

Initial Environmental Examination

PUBLIC

Document Stage: Addendum
Project Number: 51077-002
November 2024

Maldives: Greater Male Environmental Improvement and Waste Management Project

DB02 - Final Design of the C&D Waste Processing Plant

Prepared by the Ministry of Environment and Energy of the Republic of Maldives for the Asian Development Bank. (ADB). This is an addendum of the document originally posted in March 2018 available on <https://www.adb.org/projects/documents/mld-51077-002-iee-0>

This addendum to the initial environmental examination is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or Staff, and may be preliminary in nature. Your attention is directed to the "terms of use" section of ADB's website.

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, ADB does not intend to make any judgments as to the legal or other status of any territory or area.

CONTENTS

I.	Background	1
II.	Project Description	1
	A. Final Design & Processes	2
	B. Proposed Location	4
III.	Anticipated Environmental Impacts and Mitigation Measures	7
	A. Environment Management Plan	7
IV.	Environmental Monitoring	15

APPENDICES

Appendix 1: Layout of the C&D Waste Processing Plant

Appendix 2: Dust Assessment

I. BACKGROUND

1. The Greater Malé Environmental Improvement and Waste Management Project will establish a sustainable solid waste management (SWM) system in the Greater Malé capital region and its inhabited outer islands by (i) establishing a modern waste collection, transfer, and disposal system, (ii) improving community-based outer island waste management systems, (iii) building institutional capacity for sustainable services delivery, and (iv) raising public awareness in reduce, reuse, recycle (3R) behaviors. Physical and non-physical investments are designed to curb climate change and disaster impacts while creating a cleaner environment in Maldives. The executing agency is the Ministry of Finance and Treasury (MOFT). The implementing agency is Ministry of Climate Change, Environment and Energy (MoCCEE) who have established a project management unit (PMU) comprising officials from MoCCEE. The PMU will have responsibility for overseeing project management, with support from Project Management, Design and Supervision Consultants (PMDSC).

2. The Project will have three outputs: (i) Output 1: Waste collection, transfer, and disposal systems improved and made climate and disaster resilient, (ii) Output 2: Community-based outer island waste management systems targeting poor and women enhanced, and (iii) Output 3: Institutional capacity and public awareness in sustainable waste management strengthened.

3. Output 1: Waste collection, transfer, and disposal systems improved and made climate and disaster resilient. This will include (i) an efficient waste collection strategy designed and applied in Malé and Hulhumalé in consultation with local communities targeting women; (ii) waste collection and transport equipment (trucks, bins, containers) for Malé, Hulhumalé and Villimalé provided; (iii) transfer stations in Malé and Villimalé constructed and transfer station in Hulhumalé designed; (iv) construction and demolition (C&D) waste processing plant and end of life vehicle (ELV) dismantling workshop constructed; (v) waste vessel harbor at Thilafushi rehabilitated; (vi) 3 vessels for waste transport from outer islands to Thilafushi provided; (vii) heavy equipment (bulldozers, excavators, roll trucks) for controlled dumpsite management at Thilafushi provided; and (viii) construction of 2 administrative buildings for WAMCO at Malé transfer station and Thilafushi waste vessel harbor. All facilities designed will consider climate change and disaster resilient features.

4. The Initial Environment Examination (IEE) has been prepared for output 1 in March 2018. This addendum has been prepared for the finalized design of the Construction and Demolition (C&D) waste processing plant.

II. PROJECT DESCRIPTION

5. The contractor for the C&D plant is China State Construction Engineering Corporation (CSCEC).

6. Construction of the C&D waste processing plant is expected to take a duration of one year from the start of construction.

7. The plant will be handed over to Waste Management Corporation Limited (WAMCO) for operations.

A. Final Design & Processes

8. C&D waste is currently disposed of with general waste. With rapid development taking place in Greater Malé, the generation of C&D waste is likely to rise from a present level of 530 tons/day to 634 tons/day in 2020 and 731 tons/day in 2040. C&D waste is composed mainly of inert material such as aggregates and dust, making up 91.8% of the total by weight, while most of the rest is wood, making up 7.1%, paper and plastic film material make up a further 1% and the final 0.2% is metal waste.

9. A general description of the C&D waste plant operations is provided in Table 1 below.

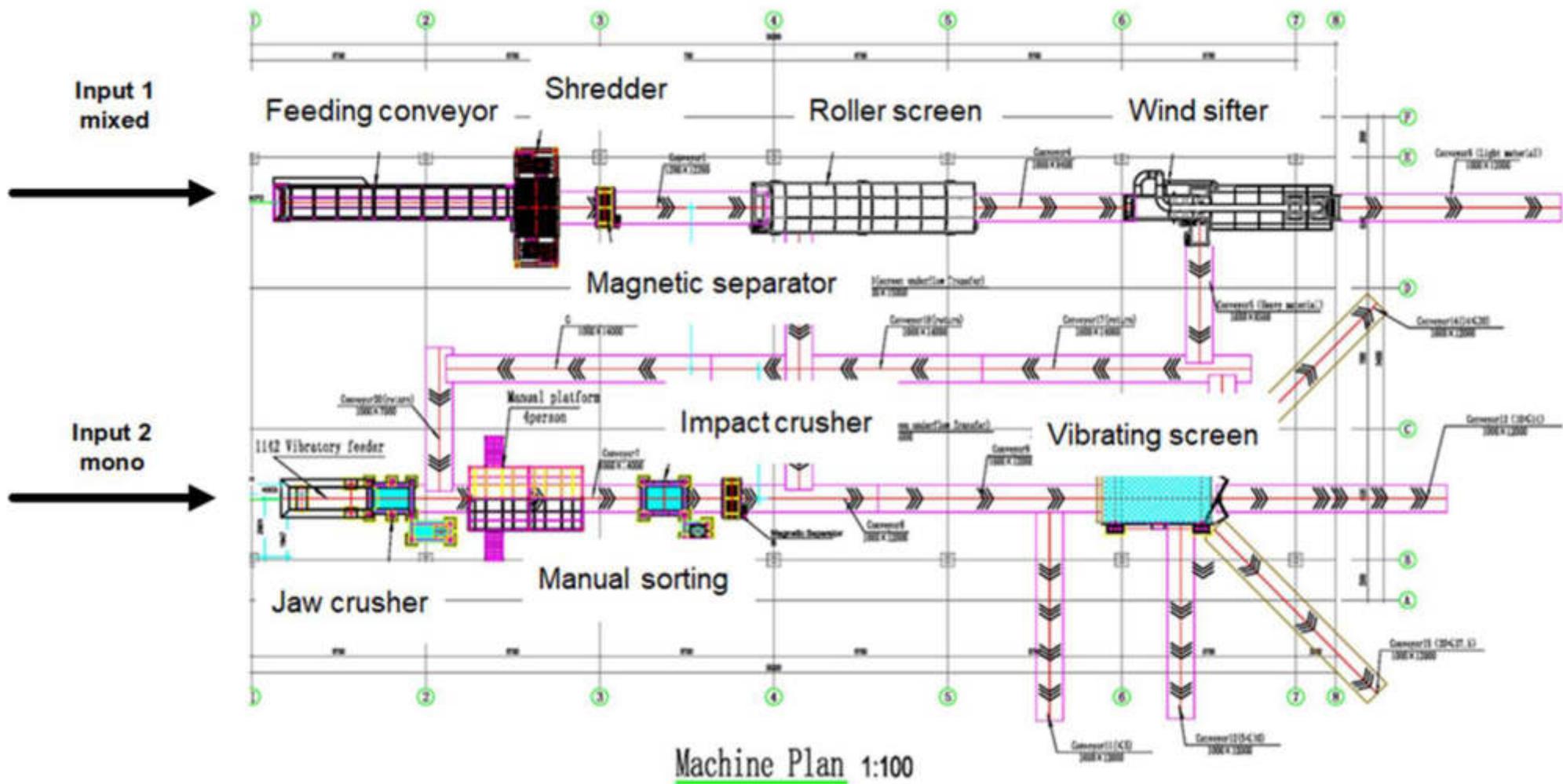
Table 1: General description of C&D waste plant operations

Aspect	Description
Capacity	~100 t/h
Input 1	Comingled/ mixed C&D waste (concrete, bricks, packaging, bags, metal, etc.)
Input 2	Mono-fractions: Concrete
Shift (planned)	1 (in case of increasing C&D waste, shift can be increased to 2)
Working hrs	6-8 hrs/ day (with legal break times)
Staff/mobile equipment	Minimum: 1-2-wheel loader(s) (1 input area/1 output area) Presorting and water spraying: 2 (mainly full time) Overall operators: 2 (in the vicinity of the site but not permanently on the working area) Manual sorting platform: 4 (full time) Maintenance staff: 2 (periodically, not permanently working on the operation area) Total (min): 12 Thereof: 8 working/exposed permanently on the site
Power consumption	~ 800 kW

10. The layout of the C&D plant is provided in Figure 1 below and detailed layout of the plant is included in Annex 1. The C&D waste plant consists of the following components:

- (i) A sorting plate to receive waste from the containers. The material is roughly presorted by using a wheel loader. Coarse concrete and stone chunks are removed and pre-crushed either using an excavator or by hand using chisels;
- (ii) A feeding hopper (minimum volume 15 m³);
- (iii) A pre-screening plant fed by a vibrating chute, fitted with flaps that can be manually adjusted to handle grain sizes of 0-10 and 10-60 millimeters (mm);
- (iv) A sorting station;
- (v) A pre-crusher for coarse concrete fragments, capable of handling material with a grain size of up to 300mm to reduce to between 150 mm approximately;
- (vi) A toggle jaw crusher;
- (vii) A separator fitted with magnets to remove magnetic metal waste;
- (viii) A sorting station using a vibrating screen, where wood, plastics and metals are sorted by hand and rejected materials are collected in containers;
- (ix) A power supply; and
- (x) belt conveyors and discharge shafts.

Figure 1: C&D waste processing plant layout



11. The plant's first line handles mixed waste, separating materials through shredding, magnetic separation, and screening. The second line processes concrete waste, primarily through crushing, and merges with the first line for further manual sorting and refining. The setup aims to ensure a continuous and efficient workflow while minimizing dust exposure. Processes for the first and second line are provided below:

First line: Mixed C&D waste is dumped and charged into the feeding conveyor (input 1), the waste is shredded, then metal parts will be removed (magnetic separation) and screened (trommel screening). Light parts (plastic, packaging etc.) will be removed through wind shifting and heavy parts will be conveyed to the second line for further sorting and refining.

