4.1 below presents generic criteria for determining impact magnitude (for adverse impacts). Each detailed assessment will define impact magnitude in relation to its environmental or social aspect.

Table 4.1 : General Criteria for Determining Impact Magnitude

Category	Description
Major	Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature and requiring significant intervention to return to baseline; would violate national standards or Good International Industry Practice (GIIP) without mitigation.
Moderate	Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change.
Minor	Detectable but small change to the specific conditions assessed.
Negligible	No perceptible change to the specific conditions assessed.

4.2.4 Sensitivity Criteria

Sensitivity is specific to each aspect and the environmental resource or population affected, with criteria developed from baseline information. Using the baseline information, the sensitivity of the receptor is determined factoring in proximity, number exposed, vulnerability and the presence of receptors on site or the surrounding area. Generic criteria for determining sensitivity of receptors are outlined in Table 4.2 below. Each detailed assessment will define sensitivity in relation to its environmental or social aspect.

Table 4.2 : General Criteria for Determining Impact Sensitivity

Category	Description
High	Receptor (human, physical or biological) with little or no capacity to absorb proposed changes
Medium	Receptor with little capacity to absorb proposed changes
Low	Receptor with some capacity to absorb proposed changes
Negligible	Receptor with good capacity to absorb proposed changes

4.2.5 Impact Evaluation

The determination of impact significance involves making a judgment about the importance of project impacts. This is typically done at two levels:

- The significance of project impacts factoring in the mitigation inherently within the design of the project; and
- The significance of project impacts following the implementation of additional mitigation measures.

The impacts are evaluated taking into account the interaction between the magnitude and sensitivity criteria as presented in the impact evaluation matrix in Table 4.3 below.

Table 4.3 : Impact Matrix

		Magnitude			
		Major	**Moderate**	**Minor**	**Negligible**
Sensitivity	**High**	Major	Major	Moderate	Negligible
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

The objective of the ESIA is to identify the likely significant impacts on the environment and people of the project. In this impact assessment, impacts determined to be 'moderate' or 'major' are deemed significant. Consequently, impacts determined to be 'minor' or 'negligible' are not significant.

4.3 Construction Noise Impacts

A summary of construction scenarios has been reproduced here to inform the prediction of noise levels from these activities.

Noise impacts during construction of the CCPP have been modelled using CONCAWE noise prediction method. Modelling inputs are similar to those used in the operational noise model.

4.3.1 Construction scenarios and impacts

The estimated construction period for the power plant, pipelines and power transmission lines is about 24 months with six months for commissioning. During this time there would be earthworks and building activities on the site as well as truck movements to and from the work areas. The truck movements adjacent to the residential areas are expected to provide the greatest degree of impact on the nearby residences with other site work mostly being completed over 600m from the local communities.

The construction phase of the Project is scheduled to last from September 2018 to September 2020. The construction of the CCPP will be carried out in the following phases:

- Clearing and earthworks;
- Foundations and drainage works;
- Erection of buildings and plant; and
- Installation of equipment.

Construction activities also include the construction of the gas pipeline and the transmission line.

It is understood that night time construction activities will rarely be required at the site. Where night time construction work is necessary, it shall be managed so that noise does not cause annoyance to neighbours unless it:

- is associated with an emergency; or
- is carried out with the prior written approval of the relevant authorities, or
- does not cause existing ambient noise levels to be exceeded.

Table 4.4 outlines a preliminary construction schedule and staging and associated equipment noise levels.

Table 4.4 : Preliminary Construction Staging and Equipment

Task	Equipment	Number	SWL
Clearing and earthworks	Dozer 40T - 50T (D8-D9)	2	114
	Excavator 40T - 50T	2	116
	Dump truck 40T - 50T	6	122
	Site generator	4	107
	Vibratory roller 10T - 20T	1	110
	TOTAL		**124**
Foundations and drainage	Concrete truck and pump	4	112
	Hand tools	12	116
	Concrete saw	1	114
	Bored piling rig	1	108
	Dump truck 40T - 50T	6	122
	Franna / truck mounted crane	4	105
	Mobile / truck mounted cranes 100T - 200T	2	102
	Hydraulic driver	1	115
	Vibratory roller 10T - 20T	1	110
	Excavator 40T - 50T	2	116
	Front end loader	1	116
	TOTAL		**126**
Erection of buildings and plant	Mobile / truck mounted cranes 100T - 200T	4	105
	Franna / truck mounted crane	6	107
	Hand tools	12	116
	Vibratory roller 10T - 20T	2	113
	Wacker packer		107
	Concrete truck and pump	2	99
	Dump truck 40T - 50T	3	119
	TOTAL		**122**
Installation of equipment	Mobile / truck mounted cranes 100T - 200T	1	99
	Franna / truck mounted crane	4	105
	Hand tools	12	116
	Concrete saw	1	114
	Vibratory roller 10T - 20T	2	113
	TOTAL		**119**

Task	Equipment	Number	SWL
Transmission line - Installation	Hand tools	6	110
	TOTAL		**110**
Gas pipeline - Installation	Franna / truck mounted crane	1	99
	Backhoe	2	97
	Hand tools	6	112
	TOTAL		**114**

4.3.2 Riau CCPP Construction Noise Impacts

Construction noise contour maps for each of the four phases of construction of the CCPP above are presented in Appendix B. As displayed noise levels well below the site criteria outlined in Section 3.2 at the nearest, most affected receiver during all four assessment scenarios. Given this, it was concluded that noise impacts during construction at the CCPP site are not expected, although measures to limit noise during these works have still been included below in Section 5.

Potential noise impacts associated with the construction of the power station have been evaluated as negligible, taking into account the negligible magnitude and negligible sensitivity of the predicted impacts.

4.4 Transmission Line Construction Noise Impacts

Owing to the linear nature of construction activities associated with construction of the transmission line, noise impacts will be temporal with the magnitude of noise levels varying as distances between receivers and the active work area changes. It is understood that construction of the towers will be largely manual, and require handtools, a truck mounted crane to deliver equipment and a concrete truck for footings.

Construction activities will be focused around each tower and are unlikely to generate noise impacts along other areas of the route.

The transmission line runs through NCA 1 only and is surrounded by very few isolated receivers. Compliance with the construction noise criteria is expected at distances of more than 100 m from each tower location. It should be noted that this assessment does not consider screening from terrain or structures and as such is a conservative estimate of construction noise.

Potential noise impacts associated with the construction of the power station have been evaluated as negligible, taking into account the minor magnitude and negligible sensitivity of the predicted impacts.

Section 5 provides measures to be incorporated into the environmental management plans to address potential noise issues during these works.

4.5 Gas pipeline Construction Noise Impacts

Owing to the linear nature of construction activities associated with construction of the gas pipeline, noise impacts will occur for an approximate two-week period with the magnitude of noise levels varying as distances between receivers and the active work area changes. It is understood that construction of pipeline will primarily be carried out with a truck mounted crane, single backhoe and hand tools.

The gas pipeline runs through NCAs 1, 4, 5 and 6 and passes several small villages and isolated rural residences. Compliance with the construction noise criteria is expected at receivers located more than the following distances:

- NCA 1 150 metres
- NCA 4 300 metres

- NCA 5 60 metres
- NCA 6 110 metres

It should be noted that this assessment does not consider screening from terrain or structures and as such is a conservative estimate of construction noise.

Potential noise impacts associated with the construction of the gas pipeline have been evaluated as minor, taking into account the moderate magnitude and negligible sensitivity of the predicted impacts.

4.6 Operational Noise Assessment

4.6.1 Supplied operational noise modelling data

The modelling data has been supplied by the contractor for the operational noise assessment process. Sound power levels (SWLs) are represented in the noise model to provide a three dimensional layout of the proposed power plant. The three dimensional noise model propagates these noise levels to a receiver location accounting for distance, air absorption, ground absorption, and screening effects.

The data in Table 4.5 summarises the significant noise sources that were accounted for in the modelling of operational noise impacts.

Table 4.5 : Significant CCPP Noise Emissions

Equipment	Status	Overall SWL dB(A)	Unit of measurement
GTG inlet			
Air inlet Filter Face	dB	85.0	per unit
Air Inlet Filter Transition	dB	99.0	per unit
Air Inlet Duct and Elbow	dB	105.0	per unit
Gas Turbine Package			
GT Enclosure	dB	101.0	per unit
Oil & Gas module enclosure	dB	99.0	per unit
GT Generator	dB	104.0	per unit
Vent Fans			
88TK	dB	91.0	per unit
88BN	dB	91.0	per unit
88BT (GT enclosure) casing	dB	90.0	per unit
88BT (GT enclosure) outlet	dB	90.0	per unit
88VG (load comp) casing	dB	92.0	per unit
88VG (load comp) outlet	dB	90.0	per unit
88VG (load comp) inlet	dB	90.0	per unit
88BL (lube oil enclosure) casing	dB	88.0	per unit
88BL (lube oil enclosure) inlet	dB	90.0	per unit
88VL (gas module enclosure) casing	dB	90.0	per unit
88VL (gas module enclosure) outlet	dB	90.0	per unit
Other Fans outlet	dB	90.0	per unit
Transition to HRSG			
GT Exhaust Diffuser Enclosure	dB	92.0	per unit

Equipment	Status	Overall SWL dB(A)	Unit of measurement
HRSG, with Duct Firing			
HRSG Inlet duct	dB	103.0	per unit
HRSG Body	dB	99.0	per unit
HRSG Stack & breaching	dB	94.0	per unit
Accessories (piping + valves + continuous vents)	dB	99.0	per unit
Stack Outlet (HRSG Stack Top) with duct firing	dB	104.0	per unit
BFPs	dB	90.0	per unit
Main cooling water pumps	dB	89.8	per unit
Closed cycle cooling water pumps, if outside	dB	85.0	per unit
Main Transformer	dB	83.0	per unit
Aux. Transformer	dB	71.0	per unit
Cooling Tower	dB	84.9	per unit
Steam turbine generator / condenser building			
ST Body	dB	108.0	per unit
HP/IP Steam Valve	dB	99.0	per unit
ST Generator	dB	106.0	per unit
Gas compressor enclosure	dB	85.0	per unit
Water treatment area	dB	<85.0	per unit
150kV substation	dB	50	per m2

A visual representation of the 3 dimensional model showing major operational noise sources in pink is provided below in Figure 4.1.

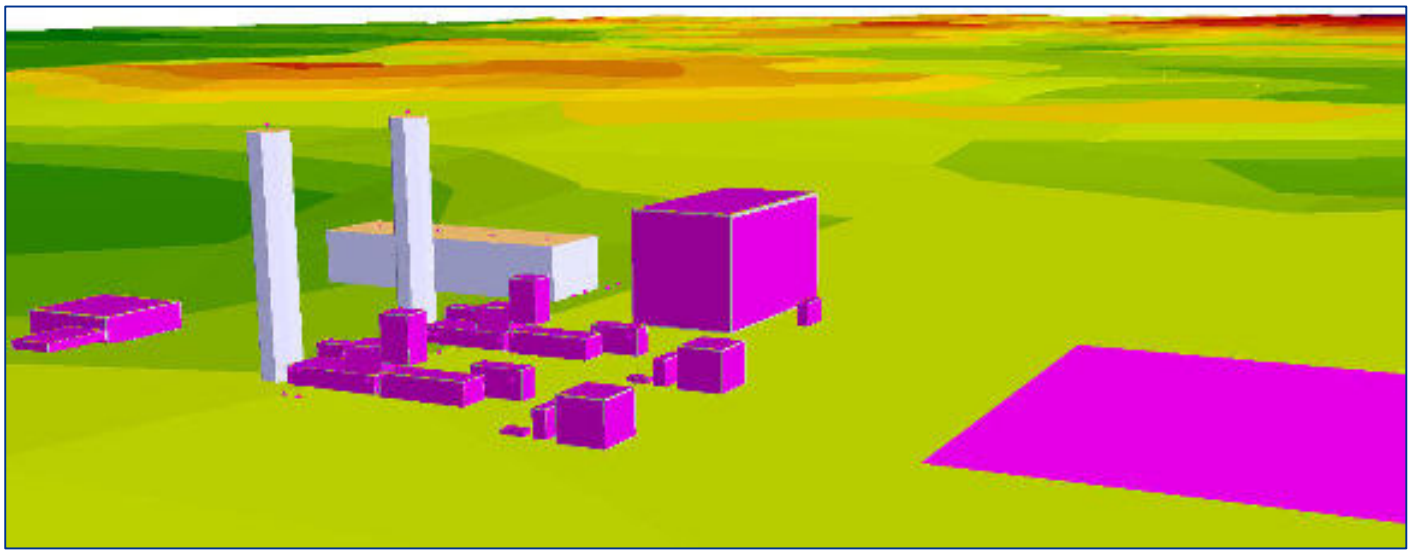


Figure 4.1 : Visual Representation of 3D Noise Model (Riau CCPP)

4.6.2 Riau CCPP impacts

4.6.3 Results of operational noise modelling

The power plant is assumed to have a constant noise emission however, in practice base load power levels are expected to decrease during the night time hours. This assessment has assumed the worst case scenario of the power station operating at full load, which may occur at any time.