Second line: Mono fractions (concrete) will be dumped and charged into the feeding conveyor and crushed (jaw crusher). After the crushing the material is transported with the material from the 1st line to the manual sorting platform for removal of impurities (small plastic parts, small metal parts etc.). After the sorting line the material is conveyed for further crushing, screening according to the requirements

12. Wood and plastics removed by the process will be transported to the WTE plant for incineration.

13. Coarse material separated out at the sorting place with material from the pre-crushing process, together with material from the coarse fraction of the screening process are fed to the crusher, following which magnetic separation takes place, extracting scrap metal which will be sold, along with non-magnetic metals.

14. Following the magnetic separation, the material will be divided up in the following fractions:

- (i) <5 mm ,
- (ii) 5-10 mm,
- (iii) 10-14 mm
- (iv) 14-20 mm, and
- (v) 20-37.5 mm.

15. The individual fractions will be stockpiled and then transported in containers to the site of re-use.

16. The plant will be housed in an open shed for protection against heavy rainfall and allowing air circulation to dissipate dust. The design is flexible, allowing for further screens and chutes to produce material of a different size range, should there be demand for it.

17. In case of unavailability of power for operation (once completed), it is anticipated that a diesel generator may be required to provide the necessary power. The facility design incorporates this possible scenario; however, the diesel generator set is not included in the scope of work.

B. Proposed Location

18. The initially proposed location for the C&D plant has been changed in the finalized

design to an area south of the existing dumpsite. The site plan for the plant is shown in Figure 2, activities in the vicinity are indicated in Figure 3 and aerial images of the proposed site are shown in Figure 4 and 5.

19. The proposed site was previously used by Maldives Transport and Contracting Company (MTCC), the contractor for harbor rehabilitation for this project. Areas adjacent to the site are used for baled waste storage, Waste to Energy facility (west of the site), landfill (north of the site) and currently vacant site belonging to MoCCEE (east of the site) and waste recycling site (further east of the site).

20. As seen in Figure 4 and 5, the proposed site does not have any significant vegetation. Waste materials kept at the site by MTCC have been removed in July 2024. A part of the current baled waste storage also falls within the proposed site. Although the baled waste storage does not fall within the construction boundary, they will require removal prior to the start of operation of the C&D plant.

21. Temporary utilities such as water and electricity connections at the site will be made through utility providers at Thilafushi, STELCO and MWSC, prior to construction.

Figure 2: Site plan for the proposed C&D plant prepared by the contractor, CSCEC

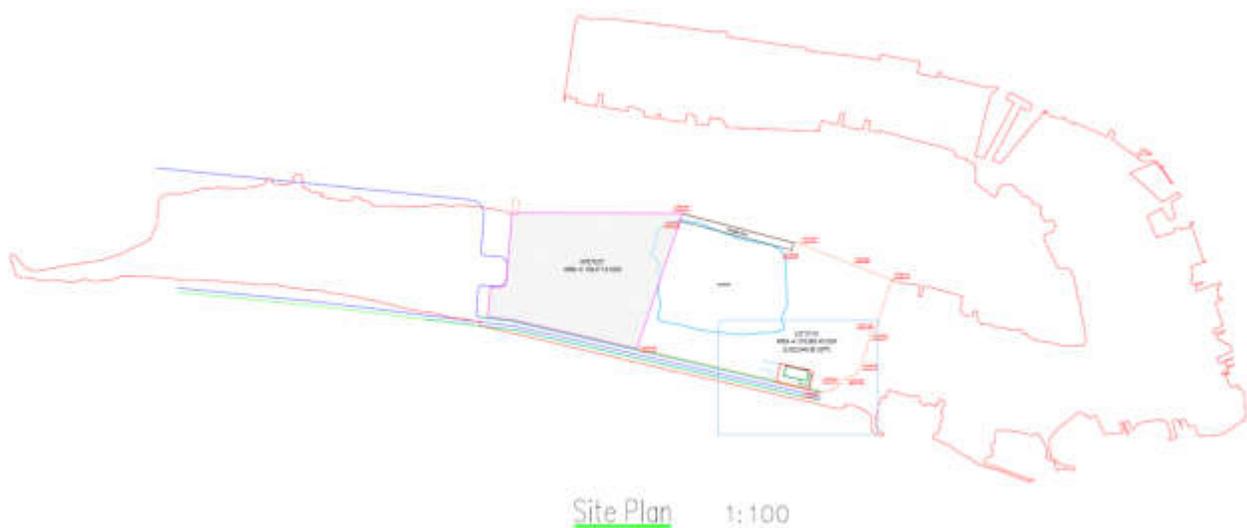


Figure 3: C&D plant site and activities in the vicinity



Figure 4: Aerial Image of the proposed site for the C&D plant (June 2024)



Figure 5: Aerial image of the proposed site for C&D plant (June 2024)



III. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

22. A detailed description of anticipated Environmental Impacts and Mitigation Measures are provided in the March 2018 IEE for the project.

23. One of the main impacts anticipated during operations stage is air pollution from dust generated at the plant. The highest levels of dust impacts are anticipated from the vibrating screen, jaw crusher and impact crusher components. Mitigation measures proposed for the vibrating screen include water spraying. While the jaw crusher and impact crusher systems are encapsulated, fully closed systems to mitigate the dispersion of dust. Additional mitigation measures at the plant include paving areas where ever possible, using water hoses for water spraying, enclosing wheel loader cabins and installing of plastic slatted curtains. The design of the plant accommodates passive air circulation through an open shed construction in order to enhance natural ventilation. A detailed assessment of anticipated dust is provided in Appendix 2.

A. Environment Management Plan

24. The detailed Environmental Management Plan for Output 1 is provided in the March 2018 IEE. The EMP specific for the C&D waste processing plant is provided in the tables below.

Table 2: Environmental Management Plan – (DESIGN AND PRE-CONSTRUCTION) and Status of Compliance

Design and Pre-Construction EMP Requirements	Status of Compliance
Incorporation into design of safe cabins for plant operators	There are no cabins included in the design at ground level. The operations include a manual sorting platform at a higher elevation. Plastic slatted curtains shall be used at the sorting platform as additional protection for operators. Wheel loader cabins will be enclosed and aerated.
Inclusion of safety features for the plant including noise suppression, dust suppression, guard rails, emergency shut-off and lighting,	<p>Guard rails are provided in the plant where necessary. Emergency shutoff and lighting is included as part of the design. The construction workers as well as plant operators shall be provided with appropriate PPE for noise and dust.</p> <p>Noise mitigation/reduction enclosures/barriers will be installed if possible. Anti-vibration mountings will be installed as required. Where enclosure is not possible, noise will be reduced by other engineering means such as:</p> <ul style="list-style-type: none"> • lining guards/panels with noise dampening material • providing acoustic screens • lining the inside of hoppers with impact-deadening material • fitting anti-vibration mountings • fitting silencers to exhaust systems • ensuring good maintenance to stop rattles and prevent noise from wear. <p>Dust mitigation measures at the plant are stated below. A detailed assessment is provided in Annex 2.</p> <ul style="list-style-type: none"> • The site will be paved wherever possible to reduce dust development • The wheel loader cabins will be enclosed and aerated. • Masks fitted with particulate filters and exhalation valves will be issued for any work that has to take place within the C&D waste plant outside the cabins and the operator shall be responsible to ensure that these masks are kept in good condition and worn whenever necessary. • Plastic slatted curtains shall be used at the sorting platform as additional protection for operators. • Dust suppression measures such as water spraying will be carried

Design and Pre-Construction EMP Requirements	Status of Compliance
	<p>out within the site by the operator (WAMCO). There are two water connections within the site for connection of hoses for water spraying.</p> <ul style="list-style-type: none"> • Open shed to allow a passive aeration and air circulation
<p>Design of the overall site (drainage, access, safety features, security to comply with EHS guidelines for Waste Management Facilities)</p>	<p>A small firefighting component is included with the detail design. The shed is at higher elevation than the ground and stormwater will flow by ground level gradient to the perimeter of the shed. The perimeter road on the south side (built under a separate project undertaken by HDC which is expected to start in Q4 2025) will have a stormwater drainage where the site will be connected. Barriers and notice to be in place to restrict unauthorized access to the C&D plant</p>
<p>Incorporation of recommendations from CRVA into detailed design (DRR and CCA Measures)</p> <ul style="list-style-type: none"> • Where ground elevation is below 2.2 meters (m) and critical components might be damaged by saline water, the BFE of floor and/or components raised above 2.2 m • To reduce inundation on slab surfaces, which serve the various facilities, include 'splash pads' to direct water flows and/or water harvesting 'pits' to increase water percolation • Mechanical and electrical systems elevated to protect from inundation in a protected and water-proof environment • The power back up system set up in a protected and waterproof environment to keep systems operational during storms • Where critical facilities are housed, mitigate seismic vulnerabilities of the buildings and update roof and building design standards to withstand Category 2 storms and related wind speeds 	<p>Considered in the final design</p> <p>Considered in the final design</p> <p>Considered in the final design</p> <p>Currently, there is no backup power system in the scope of works</p> <p>Considered in the final design</p>
<p>Preparation of Contractor's Environmental Management Plan providing specific detail in relation to chosen construction methods</p>	<p>Will be prepared by the Contractor for approval of the PMU prior to the start of construction.</p>
<p>Provision of information to the public on Grievance Redress Mechanism</p>	<p>Information on GRM is disclosed on the project website and at the project site.</p>

Design and Pre-Construction EMP Requirements	Status of Compliance
IEE / EMP to be updated to reflect final detailed design and construction methods. ADB clearance obtained before proceeding	This addendum is prepared to reflect the final design of the C&D Plant. A CEMP shall be prepared by the contractor with details of construction methods for approval of PMU prior to the start of construction.