Figure 4.2 and Figure 4.3 present predicted noise contours for the operational impacts from Riau CCPP alone under both neutral and adverse meteorological conditions.

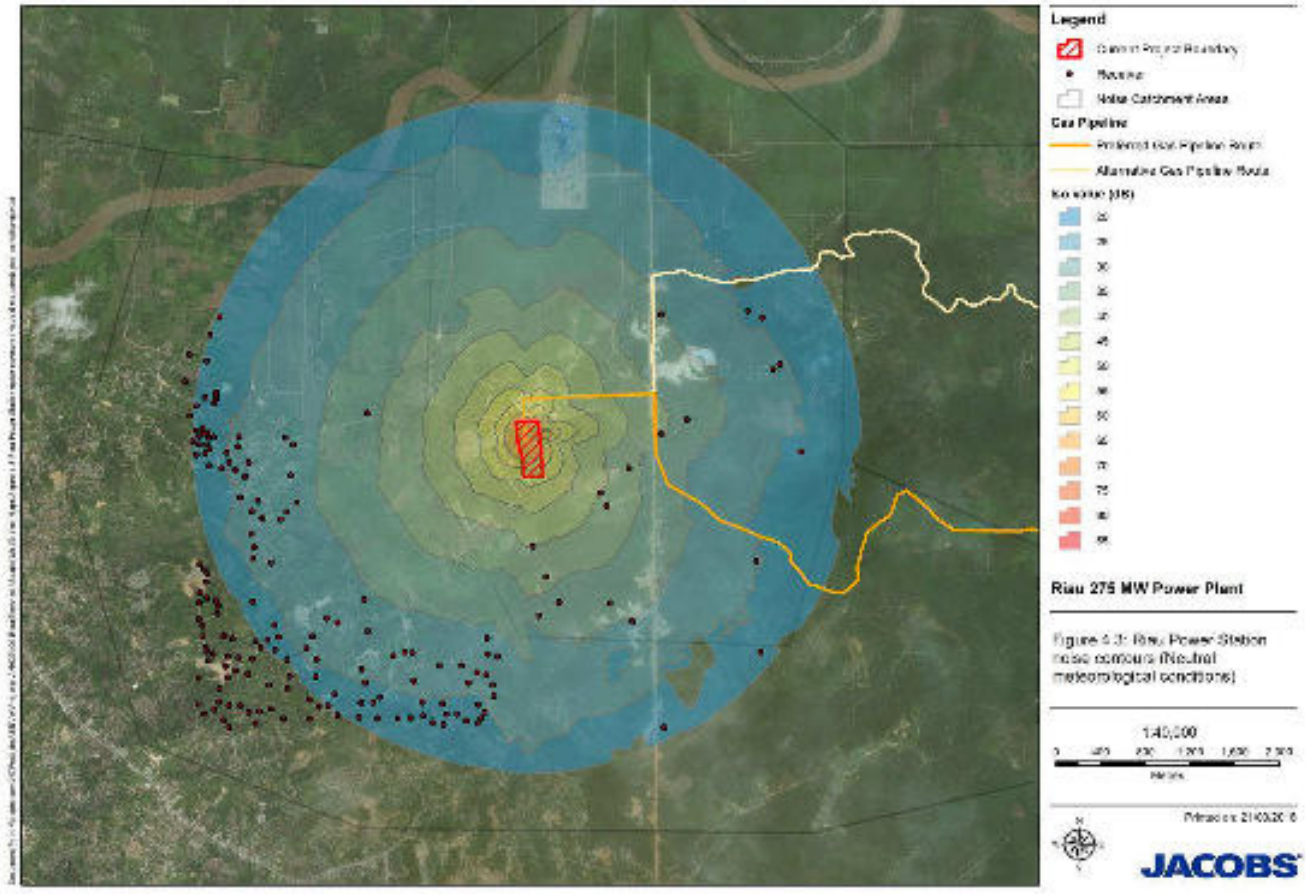


Figure 4.2 : Riau Power Station Noise Contours (Neutral Meteorological Conditions)

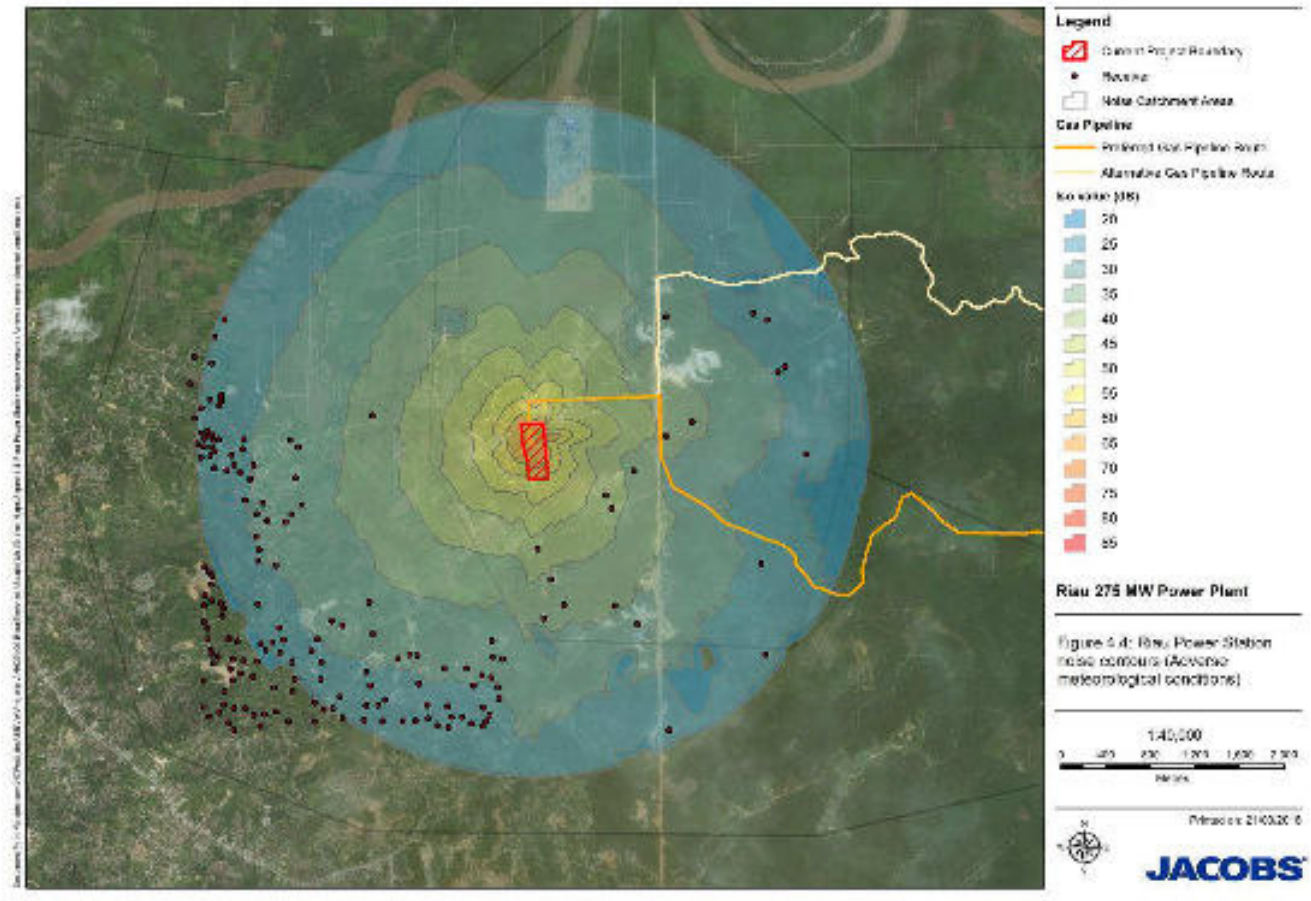


Figure 4.3 : Riau Power Station Noise Contours (Adverse Meteorological Conditions)

Under worst case, adverse weather conditions, the predicted noise levels from the plant alone at the nearest receivers (NCA 1 - sparse rural properties located to the east and north east) are expected to be below 40 dB(A) L_{Aeq}. For semi-rural properties located on the outskirts of Pekanbaru, noise levels are expected to be below 30 dB(A), while noise levels in all other NCAs are expected to be inaudible.

Under neutral meteorological conditions, noise levels are predicted to be approximately 5 dB(A) below these levels.

Noise levels are expected to remain within project criteria at all identified receiver locations under worst case meteorological conditions.

4.6.4 Cumulative impacts – Riau CCPP and Tenayan CFPP

Figure 4.4 and Figure 4.5 present the predicted noise contours for the operational impacts from the combined operation of both power stations.

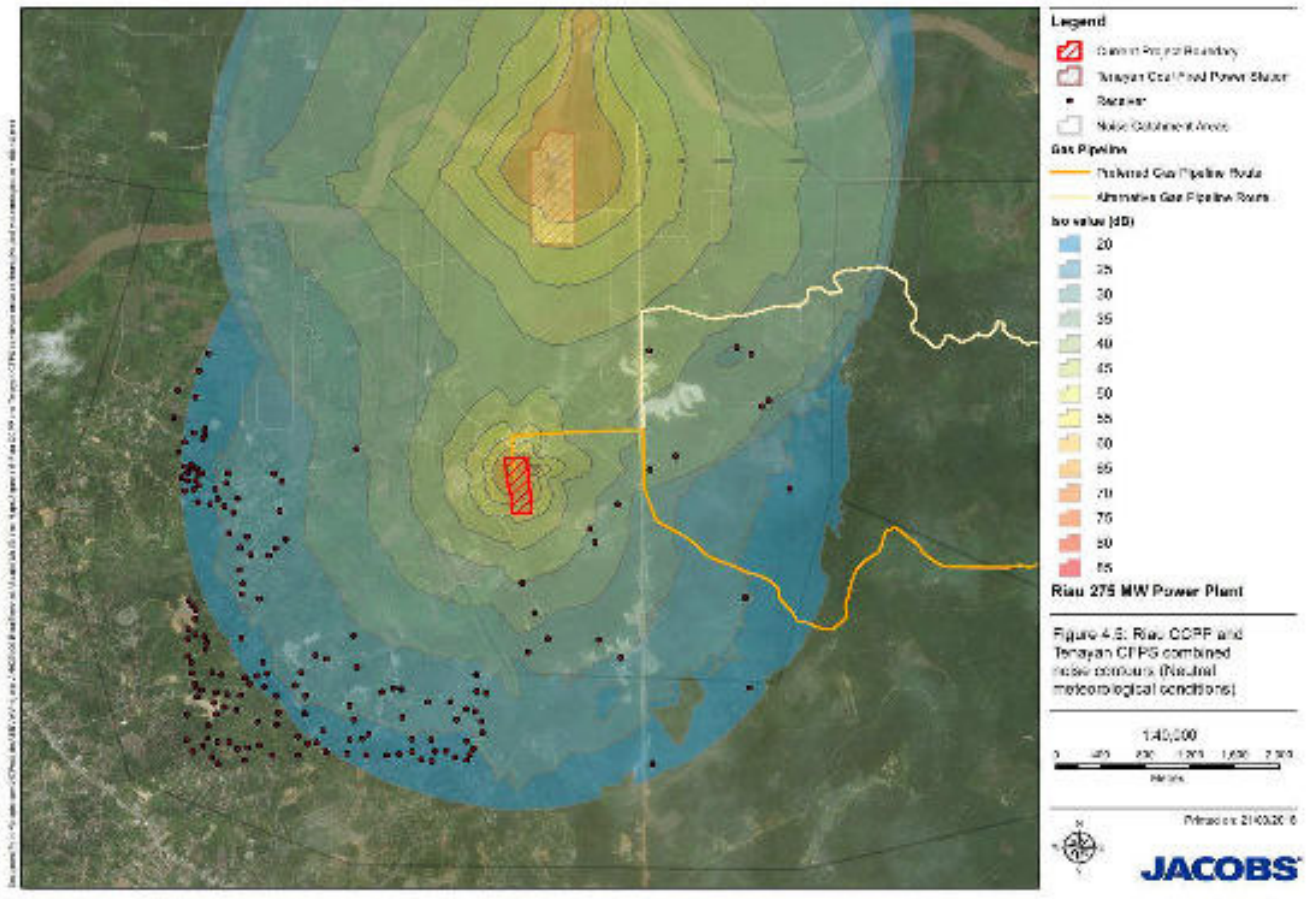


Figure 4.4 : Riau CCPP and Tenayan CFPP Combined Noise Contours (Neutral Meteorological Conditions)