Table 3: Environmental Management Plan (Construction & Operation Stage)

Impacts	Mitigation Measures	Performance Standard	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Construction Stage					
Waste Generation from construction activities	Construction waste must be stored within the site until it is handed to WAMCO for disposal	Waste disposed responsibly	Construction cost	Contractor	PMU
Water pollution	<p>Vehicles and equipment are to be maintained in sound operable condition, free of leaks.</p> <p>Construction materials should be stored safely to avoid spillage and contamination.</p>	<p>The condition of vehicles and equipment will be periodically checked.</p> <p>Material storage areas to be on surfaced areas and checked periodically.</p>	Construction cost	Contractor	PMU
Community health and safety hazards	<p>Restriction of access to the site</p> <p>Contractors to adopt the WB EHS Guidelines on Community Health and Safety, particularly those that relate to construction works.</p>	Barriers and notice to be in place	Construction cost	Contractor	PMU
Occupational health and safety hazards	Contractor to appoint a health	Member of the Contractor's staff nominated as	Construction cost	Contractor	PMU

Impacts	Mitigation Measures	Performance Standard	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
	<p>and safety officer to the site.</p> <p>Workers to be briefed on health and safety practices.</p> <p>Adequate PPE to be provided for the workers.</p> <p>Contractors to adopt the WB EHS Guidelines on OHS, particularly those that relate to construction works.</p> <p>Fire safety measures to be in place.</p>	<p>health and safety officer to be present on site.</p> <p>Appropriate protective equipment to each construction operation to be worn at all times (including steel toe capped boots at all times, hard hats when working near machinery or roofing work, eye protection for welding)</p> <p>Fire safety measures in place.</p>			
Operations Stage					
Occupational health and safety (injuries, dust, noise, etc)	Preparation and implementation of a detailed Environment, Health & Safety plan for operations.	<p>Environment, Health & Safety plan (administrative controls) in place.</p> <p>Allocation of responsibility for safety standards to</p>	Operation cost	WAMCO	MoCCEE

Impacts	Mitigation Measures	Performance Standard	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
	<p>Operators trained to recognize risks and hazards. Personal safety equipment issued and worn. Health and safety recognized as primary employer responsibility. Protection from noise and dust to be provided for C&D waste plant</p> <p>Provision of breathing apparatus and rules of operation; allocation of responsibility to ensure these are used</p> <p>Fire safety measures to be in place.</p> <p>Duration of exposure to high noise and vibration levels reduced through job rotation, if needed</p>	<p>a full-time member of staff.</p> <p>Engineering controls in place such as enclosures/noise refuge.</p> <p>Appropriate personal protective equipment in good condition are provided to each C&D plant worker, and worn at all times (including steel toe capped boots and hard hats at all times).</p> <p>Provision of PPE (including dust mask, hearing protection, and safety goggles_ in good condition and requirement of staff to wear them in designated and clearly marked zones.</p>			

Impacts	Mitigation Measures	Performance Standard	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
	Monitoring of noise levels within the plant	Fire safety measures are functional and regularly checked. Noise monitoring records			
Community health and safety hazards	Restriction of access to the site	Barriers and notice to be in place	Operation cost	WAMCO	MoCCEE
Water pollution	Vehicles and equipment are to be maintained in sound operable condition, free of leaks. Waste and materials should be stored safely to avoid spillage and contamination.	The condition of vehicles and equipment will be periodically checked. Material and waste storage areas to be on surfaced areas and checked periodically. Occurrence of floating waste	Operation cost	WAMCO	MoCCEE

IV. ENVIRONMENTAL MONITORING

25. Environmental monitoring during construction will be the responsibility of the contractor for the project and monitoring during operations will be the responsibility of WAMCO. Operations phase monitoring for the C&D plant will be conducted as a part of overall monitoring for the Thilafushi Waste Management Facility. Environmental monitoring requirements are given in Table 4 below.

26. Compliance monitoring is required during construction, to ensure that the mitigation measures specified in the EMP is carried out to an adequate standard. Compliance monitoring is a function of the PMU and costs associated with monitoring is a part of the running cost of the PMU.

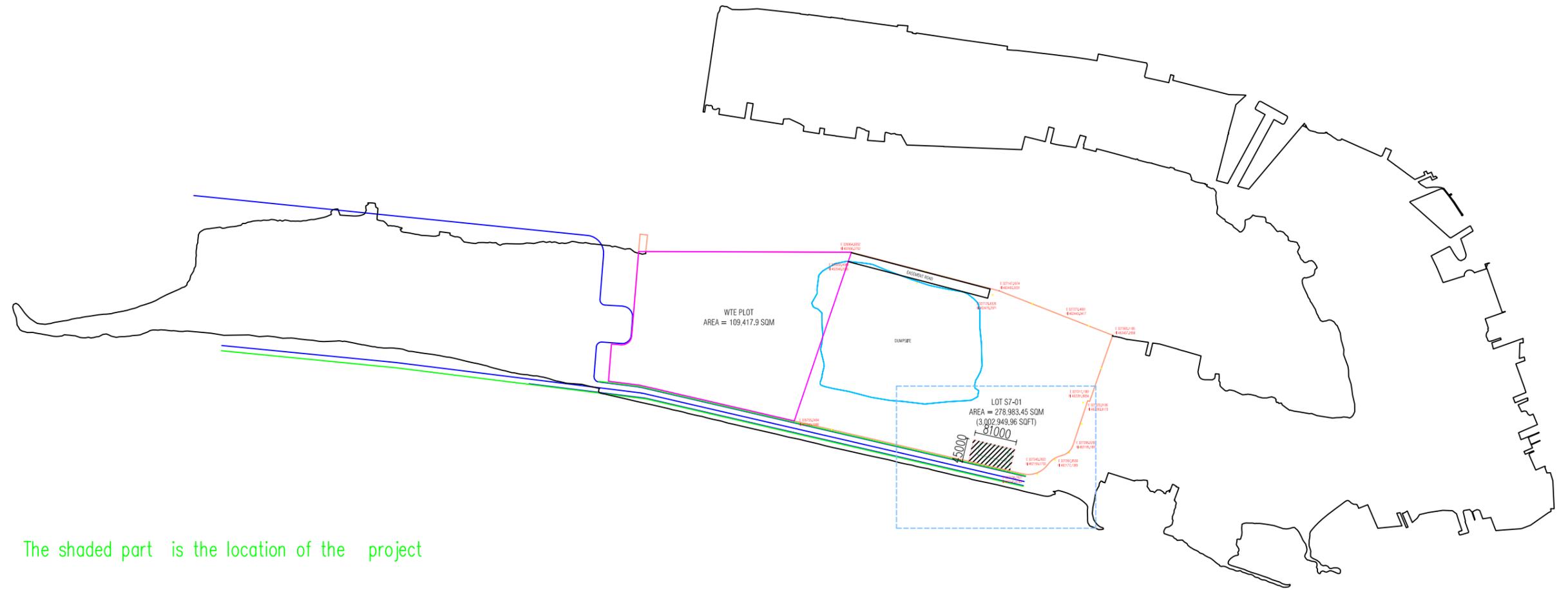
27. Compliance monitoring results will be included in the Semi-Annual Monitoring Report (SEMR) submitted to ADB by the PMU.

Table 4: Environmental Monitoring Plan

Impact to be Monitored	Means of Monitoring	Construction Phase		
		Frequency	Responsible Agency	Indicative Annual Cost
Design/Pre-Construction Phase				
Inclusion of mitigation measures in design/build and/or detailed design documentation and construction activities Air and water quality Noise	Compliance with EMP design measures Water Quality: BOD, TSS, TPH Faecal coliform/enterococci; Metals (Pb, Cu, Cd, Hg, Cr) Air Quality: SO ₂ , NO ₂ , PM ₁₀ , PM _{2.5} , O ₃ Noise LAeq 1hr (dBA)	Once before construction	Contractor	Part of Total Contract Price
Construction Phase				
General Construction Impacts	GRM in place Complaints received Contractor's records relating to minor and major pollution and health and safety incidents (with a target of zero incidents)	Continuous	PMU	Covered in project participation plan
Compliance with EMP	Inspections	Monthly	PMU	Project management costs
Air quality	Measurement of SO ₂ , NO ₂ , PM ₁₀ , PM _{2.5} , O ₃	Monthly	Contractor	Construction cost
water quality	BOD, TSS, TPH ,Fecal coliform, Metals (Pb, Cu, Cd, Hg, Cr)	Monthly	Contractor	Construction cost
Noise levels	Measurement of noise levels at the site and nearest sensitive receptor: LAeq 1hr (dBA)	Monthly	Contractor	Construction cost
Operations Phase				

Impact to be Monitored	Means of Monitoring	Construction Phase		
		Frequency	Responsible Agency	Indicative Annual Cost
General Operation Impacts	GRM in place Complaints received	Continuous	WAMCO	Operational cost
Compliance with EMP	Inspections	Monthly	WAMCO	Operational cost
Environmental quality	Air, water quality and noise (same parameters as in construction phase)	Monthly	WAMCO	Operational cost