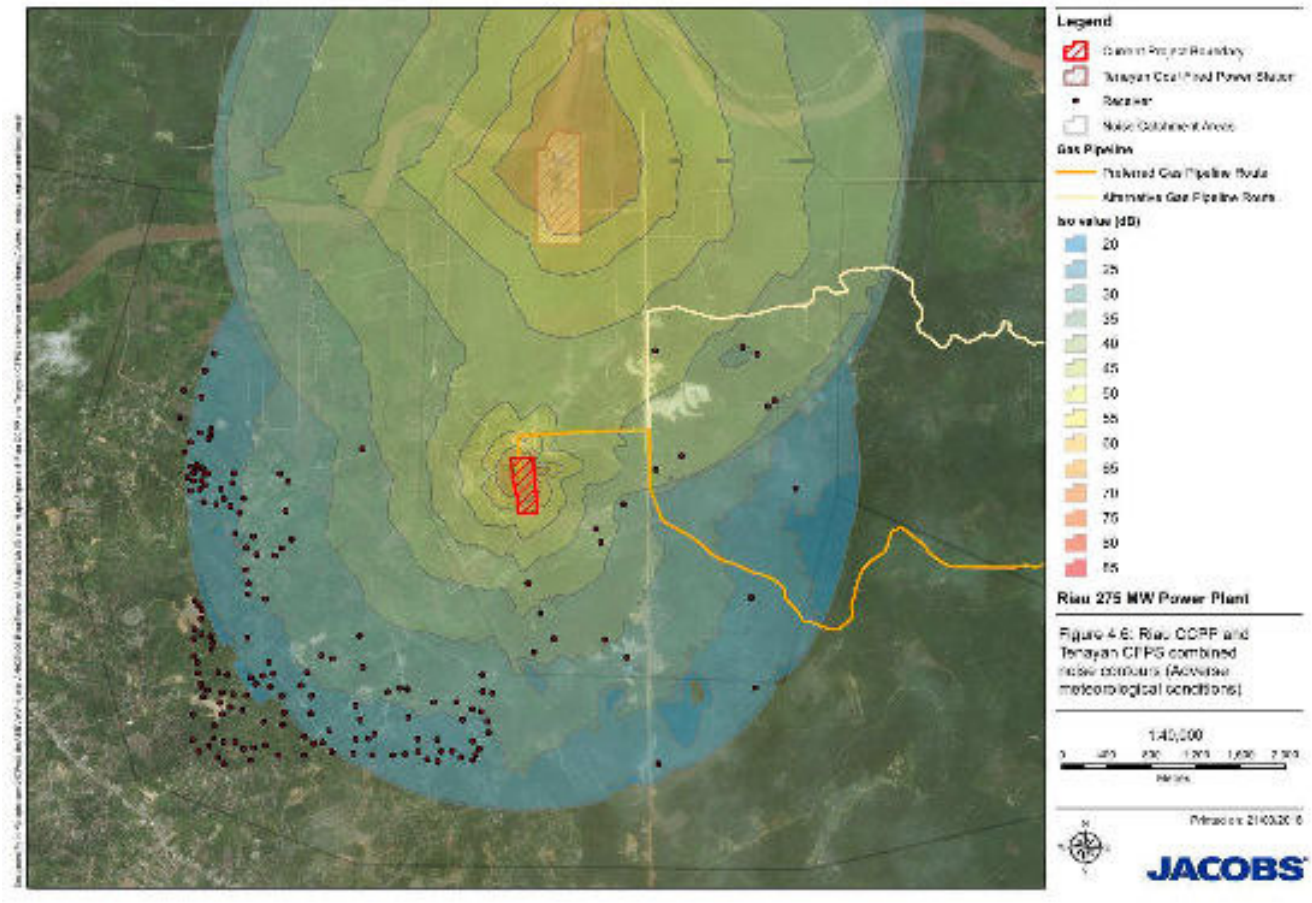


Figure 4.5 : Riau CCPP and Tenayan CFPP Combined Noise Contours (Adverse Meteorological Conditions)

It can be seen that as most noise receivers are generally located south of the Riau CCPP, combined impacts are not substantially different to those from the Riau CCPP alone.

Under worst case, adverse weather conditions, the largest increases in noise under accumulative scenario are predicted for receivers located to the north east and north west of the Riau CCPP. In these areas cumulative noise levels are forecast to be up to 5 dB(A) above those of the Riau CCPP alone, however are predicted to remain below the project criteria at all receiver locations. No change to predicted noise levels is expected in other NCAs.

Predicted noise levels under neutral meteorological conditions are expected to be 5 dB(A) below those predicted above for NCA, while no change is predicted in other NCAs.

Cumulative noise impacts are expected to remain below the project criteria at all receiver properties under all meteorological conditions.

4.6.5 Gas pipeline impacts

Following construction, the gas pipeline is not expected to generate any operational noise.

4.6.6 Electricity transmission line impacts

Under most meteorological conditions, the electricity transmission line will also not generate any operational noise. However, during sustained periods of high winds, steady rainfall or high humidity, the transmission line may generate corona / arcing noise. This noise is caused by the breakdown of air into charged particles caused by the electrical field at the surface conductors.

Research has indicated that this noise source is typically in the order of 40 dB(A) at a distance of 50 m from the source (*Nyngan Solar Plant Noise Assessment, NGH Environmental, March 2013*).

The nearest identified receivers to the power line are located approximately 1 km to the west of the proposed route. At this distance, coronal noise would be inaudible.

4.6.7 Operational impact evaluation

Potential noise impacts associated with the construction of the power station have been evaluated as **negligible**, taking into account the negligible magnitude and negligible sensitivity of the predicted impacts.

5. Noise Mitigation

5.1 Construction Noise Mitigation

Table 5.1 : presents safeguards and measures to manage potential noise impacts during construction. These measures should be considered prior to any construction activities being undertaken.

Table 5.1 : Noise Management Measures and Safeguards During Construction

Impact	Environmental safeguards
All sites	• Regularly train workers and contractors to use equipment in ways to minimise noise • Ensure site managers periodically check the site and nearby residences for noise problems so that solutions can be quickly applied • Regularly inspect and maintain plant to avoid increased noise levels from rattling hatches, loose fittings etc. • Truck routes to and from the worksite should be contained to major roads where possible
Riau CCPP	• Wherever possible, schedule noisy activities during standard hours of construction
Transmission line	• Wherever possible, schedule noisy activities during standard hours of construction • Use non-'beeper' reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise sensing alarms
Gas pipeline	• All residential properties and other key stakeholders such as schools and educational facilities should be notified prior to the commencement of noisy activity • Use non-'beeper' reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise sensing alarms • Schedule noisy activities during standard hours of construction • Turn off all vehicles, plant and equipment when not in use • Ensure that all doors/hatches are shut during operation of plant and equipment • Work compounds, parking areas, equipment and material stockpile sites will be positioned away from noise-sensitive locations

5.2 Operational Noise Mitigation

Given the remote locations of the proposed Riau CCPP site, no operational noise impacts have been predicted. As such, noise mitigation is not considered necessary.

However, to promote best practice at the site and to ensure that noise impacts are maintained at or below the modelled levels, the following operational noise management measures are recommended:

- Where noise levels differ from those outlined in described above, remodelling should be conducted to confirm noise impacts;
- Noise levels modelled in this report should be confirmed prior during the commissioning of the plant;
- Operational equipment should be maintained and operated in the recommended manner in order to keep noise emissions to a minimum;
- Hatches on noisy plant and doors to noisy work areas should remain closed where possible; and
- It is recommended that all noise generating equipment is selected based in part on its acoustic rating where multiple choices exist.

5.3 Monitoring

Monitoring is not linked to the impact evaluation but is an important component of the ESIA. Monitoring and follow-up actions should be completed to:

- Continue the collection of noise data throughout construction, operation and later decommissioning to check that noise criterion is being complied with.
- Evaluate the success of mitigation measures, or compliance with project standards or requirements.
- Assess whether there are impacts occurring that were not previously predicted.
- In some cases, it may be appropriate to involve local communities in monitoring efforts through participatory monitoring. In all cases, the collection of monitoring data and the dissemination of monitoring results should be transparent and made available to interested project stakeholders.

6. Conclusion

An assessment of operational and construction noise impacts for the Project has been completed by Jacobs in accordance with the local and international regulatory guidelines for this type of impact. The Project was assessed using available information of the proposed site, the equipment types and their associated noise levels, and the location of the nearest noise sensitive receptors.

Weather conditions at the site are generally from south to north, and are favourable for the mitigation of operational noise at the nearest receivers.

The assessment of operations from Riau CCPP alone indicate that operational noise impacts are unlikely to generate an exceedance of the international noise goals during either day or night time periods under adverse weather conditions. Under neutral and favourable weather conditions, noise impacts will be lower.

The assessment of cumulative impacts of both Riau CCPP and Tenayan CFPP operations indicate that operational noise impacts at receivers in the vicinity of Riau CCPP are unlikely to be substantially different to those of the CCPP operating along. Cumulative noise levels are expected to comply with international noise goals under all meteorological conditions.

The IFC industrial noise goals and Indonesian noise guidelines (*KEP-48/MENLH/11/96)* are met for all predicted operational scenarios. Overall operational noise impacts are predicted to be negligible.

To ensure that there are no exceedances of the proposal criteria, operational mitigation measures are recommended to be implemented during the detailed design phase. Additionally, where proposed equipment is substantially different to that assessed in this document, further assessment should be carried out.

Construction noise impacts would typically meet the noise criteria for the proposal due to the distance from the site to receiver locations. Noise from the site would vary depending on the activities being undertaken and their location within the site. Site construction noise impacts are predicted to be negligible.

During construction of the access road, transmission line and gas pipeline, noise goals may be exceeded where construction takes place in close proximity to receiver locations, however this impact would be of short duration. Construction noise impacts during these work stages are predicted to be minor or negligible. Mitigation measures and safeguards should be employed to minimise these impacts where possible.