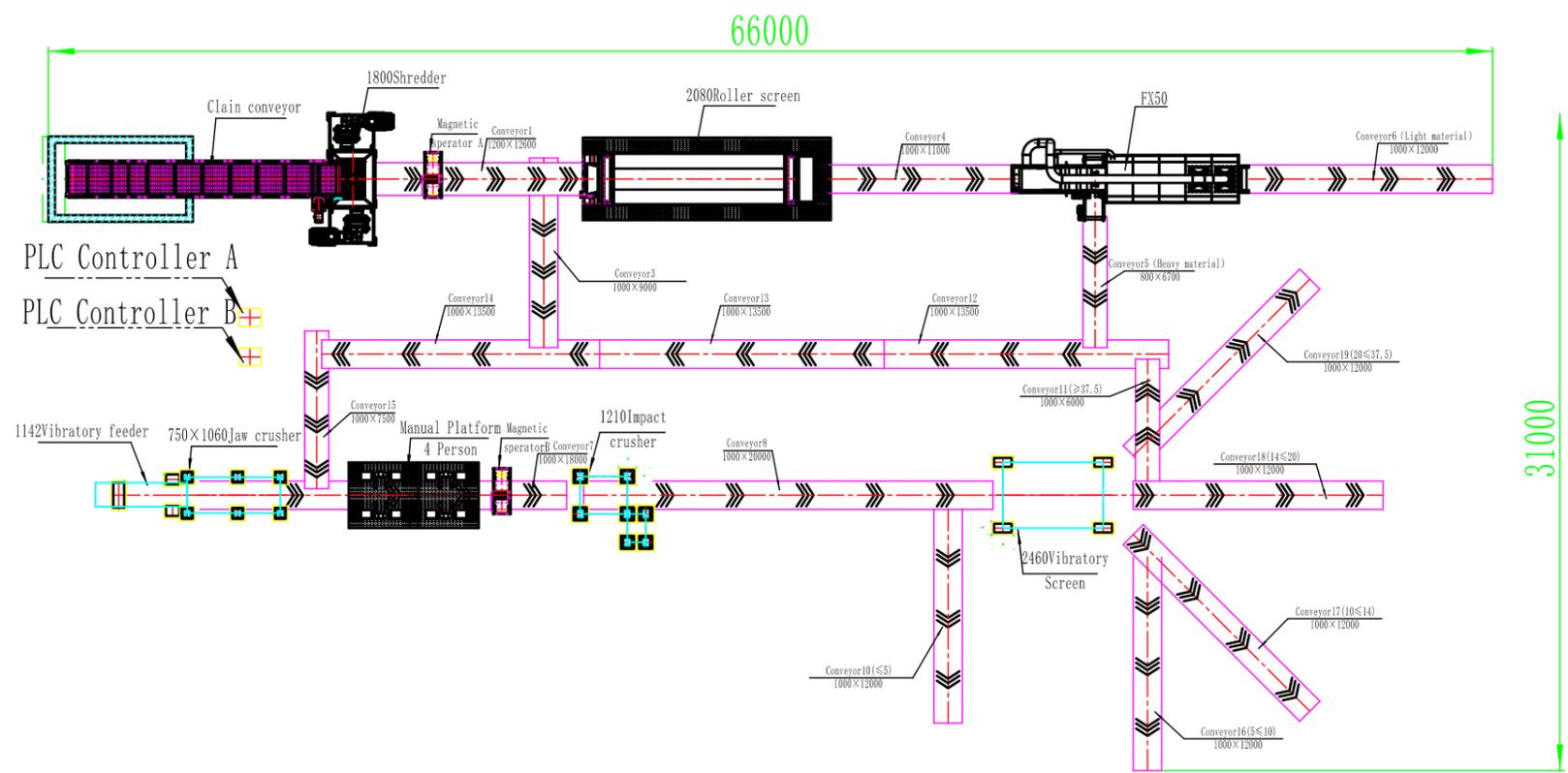
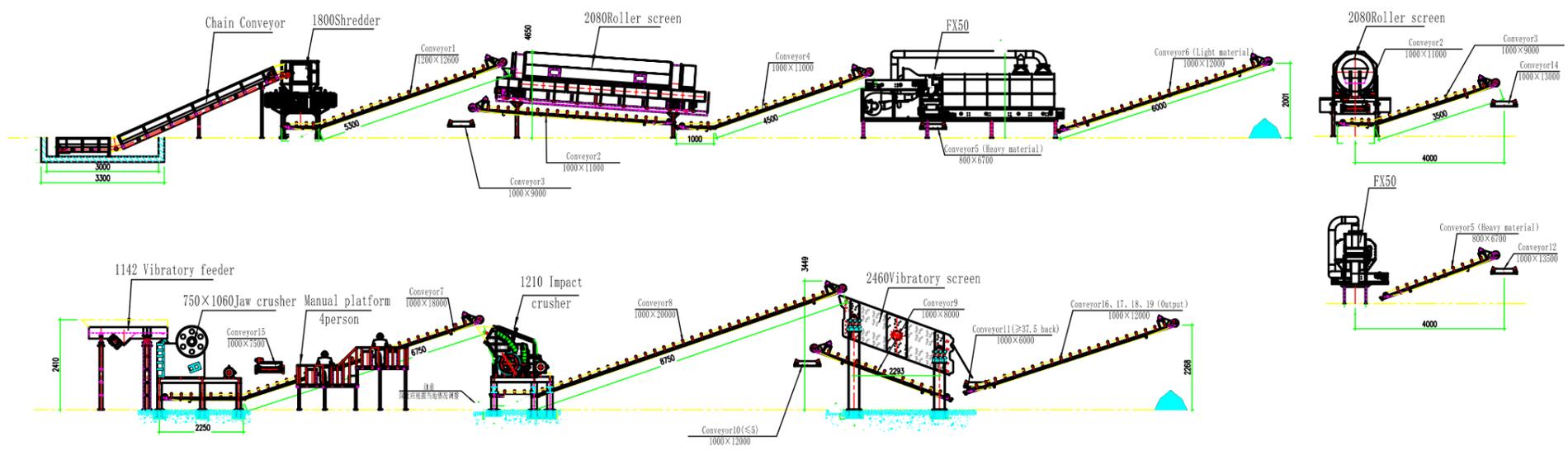
APPENDIX 1: LAYOUT OF THE C&D WASTE PROCESSING PLANT



The shaded part is the location of the project

Location Plan 1:100

CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker	Architect	LIU QI JUN	Project Name	Thilafushi C&D Plant	Scale	1:100
	Structure Checker	Engineer	KANG JIE	Item Name	Architecture Design	Date	2024/1/2
		Design Manager	MA PING	Drawing Name	Location Plan	Number	CN0-A-1
						Version	V02

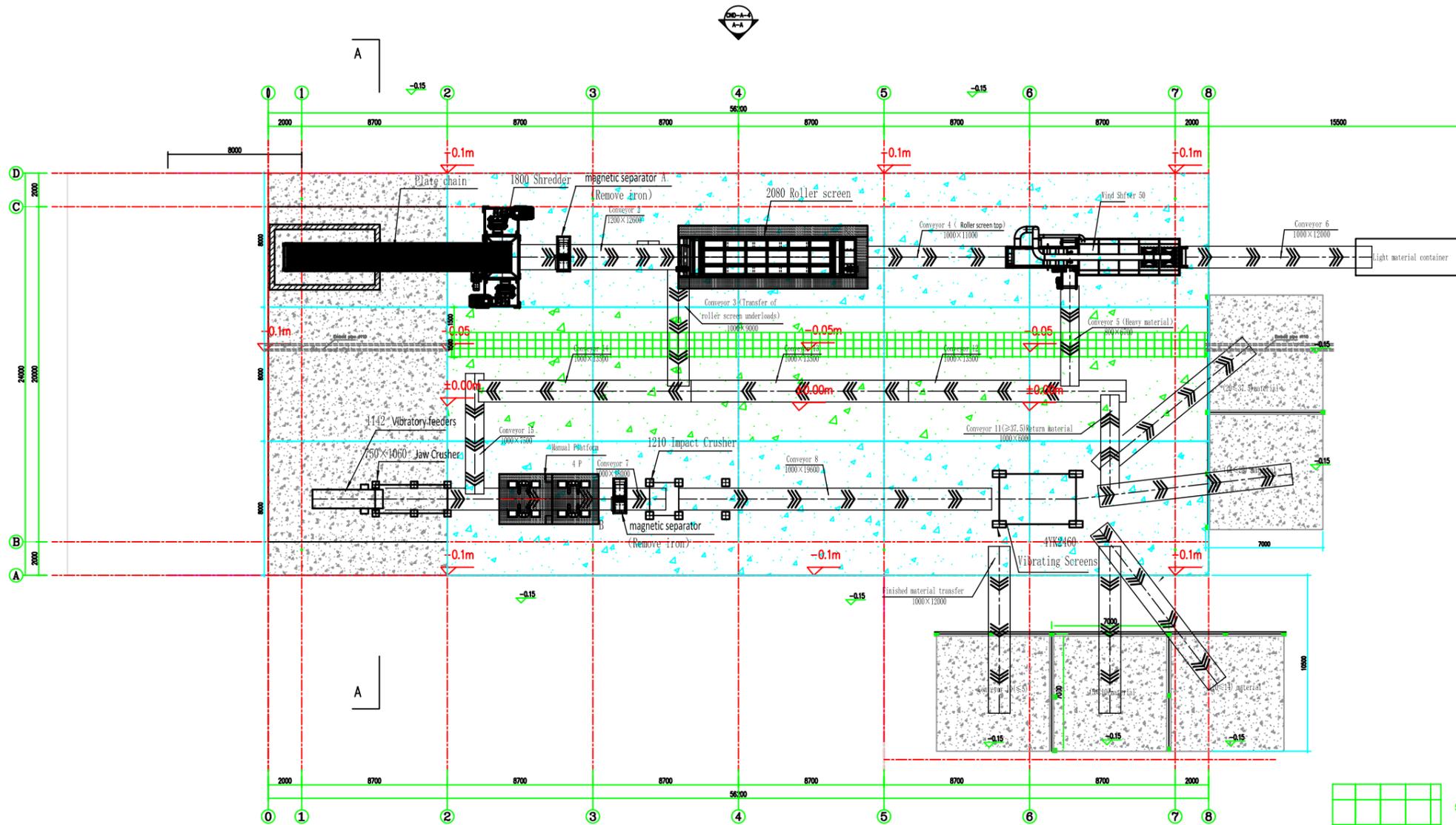


Machine Plan 1:100

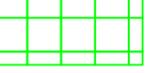
CONTRACTOR

 中国建筑股份有限公司
 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.