7. References

Indonesian State Minister of Environment Decree No 48;

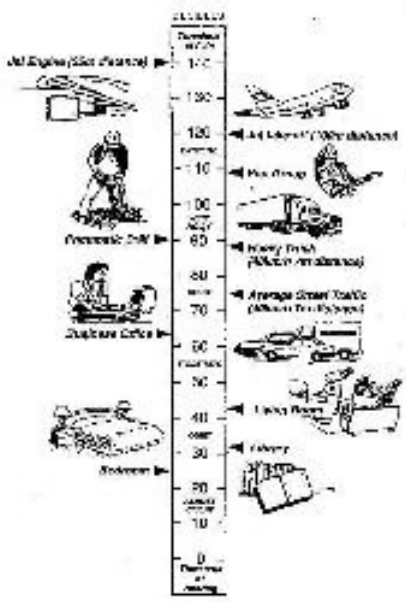
IFC / World Bank Group Environmental, Health and Safety General Guidelines (April 2007); and

IFC/World Bank Group Environmental, Health and Safety Guidelines for Thermal Power Plants (December2008)

Appendix A. Acoustic Terminology

A-weighted sound pressure	The human ear is not equally sensitive to sound at different frequencies. People are more sensitive to sound in the range of 1 to 4 kHz (1000 – 4000 vibrations per second) and less sensitive to lower and higher frequency sound. During noise measurement an electronic '*A-weighting*' frequency filter is applied to the measured sound level *dB(A)* to account for these sensitivities. Other frequency weightings (B, C and D) are less commonly used. Sound measured without a filter is denoted as linear weighted dB(linear).
Ambient noise	The **total** noise in a given situation, inclusive of all noise source contributions in the near and far field.
Community annoyance	**Includes** noise annoyance due to: ▪ character of the noise (e.g. sound pressure level, tonality, impulsiveness, low-frequency content) ▪ character of the environment (e.g. very quiet suburban, suburban, urban, near industry) ▪ miscellaneous circumstances (e.g. noise avoidance possibilities, cognitive noise, unpleasant associations) ▪ human activity being interrupted (e.g. sleep, communicating, reading, working, listening to radio/TV, recreation).
Compliance	The process of checking that source noise levels meet with the noise limits in a statutory context.
Cumulative noise level	The total level of noise from all sources.
Extraneous noise	Noise resulting from activities that are not typical to the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
Feasible and reasonable measures	Feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors: ▪ Noise mitigation benefits (amount of noise reduction provided, number of people protected). ▪ Cost of mitigation (cost of mitigation versus benefit provided). ▪ Community views (aesthetic impacts and community wishes). ▪ Noise levels for affected land uses (existing and future levels, and changes in noise levels).

Impulsiveness	Impulsive noise is noise with a high peak of short duration or a sequence of these peaks. Impulsive noise is also considered annoying.
Low frequency	Noise containing major components in the low-frequency range (20 to 250 Hz) of the frequency spectrum.
Noise criteria	The general set of non-mandatory noise levels for protecting against intrusive **noise** (for example, background noise plus 5 dB) and loss of amenity (e.g. noise levels for various land use).
Noise level (goal)	A noise level that should be adopted for planning purposes as the highest acceptable noise level for the specific area, land use and time of day.
Noise limits	Enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels, which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action.
Performance-based goals	Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.
Rating Background Level (RBL)	The rating background level is the overall single figure background level representing each day, evening and night time period. The rating background level is the 10th percentile min L_{A90} noise level measured over all day, evening and night time monitoring periods.
Receptor	The noise-sensitive land use at which noise from a development can be heard.
Sleep disturbance	Awakenings and disturbance of sleep stages.
Sound and decibels (dB)	**Sound** (or noise) is caused by minute changes in atmospheric pressure that are detected by the human ear. The ratio between the quietest noise audible and that which should cause permanent hearing damage is a million times the change in sound pressure. To simplify this range the sound pressures are logarithmically converted to decibels from a reference level of 2 x 10-5 Pa. The picture below indicates typical noise levels from common noise sources.



dB is the abbreviation for decibel – a unit of sound measurement. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.

Sound power Level (SWL)

The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in *dB(A)*.

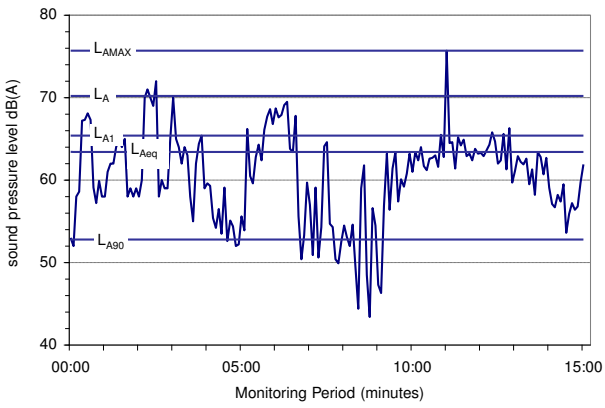
Sound Pressure Level (SPL)

The level of noise, usually expressed as SPL in *dB(A)*, as measured by a standard sound level meter with a pressure microphone. The sound pressure level in *dB(A)* gives a close indication of the subjective loudness of the noise.

Statistic noise levels

Noise levels varying over time (e.g. community noise, traffic noise, construction noise) are described in terms of the statistical exceedance level.

A hypothetical example of A weighted noise levels over a 15 minute measurement period is indicated in the following figure:



Key descriptors:

L_{Amax} Maximum recorded noise level.

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

	L_{A10} Noise level present for 10% of the 15 minute interval. Commonly referred to the average maximum noise level. L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound. L_{A90} Noise level exceeded for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).
Threshold	The lowest sound pressure level that produces a detectable response (in an instrument/person).
Tonality	Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 2 to 5 dB(A) penalty is typically applied to noise sources with tonal characteristics

Appendix B. Construction Noise Contour Map

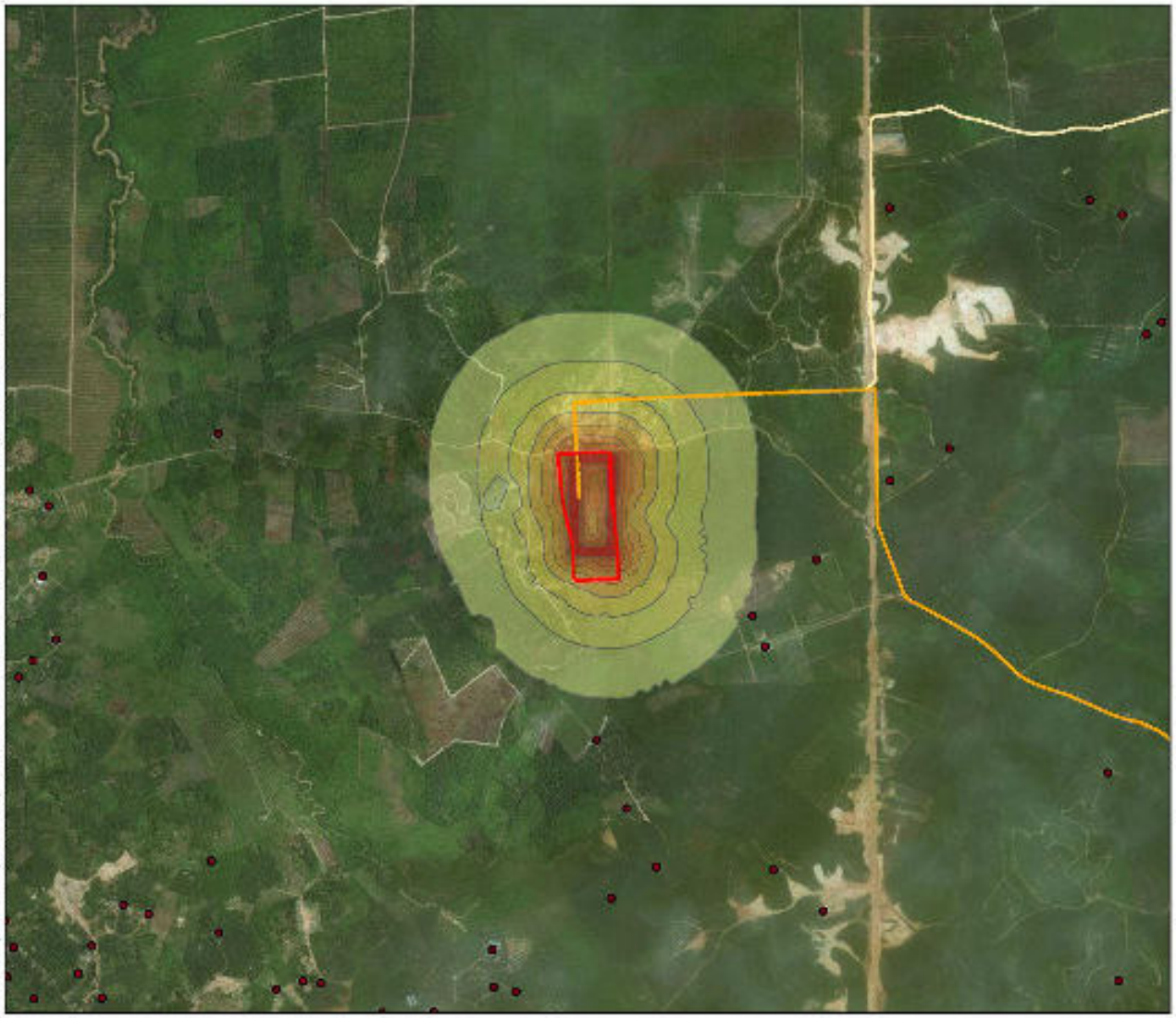
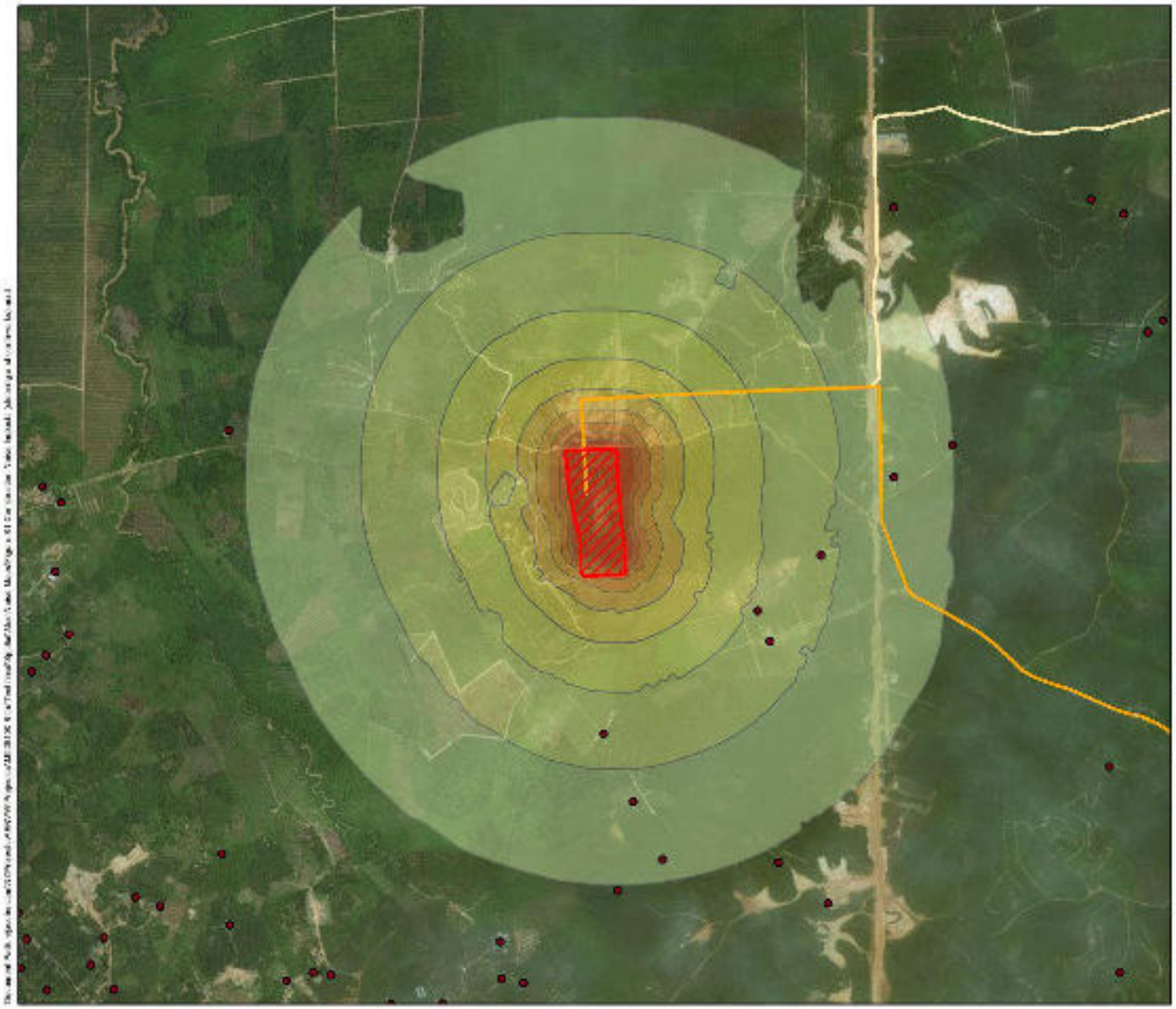