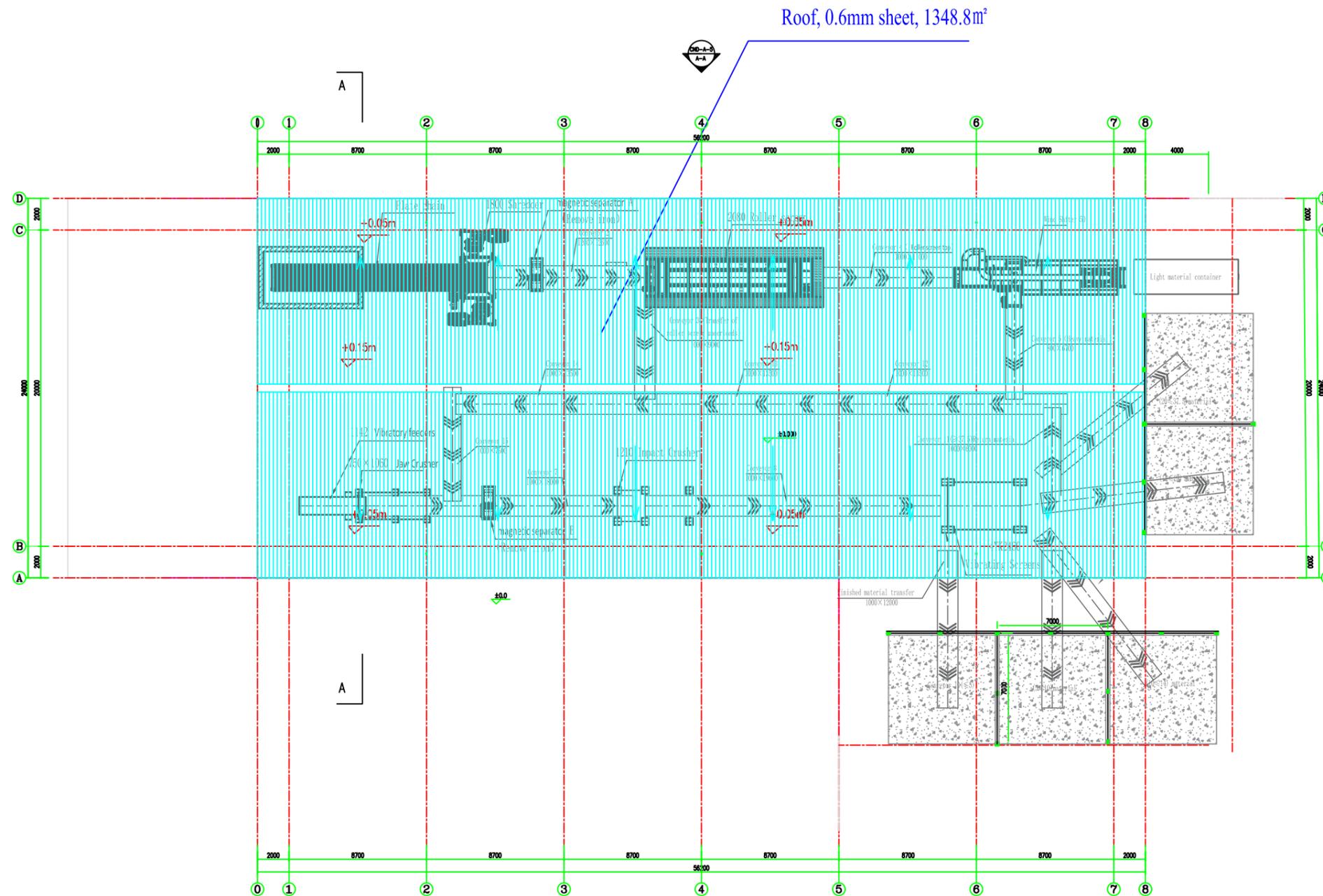
Project Name	Design-Building of Waste Transfer Station	Scale	1:100
Item Name	Thilafushi C&D Waste Treatment Production Line	Date	2024/1/2
Drawing Name	C n D system	Number	CND-1-3
		Version	V02



Ground Floor Plan 1:100

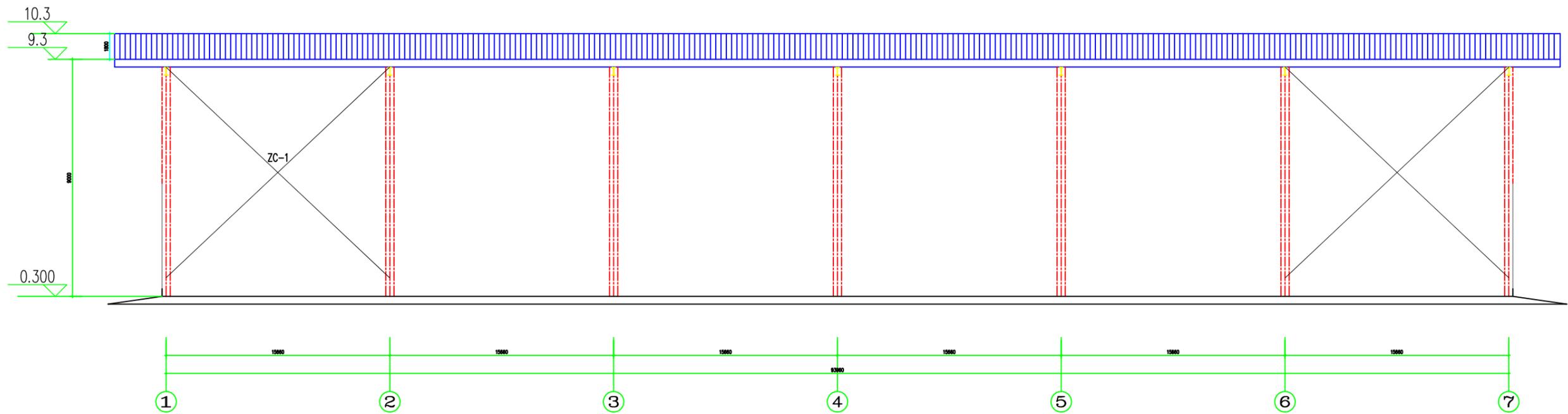
-  500x500 50mm block pavement
-  100mm C30 concrete with rebar T8@200
-  150mm C30 concrete with rebar T8@200
-  200mm C30 concrete with rebar T8@200
-  2m height 240mm brickwork wall

CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker 	Architect LIU QI JUN	Project Name Thilafushi C&D Plant	
	Structure Checker Ihsaan Waheed	Engineer KANG JIE	Item Name Architecture Design	Scale 1:100 Date 2024/1/2
		Design Manager MA PING	Drawing Name Ground Floor	Number CSD-A-1 Version V02



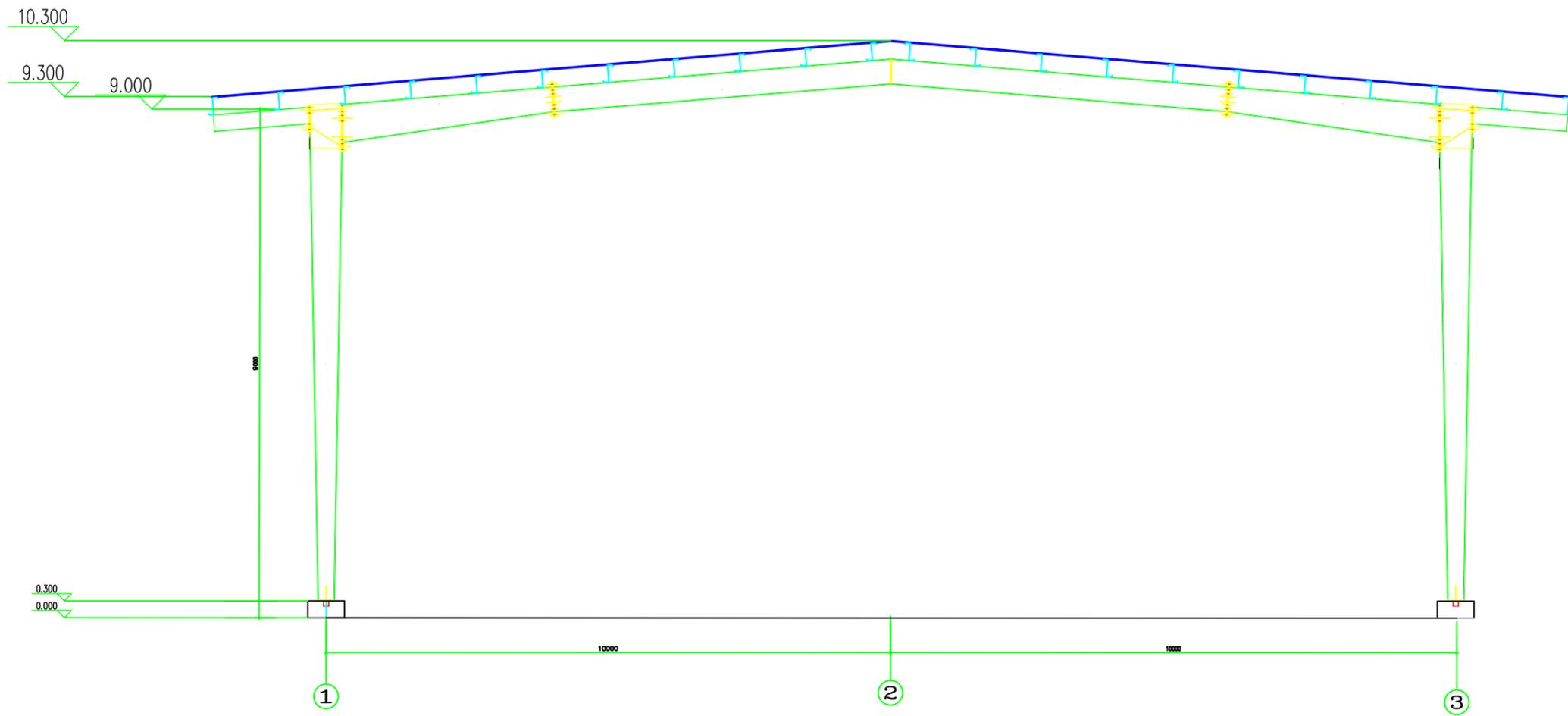
Roof Plan 1:100

CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker 	Architect LIU QI JUN	Project Name Thilafushi C&D Plant	Scale 1:100
	Structure Checker Ihsaan Waheed	Engineer KANG JIE	Item Name Architecture Design	Date 2024/1/2
		Design Manager MA PING	Drawing Name Roof Floor	Number CN-1-5
				Version V02



Elevation 1-7 1:100

CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker	Architect	LIU QI JUN	Project Name	Thilafushi C&D Plant	Scale	1:100
	Structure Checker	Ihsaan Waheed	Engineer	KANG JIE	Item Name	Architecture Design	Date
		Design Manager	MA PING	Drawing Name	Elevation	Number	CD-A-6
						Version	V02



A-A Side Section 1:100

CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker	Architect	LIU QI JUN	Project Name	Thilafushi C&D Plant	Scale	1:100
	Structure Checker	Ihsaan Waheed	Engineer	KANG JIE	Item Name	Architecture Design	Date
		Design Manager	MA PING	Drawing Name	Section	Number	CSU-A-7
						Version	V02

General description of construction drawing design

1 General

1.1 In the engineering structure design documents, unless otherwise indicated, the unit of measurement is agreed to be: the size is in millimeters, the elevation and coordinates are in meters, and the angle is in degrees. All dimensions in the drawings are subject to the actual construction, the construction shall be carried out according to the dimensions marked in the drawing.

1.3 During the design service life, the project should be used according to the function indicated in the architectural drawing, and the use of the structure and the use environment shall not be changed without technical appraisal or design permission.

2 Project Overview

2.1 The name of the project: Thilafushi CnD Plant

2.2 Construction site: Maldives

2.3 Project Overview:

Subkey name	Thilafushi CnD Plant
±0.00 is equivalent to absolute elevation (m)	1.15m
Main functions	CnD waste treatment
Structure height above ground (m)	9.500
structure type	Portal steel frame
base type	Independent foundation

3 Design Basis

MALDIVES DOCUMENTS AND REFERENCES

- NATIONAL BUILDING CODE HANDBOOK -MINISTRY OF CONSTRUCTION AND PUBLIC INFRASTRUCTURE -2008
- COMMENTARY ON DURABILITY TO NATIONAL BUILDING CODE HANDBOOK -MINISTRY OF CONSTRUCTION AND PUBLIC INFRASTRUCTURE -2007

BRITISH STANDARDS:

- BS 648 -SCHEDULE OF WEIGHTS OF BUILDING MATERIALS
- BS 6399 -LOADING FOR BUILDINGS
- BS 8110 -CODE OF PRACTICE FOR STRUCTURAL USE OF CONCRETE
- BS 5950 -STRUCTURAL USE OF STEELWORKS IN BUILDING
- BS 8004 -CODE OF PRACTICE FOR FOUNDATIONS -1986
- BS 8002 -CODE OF PRACTICE FOR EARTH RETAINING STRUCTURES -1994
- BS 8007 -CODE OF PRACTICE FOR DESIGN OF CONCRETE STRUCTURES FOR RETAINING AQUEOUS LIQUIDS -1987
- BS 1377 -SOILS FOR CIVIL ENGINEERING PURPOSES

4 Natural Conditions

4.1 General conditions:

Basic wind pressure (once in 50 years)	Basic snow pressure (once in 50 years)
0.70kN/m ²	0

5 Building classification grades

5.1 The design reference period of the engineering structure is 50 years, the design work life is 50 years, the structural durability life is 50 years, and the safety level of the building structure is Grade 1. The fire resistance grade: the ground is the second grade. The cross-sectional dimensions of various components and the thickness of the concrete protective layer of reinforced concrete component reinforcement should meet the fire resistance limit requirement of corresponding component.

7 Values of the main loads

- 7.1 Dead load standard value:
Dead load on the roof: 0.20kN/m²;
- 7.2 Soil bearing capacity 100kPa ;
- 7.3 Basic wind pressure: 0.70kN/m²
- 7.4 Live load standard value:
Roof live load: 0.50kN/m²;
Ash load: 0.50kN/m²;

8 Main structural materials

8.1 The concrete strength foundation, beams and structural columns used in this project are all made of C30 concrete (except for those clearly indicated in the monomer drawing):

8.2 Rebar:

8.2.1 Hot rolled steel bars

8.2.2 The steel bars used in this project are all HRB500

8.3 Rebar joint forms and requirements:

8.3.1 The steel bar joints in this project are all tied and lapped. *

8.3.2 The connecting joints of the stress-bearing steel bars should be set at places where the stress is small, and fewer joints should be installed on the same stress-bearing steel bar. It is not appropriate to install connecting joints in important components of the structure and key force-transmitting parts (such as frame beam ends and stirrup density areas at column ends).

9 Foundation foundation and underground engineering

9.1 The basis of this project adopts isolated foundation.

9.2 When using machinery to excavate foundation pits, a certain thickness of soil must be reserved for manual excavation when approaching the design elevation. The thickness of the reserved soil layer is generally 300 to 500mm. Unless otherwise specified, the thickness of the C15 plain concrete cushion at the bottom of the foundation (including cap platform and foundation beam) is 100mm, and each side extends 100mm beyond the edge of the foundation.

9.4 Materials:

(1) Select sand and stone aggregates to reduce the porosity of the stone to within the acceptable range.

10 Construction requirements for concrete structures

10.1 The thickness of the concrete protective layer of the stressed steel bars in the components is 50mm.

11 Other

11.1 This professional drawing should be constructed in conjunction with other professional drawings such as construction, water, electricity, general drawings, etc.

11.2 If the relevant content of this general description is specifically explained in the specific design drawings (planar elevations, detailed drawings, etc.) or if methods are different from those in the general description, the specific design drawings shall prevail.

Unified instructions for steel structure design

1 Material

1.1 Structural materials

1.1.1 The rigid frame beams and columns of this project are made of Q355B, and the beam and column end plates are made of Q355B. The stiffeners are made of Q355B. The anchor bolt is Q235B.

1.2 bolt

1.2.1 All unspecified bolts in this project are grade 10.9 friction-type high-strength bolts, and the products use torsion-shear type high-strength bolts.

1.2.2 Unspecified mounting bolts are all Grade C bolts, with a performance level of 4.6.

1.3 Pegs

The bolt steel is ML15, the tensile strength is $\geq 400\text{N/mm}^2$, the yield strength is $\geq 320\text{N/mm}^2$, and the elongation is $\geq 14\%$.

Unless otherwise noted, bolt specifications are as shown in the figure below:



Note: 1) Bolt diameter = 19mm, length = 80mm (unless otherwise noted); 2) The spacing of the bolts can be the same as the rib spacing of the pressure-type steel plate, and should not be greater than the spacing of 200.

1.4 Anchor bolt

Should be made of Q235B steel.

1.5 Column base grouting

Grouting should use high-strength non-shrinking fine stone concrete or high-strength expansion grouting material, and the compressive strength should be greater than the compressive strength of the underlying concrete structure.

2 Steel structure anti-corrosion

2.1 The anti-corrosion design life of the steel structure of this project is 15 years. Anti-corrosion coatings should meet good adhesion.

2.2 Anti-corrosion method:

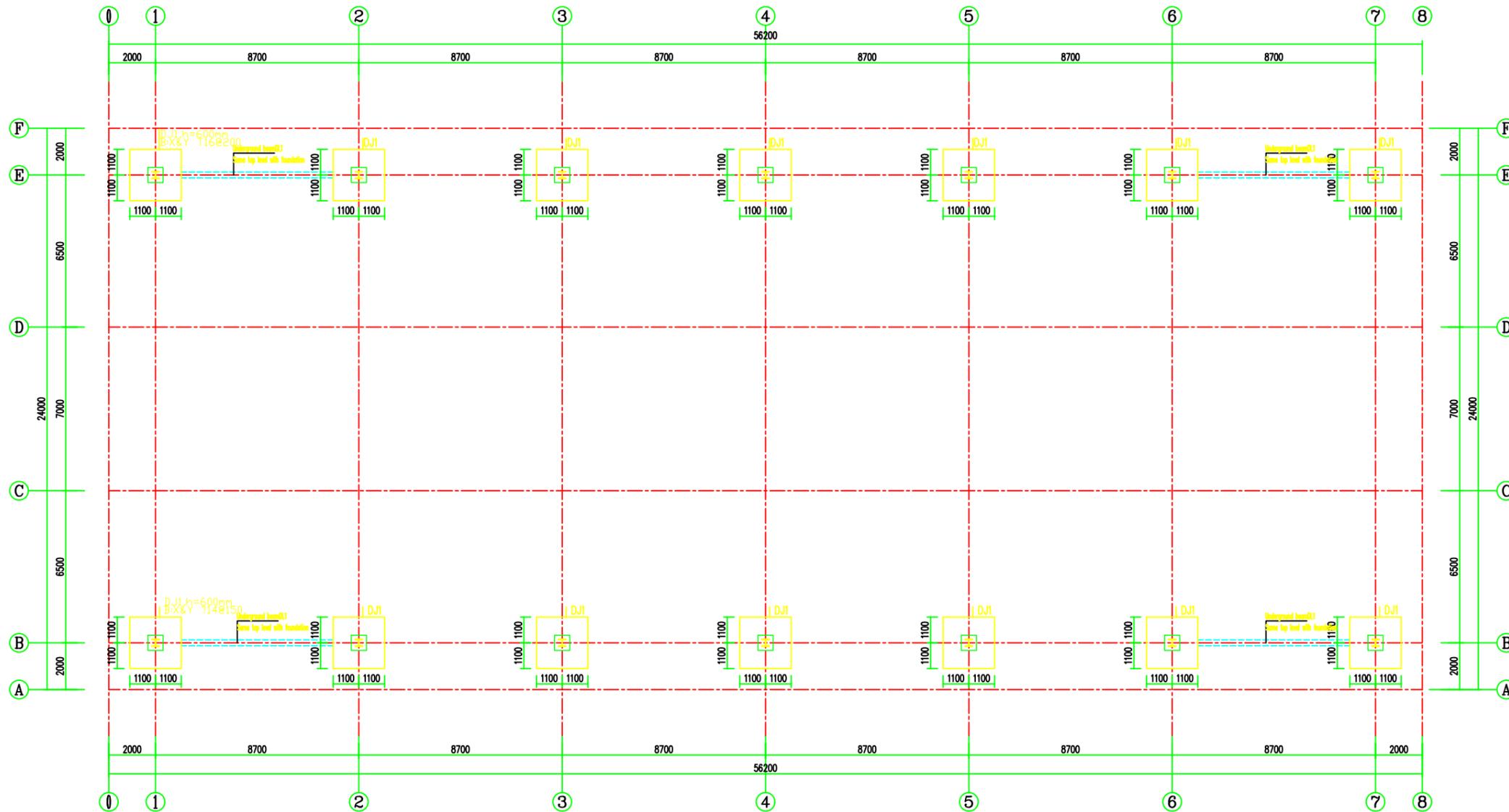
- 2.2.1 Steel frame anti-corrosion and anti-rust technology:
- 2.2.2 One pass of 80um, thick coating of zinc phosphate paint, factory finished
- 2.2.3 Two coats of 140um, oily mica iron oxide phenolic paint, factory finished
- 2.2.4 Two coats of fluorocarbon paint (60um, fluorocarbon paint, factory or on-site completion)

3 Use and maintenance requirements

3.1 The owner should strictly follow the load conditions specified in the instructions for normal use, and shall not use it for purposes exceeding the design load.