Figure B.2: Construction noise contours (Foundations and drainage)



Legend

Current Project Boundary

Preferred Gas Pipeline Route

Alternative Gas Pipeline Route

Receiver

Iso value (dB)

20
25
30
35
40
45
50
55
60
65
70
75
80
85

Riau 275 MW Power Plant

Figure B.1: Construction noise contours (Clearing and earthworks)

1:20,000

0 200 400 600 800 1,000

Metres

Printed on: 21/03/2018

JACOBS

Appendix G. Technical Report – Water Quality and Freshwater Ecology Assessment

Riau 275 MW Gas Combine Cycle Power Plant IPP - ESIA

Medco Ratch Power Riau

Technical Report - Water Quality and Aquatic Ecology Technical Report

AM039100-400-GN-RPT-1011| V1

May 2018

Document history and status

Revision	Date	Description	By	Review	Approved
Draft A	January 2018	Draft assessment for power plant only for internal review (excluding gas pipeline route)	I Wiseman	S Treadwell	n/a
Draft B	March 2018	Draft assessment for power plant and pipeline route	I Wiseman	S Treadwell	B Clarke
V0	April 2018	Final Draft for Issue	A Kubale	B Clarke	E Morrissey
V1	May 2018	Final Draft for Disclosure	A Kubale	B Clarke	E Morrissey

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
Draft B	March 2018	27 March 2018	Medco Ratch Power Riau	Draft issued for client review
V0	April 2018	19 April 2018	Medco Ratch Power Riau	Final Draft for Issue
V1	May 2018	18 May 2018	Medco Ratch Power Riau	Final Draft for Disclosure

Riau 275 MW Gas Combine Cycle Power Plant IPP - ESIA

Project No:	AM039100
Document Title:	Technical Report - Water Quality and Aquatic Ecology Technical Report
Document No.:	AM039100-400-GN-RPT-1011
Revision:	V1
Date:	May 2018
Client Name:	Medco Ratch Power Riau
Project Manager:	Eamonn Morrissey
Author:	Ian Wiseman
File Name:	I:\AENVW\Projects\AM039100 Riau\Deliverables\ESIA\Technical Assessments\Water Quality and Freshwater Ecology\AM039100_Riau ESIA - Technical Assessment - Water Quality and Freshwater Ecology_V1_Final Draft for Disclosure.docx

Jacobs New Zealand Limited

Level 3, 86 Customhouse Quay,
PO Box 10-283
Wellington, New Zealand
T +64 4 473 4265
F +64 4 473 3369
www.jacobs.com

Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs New Zealand Limited (Jacobs) is to describe the water quality and freshwater ecology impacts for Riau IPP Project Environmental and Social Impact Assessment (ESIA), in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

This document is a technical assessment of the potential impacts of the proposed Riau 275 MW Gas Combined Cycle Power Plant on the water quality and freshwater ecology of watercourses in the vicinity of the project.

1.1 Project background

The proposed project consists of a 275 MW combined cycle power plant and ancillary facilities, a 40 km long 12-inch gas pipeline, and a switchyard and a 750 m 150 kV transmission line which will be built, owned and operated by PT Medco Ratch Power Riau (MRPR). The Project is located in the Tenayan Industrial Village (previously known as Sail Village), Tenayan Sub District, Pekanbaru City, Province of Riau.

The power plant is located approximately:

- 10 km due east of the city of Pekanbaru in central Sumatra, Indonesia;
- 3 km south of the Siak River; and
- 2 km south of PLN's existing 2 x 110 MW RIAU Coal Fired Power Plant (CFPP).

The power plant and switchyard will be located within the 9.1 ha of privately owned land currently being used as a palm oil plantation. The site is bounded by palm oil plantations to the west, south and east and Road 45 on the north.

MRPR will construct a gas supply pipeline from a connection point at an offtake location known as SV1401 on the main Grissik to Duri gas pipeline which is located north-east of the power plant in the Siak Regency. The gas will be delivered to the power plant by approximately 40 km of pipeline, the majority of which, will be located within the existing road reserve.

An outline of the Project area and main components of the power plan development are shown in

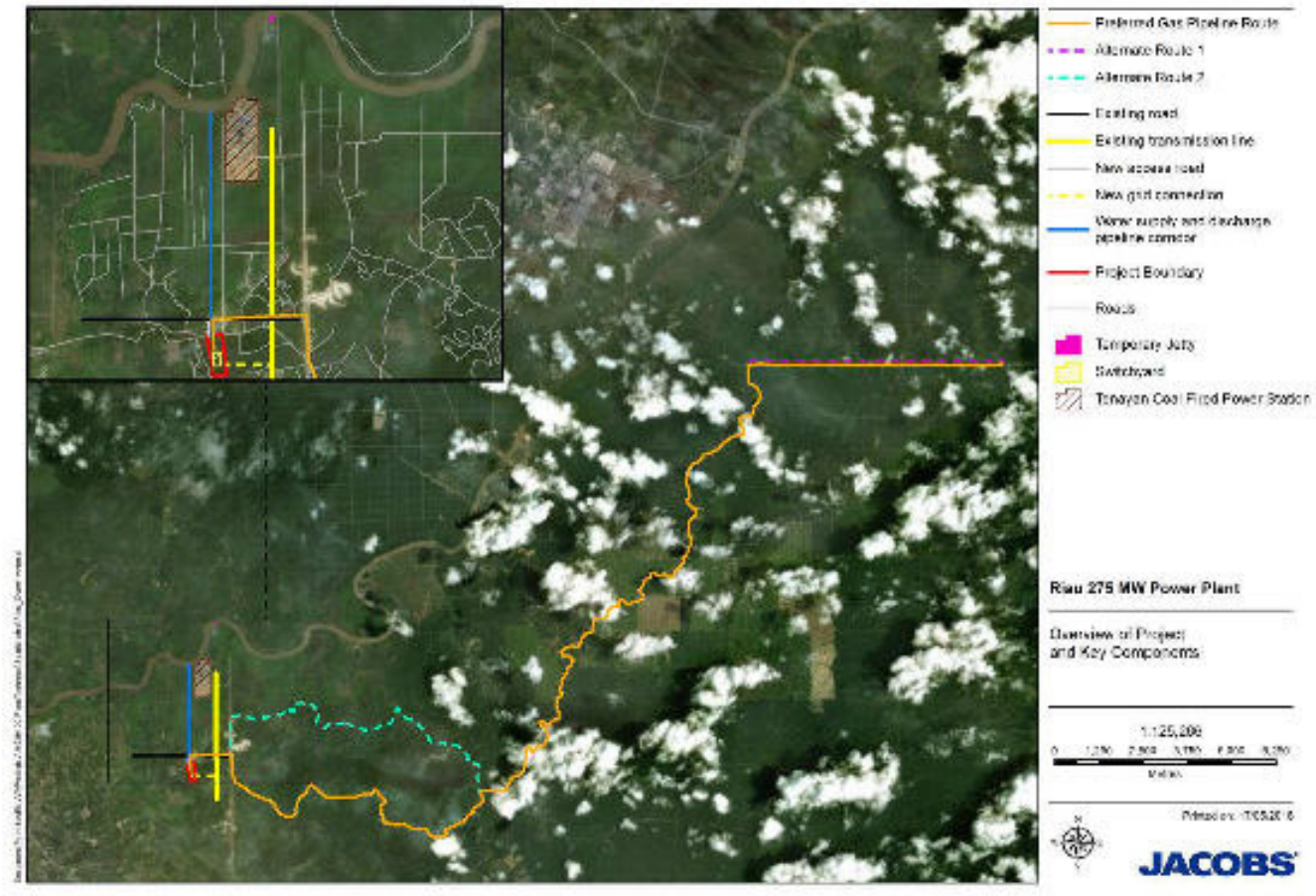


Figure 1.1. This includes the following:

- The new power plant site;
- Access road onto the site;
- A 750 m transmission line to connect to existing transmission lines;
- A temporary jetty on the Siak River to unload construction materials;
- A water intake structure and water supply pipeline on the Siak River; and
- A water discharge pipeline and outlet structure on the Siak River.

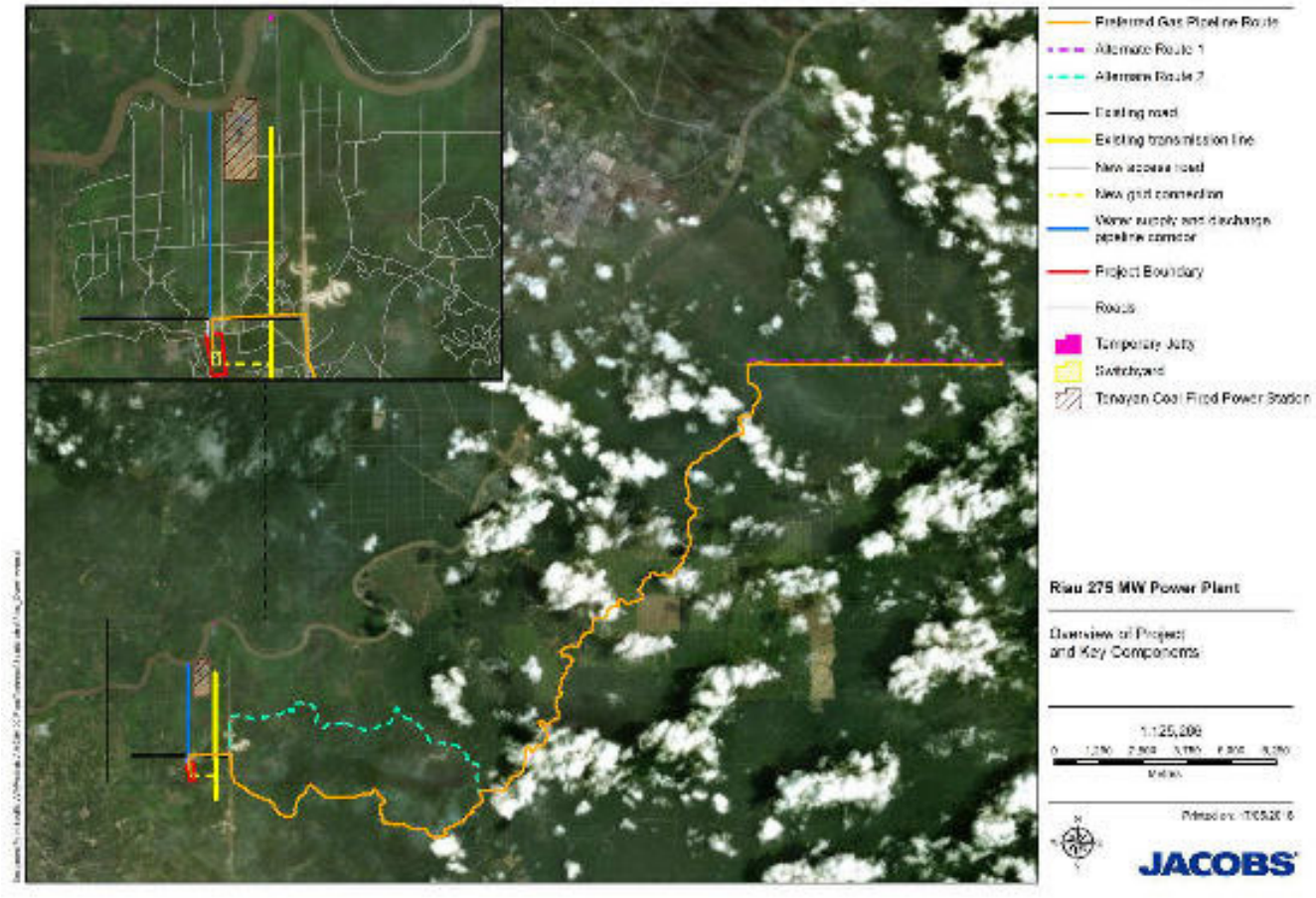


Figure 1.1 : Power Plant General Area

1.2 Document Structure

This report has the following structure:

- Section 2 of this report outlines the baseline water quality and ecology of the project area
- Section 3 documents the impact assessment methodology used in this assessment
- Section 4 identifies the activities that have the potential to impact upon the river environments of the project area and provides an assessment of the potential impacts of the project as currently proposed
- Section 5 recommends additional mitigation that is required to reduce significant potential impacts to an acceptable level and monitoring that is required to manage potential impacts during construction and operation of the power plant
- Section 6 assesses the residual impact remaining after the recommended additional mitigation has been implemented
- Section 7 provides an assessment of the cumulative impacts of the proposed plant alongside the existing coal fired power plant.

2. Baseline

The project area contains the Siak River as the main watercourse. This is a large river draining north-east from the Project area. In the general project vicinity, the river is approximately 125 m wide. The river at this location is over 100 km from the sea at an elevation of approximately 10 m aMSL. Based on available monitoring and ecology data and published data in Yuliati (2017) the river would be freshwater at this location and well above any saline water intrusion through tidal influence. The river water level within the Project area has been observed to fluctuate due to tidal influences but is anticipated to be a result of freshwater backing up above the saline reach of the tide. The Siak River is located approximately 3 km north of the power plant location. The water supply for the power plant will be sourced from this river and blowdown and other effluents will be discharged back to the river. A temporary jetty for the unloading of equipment for the construction of the power plant will also be constructed in the Siak River. Baseline data has been gathered to characterise the quality of the Siak River in both wet and dry season conditions. The Tenayan River is a tributary of the Siak River and is located to the west of the project location. No other permanent watercourses occur within the power plant (including transmission line, new road, water supply/discharge pipeline) project area.

Five watercourses will be crossed by the proposed gas pipeline route. Data has been gathered from three of these including the Gasib River to characterise the general quality of these waterbodies.

2.1 Methodology and sample locations

Water quality, ecology and sediment quality data has been gathered from eight locations for this project by PT Nusa Buana Cipta (NBC). The sample locations are outlined in Table 2.1 and Figure A.1Figure A.1 : in Appendix A. the following sections outline the methodology for data gathering that have been used.

Additional data on water quality has been sourced from the impact assessment undertaken for the existing PLTU Tenayan 2x100 MW CFPP that is located on the banks of the Siak River near to the proposed water supply intake and discharge point. Three sample sites were analysed for the impact assessment at locations shown in Figure A.1.

Table 2.1 : Water Quality, Macroinvertebrate Ecology and Sediment Quality Sample Locations

Site name	River	General location	Coordinates: Latitude, Longitude	Water quality sampling		Macroinvertebrate ecology sampling date	Sediment sampling date
				Dry season sampling date	Wet season sampling date		
WQ 01 PP	Upstream Tenayan River	Wider power plant area	N= 00°32'38.32" E= 101°30'16.65"	17/07/2017	No data	Not sampled	Not sampled
WQ 02 PP	Downstream Siak River	Downstream of water intake and discharge	N= 00°34'10.1" E= 101°30'47.0"	19/07/2017	17/01/2018	22/09/2017# 17/01/2018	22/09/2017# 06/02/2018
WQ 03 PP	Upstream Siak River	Upstream of water intake and discharge	N= 00°34'01.1" E= 101°31'16.4"	19/07/2017	17/01/2018	22/09/2017# 17/01/2018	22/09/2017# 06/02/2018
WQ 04 PP	Downstream Tenayan River	Wider power plant area	N= 00°33'37.7" E= 101°30'19.6"	19/07/2017	No data	22/09/2017#	22/09/2017# 07/02/2018
WQ 5 PP	Temporary Jetty - Downstream Siak River	Downstream of intake and discharge	N= 00°34'40.14" E= 101°31'39.28"	No data	17/01/2018	17/01/2018	17/01/2018

Site name	River	General location	Coordinates: Latitude, Longitude	Water quality sampling		Macroinvertebrate ecology sampling date	Sediment sampling date
				Dry season sampling date	Wet season sampling date		
		and at Jetty location					
RW-01PL	Gasib River	Pipeline Route	N= 00°38'36.37" E= 101°43'05.34"	No data	17/01/2018	17/01/2018	17/01/2018
RW-02 PL	Gasib River	Pipeline Route	N= 00°38'35.49" E= 101°42'28.40"	No data	17/01/2018	17/01/2018	17/01/2018
RW-03 PL	Unnamed Creek in plantation	Pipeline Route	N= 00°33'23.96" E= 101°33'01.55"	No data	19/01/2018	17/01/2018	No data
RW-03B-PL	Pasir River	Pipeline Route	N= 00°33'23.86" E= 101°34'50.00"	No data	No data	17/01/2018	No data

Note: #These three July macroinvertebrate samples were composited into one sample for analysis

2.1.1 River Morphology

A cross channel survey has been undertaken at three locations on the Siak River in proximity to the Project area. This involved measurements of the channel width and depth to create cross channel surveys and spatial location of the survey using GPS. Visual observations and photographs of the channels were also made by both NBC and Jacobs staff visiting the site in 2017.

2.1.2 Physical and chemical properties

Water quality samples and field observations were gathered from the survey locations. Some sites were sampled in wet and dry seasons and some in one season only as shown in Table 2.1. Field results were gathered for temperature with the remaining parameters analysed in the laboratory. Samples were collected and stored in accordance with requirements specified in Government Regulation No. 82 Year 2001 regarding Water Quality Management and Pollution Control Class II. Samples were analysed by PT. Organo Science Laboratory which is accredited by KAN (certified by the Indonesian Government) following Indonesian standards set in APHA: Standard Methods for the Examination of Water and Wastewater 21st Edition 2005. Samples were analysed for a range of physical, chemical, microbiological and organic parameters as shown in Table 2.3.

To understand the quality of the environment data it has been compared to the guidelines outlined in the Government Regulation No. 82 Year 2001 regarding Water Quality Management and Pollution Control Class II.

2.1.3 Macroinvertebrates

Macroinvertebrate sampling was conducted in dry season conditions in three of the sample sites shown in Table 2.1. This was WQ 2 PP, WQ 3 PP and WQ 4 PP being the downstream site on the Tenayan River and the two sites on the Siak River. Sediment samples were extracted from transects across the river at these three sites, using a grab or corer box method. The three samples were then composited together into one composite sample for analysis. Benthic fauna was extracted from the sediments and sent to the laboratory of the Scientific Authority for identification. Indices including abundance and the Shannon-Wiener Diversity Index (H) were calculated to aid assessment of the macroinvertebrate populations. As samples were composited across all sample sites they only allow for general identification of ecological quality and no differentiation between sites.

Macroinvertebrate sampling was also conducted in wet season conditions in the above sample sites along with WQ 5 PP in proximity to the proposed temporary jetty and the three sites along the pipeline route (RW-01, RW-02 and RW-03). For this round of sampling the samples gathered were analysed individually and not composited thus providing data that can differentiate between the sites.

2.1.4 Fish

The Fish Abundance Survey was conducted to obtain data and information on species richness and abundance of fish in the upstream and downstream waters of the project area. The survey method utilised a range of fishing techniques plus secondary data gathered through discussion with local fishermen. This secondary data aimed to support the primary data in giving a more balanced picture of the species present throughout the year, and to understand the public perception of the proposed project and changes in fish populations in the past.

The fishing techniques used were cast net, gill net, landing net, and fishing rod techniques. The use of such techniques was considered by NBC to be effective and widely practiced by the population. Gill nets were used at both points on the Siak River. On the tributary Tenayan River, cast net and landing nets were used.

Dry weather sampling was undertaken on the Siak and Tenayan Rivers and further fish surveys were undertaken in January in the wet season at the same sites on the Siak and Tenayan Rivers and three locations on the pipeline route.

Other methods such as drive nets and fyke nets were considered but discounted due to various reasons including their ability to disrupt the transport lanes and passing boats in the Siak River which is used as a shipping route. The locations of fishery surveys are shown in Table 2.2 and Figure A.1.

Table 2.2 : Fish Sampling Locations

No	Sample point	Coordinates (Latitude, Longitude)
Siak River		
1	Upstream	N=0°33'50.95" E=101°30'31.74"
2	Downstream	N=0°34'2.06" E=101°31'7.06"
Tenayan River		
1	Upstream	N=00°31'33.07" E=101°30'56.05"
2	Middle reach	N=0°32'23.54" E=101°30'16.12"
3	Downstream	N=0°33'31.58" E=101°30'17.75"
Pipeline Route		
RW-01	Gasib River crossing location	N= 00°38’36.37” E= 101°43’05.34”
RW-02	Gasib River tributary crossing location	N= 00°38’35.49” E= 101°42’28.40”
RW-03	Pasir River crossing location	N= 00°33’23.96” E= 101°33’01.55”

2.1.5 Sediment Quality

Sediment samples were gathered using grab or corer box methods. In a similar manner to the macroinvertebrate samples the three samples from the three sites in the dry weather sampling were composited into one sample for analysis. This data can be used only to provide a general indication of the current quality of the environment. Sampling undertaken in the wet season were not composited between sites allowing this data to better indicate the range of sediment quality in the various areas potentially impacted by the project. Analysis was undertaken for heavy metal and organic contaminants. Laboratory analysis was undertaken in accordance with USEPA 3050 and APHA 3120 B methods.

No relevant Indonesian sediment quality guidelines exist for comparison. Therefore, the ANZECC (2000) Guidelines were used to establish relevant sediment guidelines to characterise the environmental quality of the rivers and drains. Guideline values used are outlined in Table 2.11, guidelines do not exist for all parameters. Two values have been provided, one for the interim sediment quality guideline (ISQG) low and high. The low values are the most relevant guideline as they are trigger values where a low risk of impacts is likely. These values are not absolute standards so do not indicate that ecosystem impacts will definitely occur if they are exceeded.

2.2 Results

2.2.1 Climate

The project area has a tropical climate with approximately 3,000 mm annual rainfall and a rainy season between November and April. It is generally warm with ambient temperatures ranging between 20 and 37°C.

2.2.2 River Morphology and Use

The Siak River is a large river approximately 125 m wide and at the proposed location of the intake and temporary jetty is at an elevation of approximately 10 m above mean sea level. Yuliati *et. al.* (2017) note that it is one of the four main big rivers in Riau Province and the deepest river in Indonesia. It is characterised as a blackwater river that contains humic acid compounds from the leaching of surrounding peat soils. The river is over 100 km from the sea so is not expected to be tidally influenced at this location especially with no saltwater ingress. Yuliati *et. al.* (2017) studied the tidal influence on water quality in the river and concluded that the maximum point of saline impact on the water was located well downstream (over 80 km) from the power plant and over 40 km from the end of the pipeline route This is also reflected in the fish species that have been found which are mostly freshwater only species. There is evidence of tidal influence on the water levels in proximity to the project area with the freshwater backing up in the river and this impact was observed by Yuliati *et. al.* (2017) as far upstream as Pekanbaru above the project area. Both the Siak River and Tenayan River are used as a source of fish for food by local communities.