3.2 Owners should conduct a comprehensive inspection of the appearance of all steel structures every five years, and if any local corrosion problems are found, they should be repaired promptly.

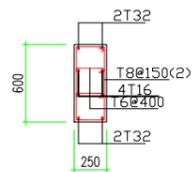
CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker		Architect	LIU QI JUN	Project Name	Thilafushi C&D Plant	Scale	
	Structure Checker	Ihsaan Waheed	Engineer	KANG JIE	Item Name	Architecture Design	Date	2024/1/2
	Design Institute	Epoch Associates Pvt. Ltd	Design Manager	MA PING	Drawing Name	General Notes	Number	CND-S-1
							Version	V02



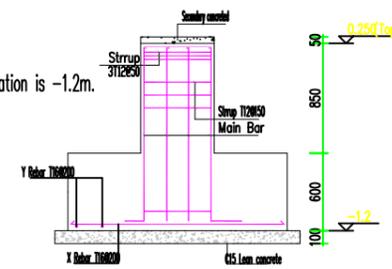
Foundation Plan 1:100

Notes

1. Foundation type is isolated foundation, concrete strength is C30(cube); Lean concrete thick is 100mm, extend edge is 100mm, strength C15;
2. Foundation designed according to 100kPa soil bearing capacity, bottom level of foundation is -1.2m.

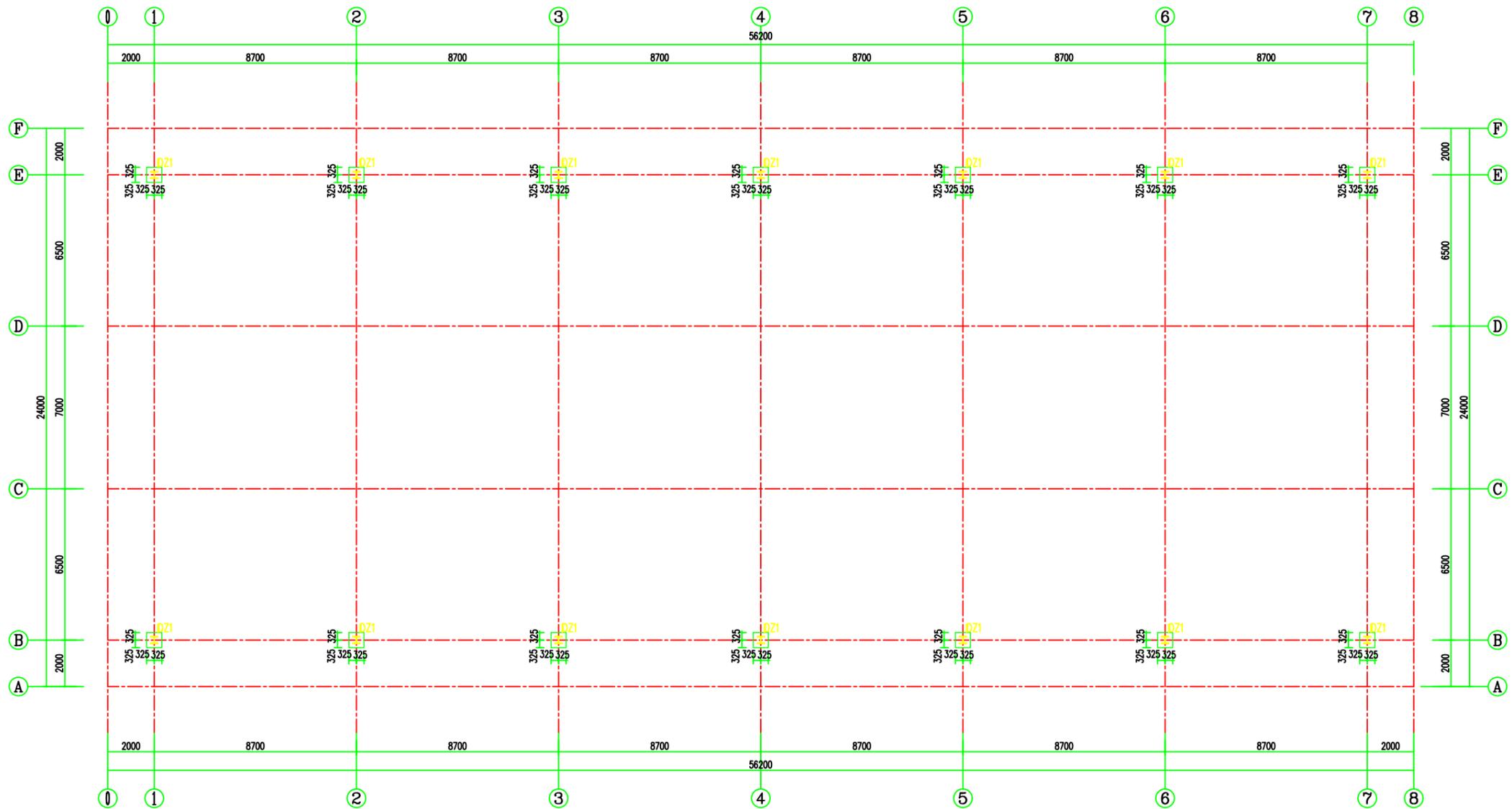


Underground beam D1 1:25

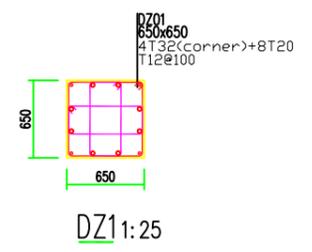


Foundation Detail 1:25

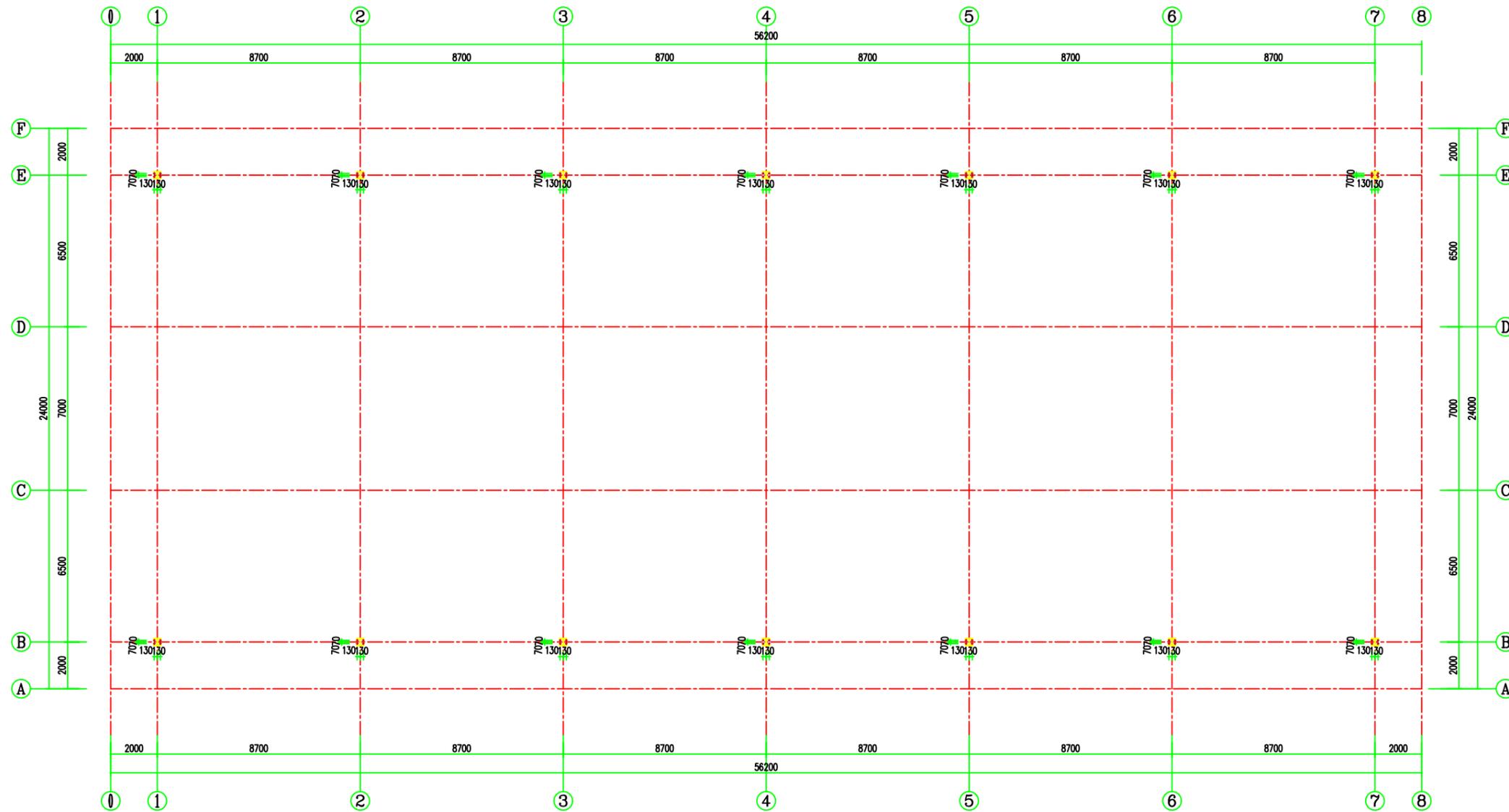
CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker 	Architect LIU QI JUN	Project Name Thilafushi C&D Plant	Scale: 1:100 Date: 2024/1/2 Number: CND-S-2 Version: V02
	Structure Checker Ihsaan Waheed	Engineer KANG JIE	Item Name Structure Design	
		Design Manager MA PING	Drawing Name Foundation	