Yuliati *et. al.* (2017) note that the Siak River is a national strategic river used for navigation, transportation, fishing and a source of raw water for industries. The river is frequently used for transportation by a range of commercial boats and tankers. These boats carry people and cargo up and down the river using various jetty's and structures along the river to load and offload people and products. In proximity to the Project there is a jetty associated with the existing Tenayan CFPP and then upstream in Pekanbaru, the largest town on the river, there are a large number of wharfs, jetty's and terminals which demonstrate the frequency and regular use of the river for transport.

The Siak River has a gentle grade and is a wide deep channel. The banks contain a range of mud banks and trees/shrubby vegetation (Figure 2.1,

Figure 2.2 and Figure 2.3). The water is visually turbid and brown. Three cross sections have been taken across the river with widths ranging from 121 to 125 m and maximum depths from 10.8 to 12.8 m. Therefore, the river is similar upstream and downstream of the proposed Project area.

Figure 2.1 : Siak River in Proximity to Water Quality Sample Sites

Figure 2.2 : Siak River at Location of Cross Section C-C1

Figure 2.3 : Siak River at Location of Proposed Temporary Jetty

The Tenayan River is smaller than the Siak River being approximately 10 m wide in the vicinity of the upstream sample point and 15 m at the downstream point near its confluence with the Siak River. The river is generally brown and turbid (Figure 2.4) with some bankside tree/shrubby vegetation in a thin strip along the river. The wider area beyond the river bank is generally palm oil plantation.

Figure 2.4 : Tanayan River at Downstream Sample Point

The main watercourse that will be crossed by the pipeline route is the Gasib River. Monitoring site RW-02 is located on the main stem of this at the proposed crossing point (Figure 2.5). At this location the river was measured in February 2018 as being 18 m wide and 2.6 m deep at high tide during a cross sectional survey. The river is generally flat and slow flowing.

Monitoring site RW-01 is located on a tributary of the Gasib River close to RW-01 (Figure 2.6). This is a similarly flat and slow flowing area and was measured at high tide as being 9 m wide and 1.9 m deep.

Figure 2.5 : Gasib River at RW-02 Sample Point and Location of Proposed Gas Pipeline Crossing

Figure 2.6 : Gasib River at RW-01 Sample Point and Location of Proposed Gas Pipeline Crossing

2.2.3 Physical and Chemical Properties

Power plant vicinity - Siak and Tenayan Rivers

Yuliati *et. al.* (2017) noted concerns about the decline in the water quality of the Siak River due to inputs of domestic and industrial waste and reports of health effects on domestic users of the water and decreases in fish populations. Putri (2011) also noted the polluted nature of the river and concerns over its health that have resulted in the government initiating a policy to control pollution in the river with a resulting suite of programmes aiming to improve the water quality.

Yuliati *et. al.* (2017) assessed the quality of water in the lower Siak River (Palas Village in Pekanbaru City for 180 km downstream to the mouth) This data was gathered over 2015 and 2016 with a focus on understanding the differences in water quality at high and low tide. The Siak River is characterised as a blackwater river (Baun *et. al.* 2007) with high levels of dissolved organic carbon and low dissolved oxygen levels controlled in part by the influence of the tides. Their study compared the water quality to an index that identifies the pollution status of waterbodies by comparison to an established range of water quality in other relevant rivers. The following was concluded from their analysis of the water quality data:

- The pH of the black water was low in line with that found by other researchers;
- Total suspended solids were variable and elevated but generally below guidelines;
- Salinity levels in the lower river were influenced by the tide but this saline impact was not observed further upstream;
- Dissolved oxygen was low due to the high dissolved organic carbon
- BOD and COD were observed to be elevated and likely to be sourced from industrial and other discharges;
- For nutrients, ammonia and nitrite concentrations were generally above guidelines and nitrate and phosphorous within guidelines;
- Total coliforms and oil and grease were generally within the guidelines; and
- For metals, cadmium and mercury were within guidelines and lead often elevated above the guidelines.

The overall conclusion of Yuliati *et. al.* (2017) was that the Siak River water quality was heavily polluted at all states of the tide.

Table 2.3 presents the dry season water quality data from the Siak and Tenayan Rivers gathered for this project. Table 2.4 presents the wet season water quality data from the Siak River gathered for this project. Table 2.5 presents data for the Siak River from 2010 gathered for the development of the existing Tenayan CFPP. The data gathered for this project indicates the following:

- The water is warm, with generally elevated suspended solids and high turbidity in both wet and dry season with suspended solid concentrations higher in dry season;
- pH and DO were low in accordance with the results discussed above;
- Where guideline values exist concentrations of most parameters were within guideline values;
- Many parameters were below detection limits including most metals and organic parameters indicating reasonable water quality;
- Iron concentrations were elevated above guidelines and it is noted that in the dry season data only boron concentrations were elevated above what may be typical in rivers;
- The chemical oxygen demand was often elevated indicated organic enrichment of the water. BOD was not generally elevated in this data in contrast to published results. Faecal contamination was evident but not always above guidelines and higher in dry season conditions;
- Nutrient concentrations were generally below guidelines where they existed with some elevation of nitrogen observed above what may be expected in good quality rivers; and

- Oil and grease were elevated in the Siak River but not the Tenayan River in data gathered for this project. This may result from the regular boat traffic on the river.

Data gathered in 2010 presents a broadly similar picture with elevated suspended solids, iron, high oxygen demand and elevated microbial contaminants. Therefore, the data gathered for this project is broadly in accordance with that gathered for other projects and discussed in published reports. Overall the rivers appear to have a high sediment load and turbidity, low dissolved oxygen and pH and some elevated metals and nutrients and a higher oxygen demand.

Table 2.3 : Siak River and Tenayan River Dry Season Water Quality Results (By NBC, sourced for this project)

Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Results			
				WQ 3 PP	WQ 2 PP	WQ 1 PP	WQ 4 PP
				Siak River Upstream	Siak River Downstream	Tenayan River Upstream	Tenayan River Downstream
				19/07/2017	19/07/2017	17/07/2017	19/07/2017
Physical							
Temperature	℃	-	±3	31.2	32.1	28.1	27.9
Total Suspended Solids (TSS)	mg/L	1	50	56	34	132	24
Conductivity	µmho/cm	1	NA[3]	48	38	20	41
Turbidity	NTU	0.5	NA[3]	30.9	19.2	107	19.1
Chemical							
pH	-	-	6 – 9	6.88	5.80	7.84	6.56
Biochemical Oxygen Demand (BOD)	mg/L	2	3	<2	<2	<2	<2
Chemical Oxygen Demand (COD)	mg/L	3	25	92	13	<3	41
Ammonia (as NH3-N)	mg/L	0.07	(-)	0.23	0.25	0.13	0.25
Nitrate (NO3)	mg/L	0.003	10	0.545	0.544	0.081	0.478
Nitrite (NO2)	mg/L	0.005	0.06	<0.005	<0.005	<0.005	<0.005
Total Nitrogen	mg/L	0.06	NA[3]	1.56	2.26	0.25	1.66
Fluoride (F)	mg/L	0.1	1.5	0.5	0.4	<0.1	0.4
Phosphorus (P)	mg/L	0.03	0.2	<0.03	0.06	<0.03	0.2
Oil and Grease	µg/L	1000	1000	2400	1000	<1000	<1000
Total Boron (B)	mg/L	0.04	NA[3]	0.62	1.01	0.63	0.75
Total Mercury (Hg)	mg/L	0.0005	NA[3]	<0.0005	<0.0005	<0.0005	<0.0005
Total Arsenic (As)	mg/L	0.005	NA[3]	<0.005	<0.005	<0.005	<0.005
Total Cadmium (Cd)[2]	mg/L	0.002	NA[3]	<0.002	<0.002	<0.002	<0.002
Total Chromium Hexavalent (Cr6+)	mg/L	0.004	NA[3]	<0.004	<0.004	<0.004	<0.004
Total Chromium (Cr)	mg/L	0.02	NA[3]	<0.02	<0.02	<0.02	<0.02
Total Copper (Cu)	mg/L	0.01	NA[3]	<0.01	<0.01	<0.01	1.20
Total Iron (Fe)	mg/L	0.09	NA[3]	0.800	1.03	1.13	<0.005
Total Lead (Pb)[2]	mg/L	0.005	NA[3]	<0.005	<0.005	<0.005	<0.01
Total Manganese (Mn)	mg/L	0.01	NA[3]	0.05	<0.01	0.04	<0.01
Total Nickel (Ni)	mg/L	0.01	NA[3]	<0.01	0.03	<0.01	<0.01

Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Results			
				WQ 3 PP	WQ 2 PP	WQ 1 PP	WQ 4 PP
				Siak River Upstream	Siak River Downstream	Tenayan River Upstream	Tenayan River Downstream
				19/07/2017	19/07/2017	17/07/2017	19/07/2017
Total Zinc (Zn)	mg/L	0.02	NA[3]	0.05	0.02	<0.02	<0.02
Dissolved Boron (B)	mg/L	0.04	1	0.50	0.60	0.44	0.34
Dissolved Mercury (Hg)	mg/L	0.0005	0.002	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Arsenic (As)	mg/L	0.005	1	<0.005	<0.005	<0.005	<0.005
Dissolved Cadmium (Cd)[2]	mg/L	0.002	0.01	<0.002	<0.002	<0.002	<0.002
Dissolved Chromium Hexavalent (Cr6+)	mg/L	0.004	0.05	<0.004	<0.004	<0.004	<0.004
Dissolved Chromium	mg/L	0.02	NA[3]	<0.02	<0.02	<0.02	<0.02
Dissolved Copper (Cu)	mg/L	0.01	0.02	<0.01	<0.01	<0.01	<0.01
Dissolved Iron (Fe)	mg/L	0.09	0.3	0.445	0.445	0.43	0.445
Dissolved Lead (Pb)[2]	mg/L	0.005	0.03	<0.005	<0.005	<0.005	<0.005
Dissolved Manganese (Mn)	mg/L	0.01	(-)	<0.01	<0.01	<0.01	<0.01
Dissolved Nickel (Ni)	mg/L	0.01	NA[3]	<0.01	<0.01	<0.01	<0.01
Dissolved Zinc (Zn)	mg/L	0.02	0.05	<0.02	<0.02	<0.02	<0.02
Microbiology							
Total Coliform	colony/ 100mL	-	5000	720	180	1100	220
Organics							
Organochlorine Pesticides (OCP)	µg/L	0.4	NA[3]	<0.4	<0.4	NA[1]	<0.4
Polychlorinated Biphenyl's (PCB)	µg/L	0.005	NA[3]	<0.005	<0.005	NA[1]	<0.005
Polycyclic Aromatic Hydrocarbon (PAHs)	µg/L	0.04	NA[3]	<0.04	<0.04	NA[1]	<0.04
PCDDs	pg/L	50	NA[3]	<50	<50	NA[1]	<50
PCDFs	pg/L	50	NA[3]	<50	<50	NA[1]	<50

Note(s):

[1] Not Available

[2] This parameter (in the described matrix) has not been accredited by KAN

[3] Not Applicable

Grey shading indicates that samples are above the guideline regulation limit

Table 2.4 : Siak River Wet Season Water Quality Results (By NBC, sourced for this project)

Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Results		
				WQ 3 PP	WQ 2 PP	WQ 5 PP
				Siak River Upstream	Siak River Downstream	Siak River at proposed Jetty
				17/01/2018	17/01/2018	17/01/2018
Physical						
Temperature	℃	-	±3	27.20	28.50	27.40
Total Suspended Solids (TSS)	mg/L	1	50	15.00	11.00	25.00
Conductivity	µmho/cm	1	NA[3]	28.00	27.00	30.00
Turbidity	NTU	0.5	NA[3]	14.30	12.40	14.60
Dissolved Oxygen	Mg/L	-	NA[3]	3.80	6.20	4.00
Chemical						
pH	-	-	6 – 9	5.54	5.77	5.67
Biochemical Oxygen Demand (BOD)	mg/L	2	3	<2	<2	<2
Chemical Oxygen Demand (COD)	mg/L	3	25	8.60	<5	18
Ammonia (as NH3-N)	mg/L	0.07	(-)	0.16	0.17	0.39
Nitrate (NO3)	mg/L	0.003	10	0.12	0.10	0.10
Nitrite (NO2)	mg/L	0.005	0.06	0.02	0.02	0.01
Total Nitrogen	mg/L	0.06	NA[3]	1.16	1.12	2.63
Fluoride (F)	mg/L	0.1	1.5	0.20	<0.1	<0.1
Phosphorus (P)	mg/L	0.03	0.2	<0.03	<0.03	<0.03
Oil and Grease	µg/L	1000	1000	<1000	3800.00	2400
Total Boron (B)	mg/L	0.04	NA[3]	<0.04	<0.04	<0.04
Total Mercury (Hg)	mg/L	0.0005	NA[3]	<0.0005	<0.0005	<0.0005
Total Arsenic (As)	mg/L	0.005	NA[3]	<0.0005	<0.0005	<0.0005
Total Cadmium (Cd)[2]	mg/L	0.002	NA[3]	<0.002	<0.002	<0.002
Total Chromium Hexavalent (Cr6+)	mg/L	0.004	NA[3]	<0.004	<0.004	<0.004
Total Chromium (Cr)	mg/L	0.02	NA[3]	<0.02	<0.02	<0.02
Total Copper (Cu)	mg/L	0.01	NA[3]	<0.01	<0.01	<0.01
Total Iron (Fe)	mg/L	0.09	NA[3]	0.58	0.64	0.65
Total Lead (Pb)[2]	mg/L	0.005	NA[3]	<0.005	<0.005	<0.005
Total Manganese (Mn)	mg/L	0.01	NA[3]	0.09	0.06	0.03
Total Nickel (Ni)	mg/L	0.01	NA[3]	<0.01	<0.01	<0.01
Total Zinc (Zn)	mg/L	0.02	NA[3]	<0.02	<0.02	<0.02
Dissolved Boron (B)	mg/L	0.04	1	<0.04	<0.04	<0.04
Dissolved Mercury (Hg)	mg/L	0.0005	0.002	<0.0005	<0.0005	<0.0005
Dissolved Arsenic (As)	mg/L	0.005	1	<0.0005	<0.0005	<0.0005
Dissolved Cadmium (Cd)[2]	mg/L	0.002	0.01	<0.002	<0.002	<0.002
Dissolved Chromium Hexavalent (Cr6+)	mg/L	0.004	0.05	<0.004	<0.004	<0.004

Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Results		
				WQ 3 PP	WQ 2 PP	WQ 5 PP
				Siak River Upstream	Siak River Downstream	Siak River at proposed Jetty
				17/01/2018	17/01/2018	17/01/2018
Dissolved Chromium	mg/L	0.02	NA[3]	<0.02	<0.02	<0.02
Dissolved Copper (Cu)	mg/L	0.01	0.02	<0.01	<0.01	<0.01
Dissolved Iron (Fe)	mg/L	0.09	0.3	0.41	0.46	0.43
Dissolved Lead (Pb)[2]	mg/L	0.005	0.03	<0.005	<0.005	<0.005
Dissolved Manganese (Mn)	mg/L	0.01	(-)	<0.01	<0.01	<0.01
Dissolved Nickel (Ni)	mg/L	0.01	NA[3]	<0.01	<0.01	<0.01
Dissolved Zinc (Zn)	mg/L	0.02	0.05	<0.02	<0.02	<0.02
Microbiology						
Total Coliform	colony/ 100mL	-	5000	110	6.1	220

Note(s):

[1] Not Available

[2] This parameter (in the described matrix) has not been accredited by KAN

[3] Not Applicable

Grey shading indicates that samples are above the guideline regulation limit

Table 2.5 : Siak River Water Quality Results (By PT PLN, sourced for the existing coal fired power station, sampled March 2010)

Parameter	Unit	Regulation Limit (PP 82/2001 class II)	Results		
			Upstream I[1]	Middle II[1]	Downstream III[1]
Physical					
Temperature	^{0}C	±3	29	30	30
Total Dissolved Solids (TDS)	mg/L	1000	40	34	23
Total Suspended Solids (TSS)	mg/L	50	84	112	104
Conductivity	µmho/cm	-	50	30	30
Salinity	0/00	-	1	0	0
Turbidity	NTU	-	19.3	19.6	20.2
Chemical					
pH	mg/L	6-9	5.8	5.4	5.2
BOD	mg/L	3	6.01	7.20	7.86
COD	mg/L	25	20	35	25
DO	mg/L	4.0	3	2.2	2.5
Phosphate (PO 4)	mg/L	0.2	0.011	0.027	0.006
Cadmium (Cd)	mg/L	0.01	<0.001	<0.001	<0.001
Copper (Cu)	mg/L	0.2	<0.001	<0.001	<0.001
Iron (Fe)	mg/L	0.3	0.611	0.642	0.611
Lead (Pb)	mg/L	0.3	<0.001	<0.001	<0.001
Zinc (Zn)	mg/L	0.05	<0.001	<0.001	<0.001

Parameter	Unit	Regulation Limit (PP 82/2001 class II)	Results		
			Upstream I[1]	Middle II[1]	Downstream III[1]
Chromium (Cr)	mg/L	0.05	<0.001	<0.001	<0.001
Mercury (Hg)	mg/L	0.001	<0.001	<0.001	<0.001
Sulphate (SO4)	mg/L	-	8.78	9.10	8.78
Oil and fat	ug/L	1000	<0.001	<0.001	<0.001
detergents	ug/L	200	70.04	120	96.7
Microbiology					
Faecal Coli	MPN/100	1000	4375	2750	1750
Total Coliform	MPN/100	5000	35000	22000	14000

Note: [1]Sample location coordinates are as follows: 500m upstream of the power plant site, by the power plant site and 500m downstream of the power plant site.

Grey shading indicates that samples are above the guideline regulation limit

Pipeline vicinity – Gasib River

Water quality data has been gathered at three rivers along the pipeline route. Two of these are on the Gasib River and one on the Pasir River. The data is presented in Table 2.6. All three rivers are characterised by slightly elevated suspended solids and turbidity. Dissolved oxygen and pH are low. COD, oil and grease and dissolved iron concentrations are generally elevated above guidelines. This data indicates that all three of the streams being crossed have similar water quality with the only notable difference is that boron concentrations are elevated in RW-03 compared to the Gasib River. Overall the water quality in these three rivers appears to be broadly similar to the water quality in the Tenayan and Siak Rivers.

Table 2.6 : Gasib River and Pasir River Wet Season Water Quality Results (By NBC, sourced for this project)

Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Results		
				RW 01 PL	RW 02 PL	RW 03 PL
				Gasib River tributary	Gasib River main stem	Pasir River
				17/01/2018	17/01/2018	19/01/2018
Physical						
Temperature	℃	-	±3	30.00	28.90	27.70
Total Suspended Solids (TSS)	mg/L	1	50	16.00	13.00	10.00
Conductivity	µmho/cm	1	NA[3]	40.00	20.00	25.60
Turbidity	NTU	0.5	NA[3]	4.39	7.66	2.56
Dissolved Oxygen	mg/L	-	NA[3]	4.10	5.10	4.70
Chemical						
pH	-	-	6 – 9	4.98	5.51	5.65
Biochemical Oxygen Demand (BOD)	mg/L	2	3	<2	<2	<2
Chemical Oxygen Demand (COD)	mg/L	3	25	60.00	51.00	40.00
Ammonia (as NH3-N)	mg/L	0.07	(-)	0.22	0.13	<0.07
Nitrate (NO3)	mg/L	0.003	10	<0.003	0.01	0.01
Nitrite (NO2)	mg/L	0.005	0.06	0.02	0.01	<0.005

Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Results		
				RW 01 PL	RW 02 PL	RW 03 PL
				Gasib River tributary	Gasib River main stem	Pasir River
				17/01/2018	17/01/2018	19/01/2018
Total Nitrogen	mg/L	0.06	NA[3]	0.51	1.20	0.87
Fluoride (F)	mg/L	0.1	1.5	0.20	<0.1	<0.1
Phosphorus (P)	mg/L	0.03	0.2	<0.03	<0.03	<0.03
Oil and Grease	µg/L	1000	1000	2600.00	1800.00	6200.00
Total Boron (B)	mg/L	0.04	NA[3]	<0.04	<0.04	-
Total Mercury (Hg)	mg/L	0.0005	NA[3]	<0.0005	<0.0005	<0.0005
Total Arsenic (As)	mg/L	0.005	NA[3]	0.0007	0.0011	<0.0005
Total Cadmium (Cd)[2]	mg/L	0.002	NA[3]	<0.002	<0.002	-
Total Chromium Hexavalent (Cr6+)	mg/L	0.004	NA[3]	<0.004	<0.004	<0.004
Total Chromium (Cr)	mg/L	0.02	NA[3]	<0.02	<0.02	-
Total Copper (Cu)	mg/L	0.01	NA[3]	<0.01	<0.01	<0.01
Total Iron (Fe)	mg/L	0.09	NA[3]	3.18	3.26	1.09
Total Lead (Pb)[2]	mg/L	0.005	NA[3]	<0.005	<0.005	-
Total Manganese (Mn)	mg/L	0.01	NA[3]	<0.01	<0.01	-
Total Nickel (Ni)	mg/L	0.01	NA[3]	<0.01	<0.01	-
Total Zinc (Zn)	mg/L	0.02	NA[3]	0.09	0.02	0.02
Dissolved Boron (B)	mg/L	0.04	1	<0.04	<0.04	1.62
Dissolved Mercury (Hg)	mg/L	0.0005	0.002	<0.0005	<0.0005	<0.0005
Dissolved Arsenic (As)	mg/L	0.005	1	<0.0005	<0.0005	<0.0005
Dissolved Cadmium (Cd)[2]	mg/L	0.002	0.01	<0.002	<0.002	<0.002
Dissolved Chromium Hexavalent (Cr6+)	mg/L	0.004	0.05	<0.004	<0.004	<0.004
Dissolved Chromium	mg/L	0.02	NA[3]	<0.02	<0.02	<0.02
Dissolved Copper (Cu)	mg/L	0.01	0.02	<0.01	<0.01	<0.01
Dissolved Iron (Fe)	mg/L	0.09	0.3	0.61	0.64	0.24
Dissolved Lead (Pb)[2]	mg/L	0.005	0.03	<0.005	<0.005	<0.005
Dissolved Manganese (Mn)	mg/L	0.01	(-)	<0.01	<0.01	<0.01
Dissolved Nickel (Ni)	mg/L	0.01	NA[3]	<0.01	<0.01	<0.01
Dissolved Zinc (Zn)	mg/L	0.02	0.05	<0.02	<0.02	<0.02
Microbiology						
Total Coliform	colony/ 100mL	-	5000	4.5	1.8	<1.8

Note(s):

[1] Not Available

[2] This parameter (in the described matrix) has not been accredited by KAN

[3] Not Applicable

Grey shading indicates that samples are above the guideline regulation limit

2.2.4 Macroinvertebrates

For the dry season sampling three surface sediment samples were taken from three separate locations, two on the Siak River and one on the downstream end of the Tenayan River. These were composited together prior to analysis hence results in Table 2.7 are from all three sites and can only be interpreted as indicating the species that generally occur within the area. No differentiation between sites can be made. The results indicate that there was a limited number of taxa with mainly worms, snails and clams being found (Figure 2.7). These are more tolerant of degraded conditions and disturbance.

Table 2.7 : Dry Season Benthic Macroinvertebrate Results (By PT Nusa Buana Cipta, sourced for this project)

Species	Family	Common name	Result (Composite sample representing WQ 2 PP to WQ 4 PP combined)
Oligochaeta		Worm species	117
Pila ampullacea	Ampullariidae	Freshwater snail	8
Polymesoda	Corbiculidae	Clam genus	17
Clithon	Neritidae	Freshwater snail genus	8
Decapoda	Crustaceae	Decapods order include crayfish, crabs, lobsters, prawns, and shrimp	8
Abundance of macrobenthic fauna/m^2			158
Total Taxa			5
Shannon-Wiener Diversity Index (H)			0.915
Hmax			1.609
Equitability index			0.569