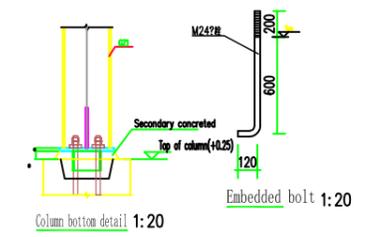
Column Plan 1:100



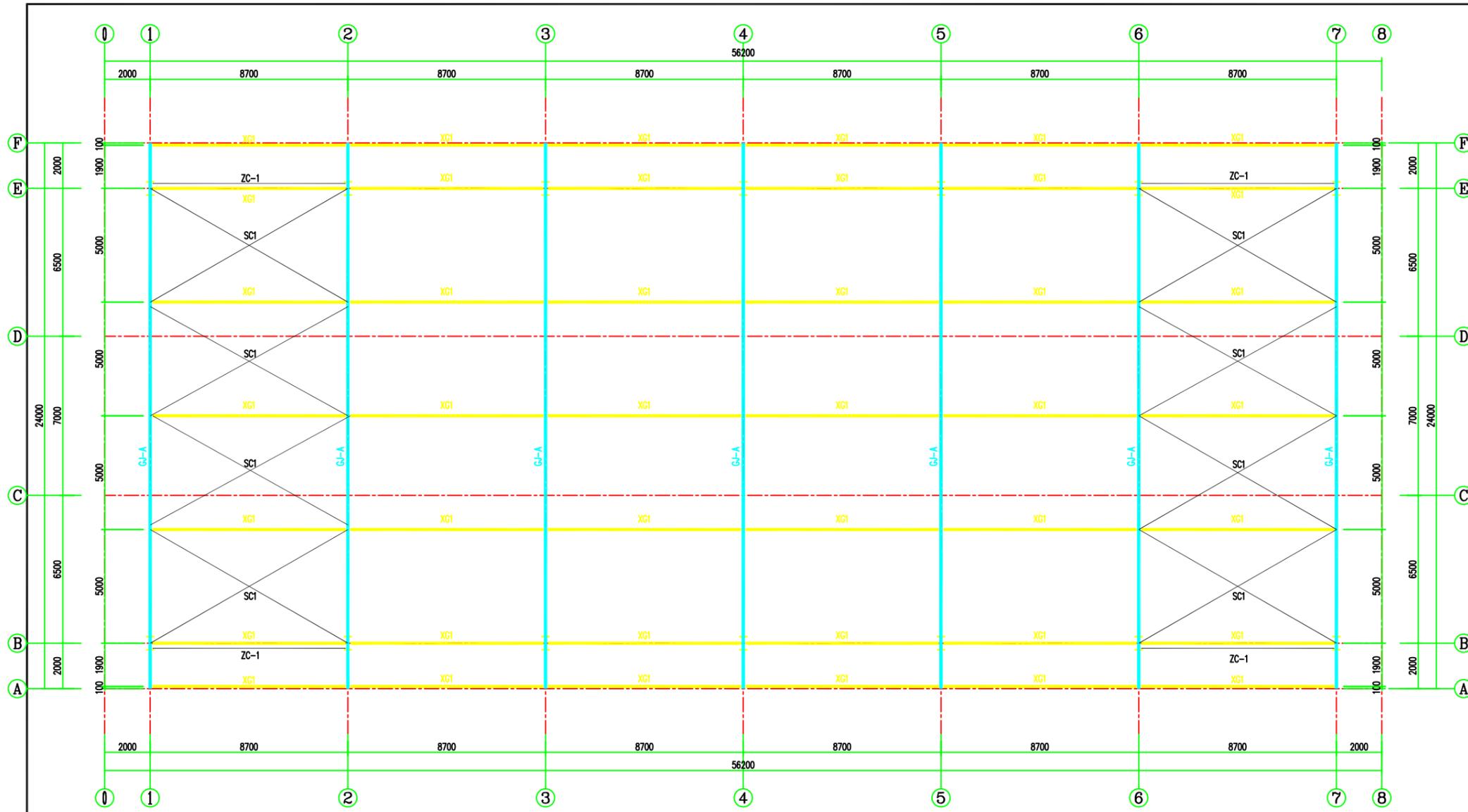
CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker 	Architect LIU QI JUN	Project Name Thilafushi C&D Plant	<table border="1"> <tr> <td>Scale</td> <td>1:100</td> </tr> <tr> <td>Date</td> <td>2024/1/2</td> </tr> <tr> <td>Number</td> <td>CND-S-1</td> </tr> <tr> <td>Version</td> <td>V02</td> </tr> </table>	Scale	1:100	Date	2024/1/2	Number	CND-S-1	Version	V02
	Scale	1:100										
	Date	2024/1/2										
Number	CND-S-1											
Version	V02											
Structure Checker Ihsaan Waheed	Engineer KANG JIE	Item Name Structure Design										
 	Design Manager MA PING	Drawing Name Foundation Column										



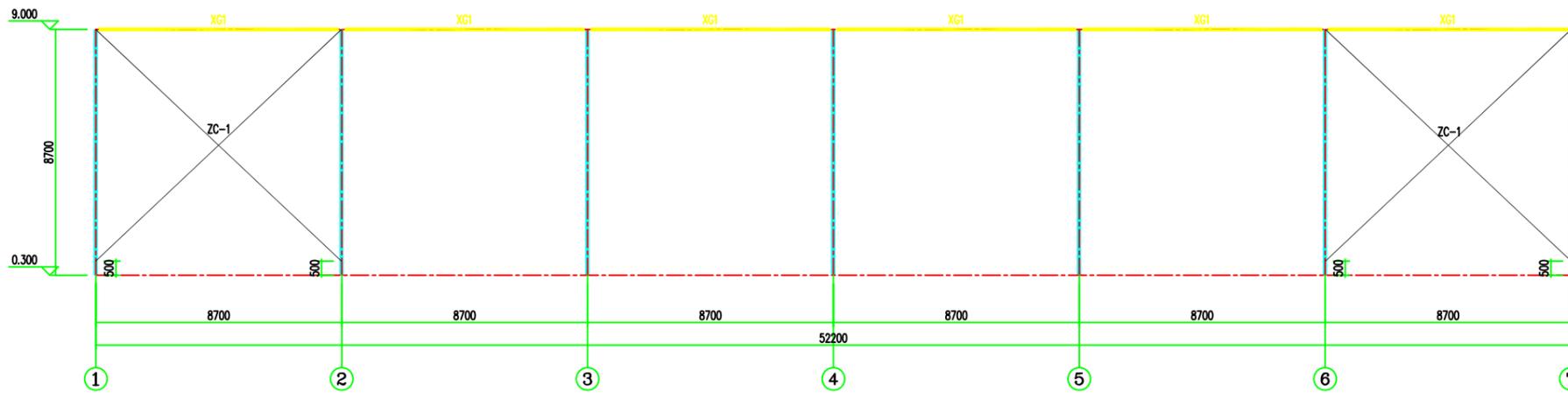
Embedded Bolt Plan 1:100



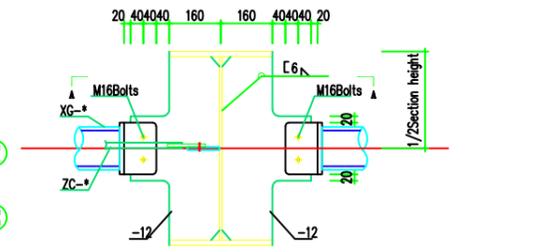
CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker		Architect	LIU QI JUN	Project Name	Thilafushi C&D Plant	Scale	1:100
	Structure Checker	Ihsaan Waheed	Engineer	KANG JIE	Item Name	Structure Design	Date	2024/1/2
			Design Manager	MA PING	Drawing Name	Foundation for Steel column	Number	CND-S-4
							Version	V02



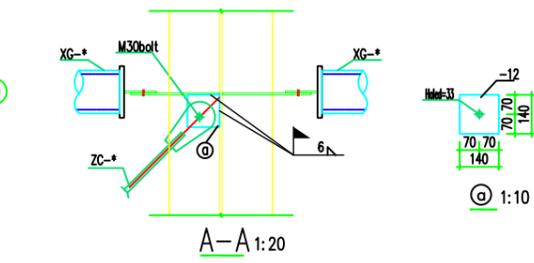
Roof Structure Plan 1:100



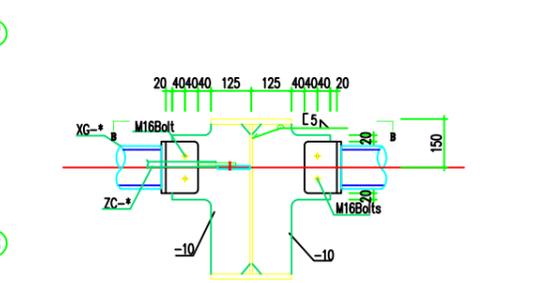
Column Structure Plan 1:100



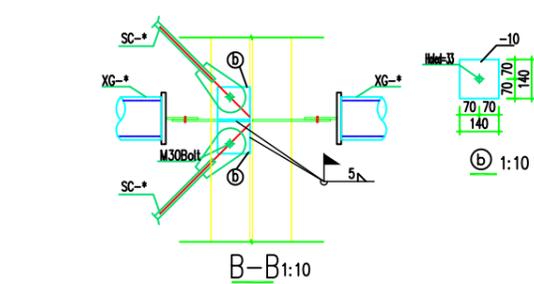
Support and tie connection detail of column 1:10



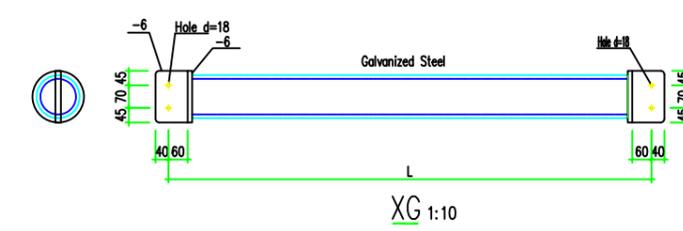
A-A 1:20



Support and tie connection detail of roof 1:10



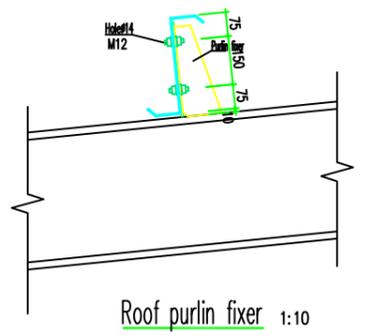
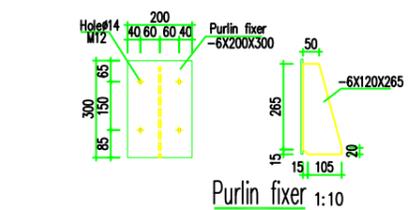
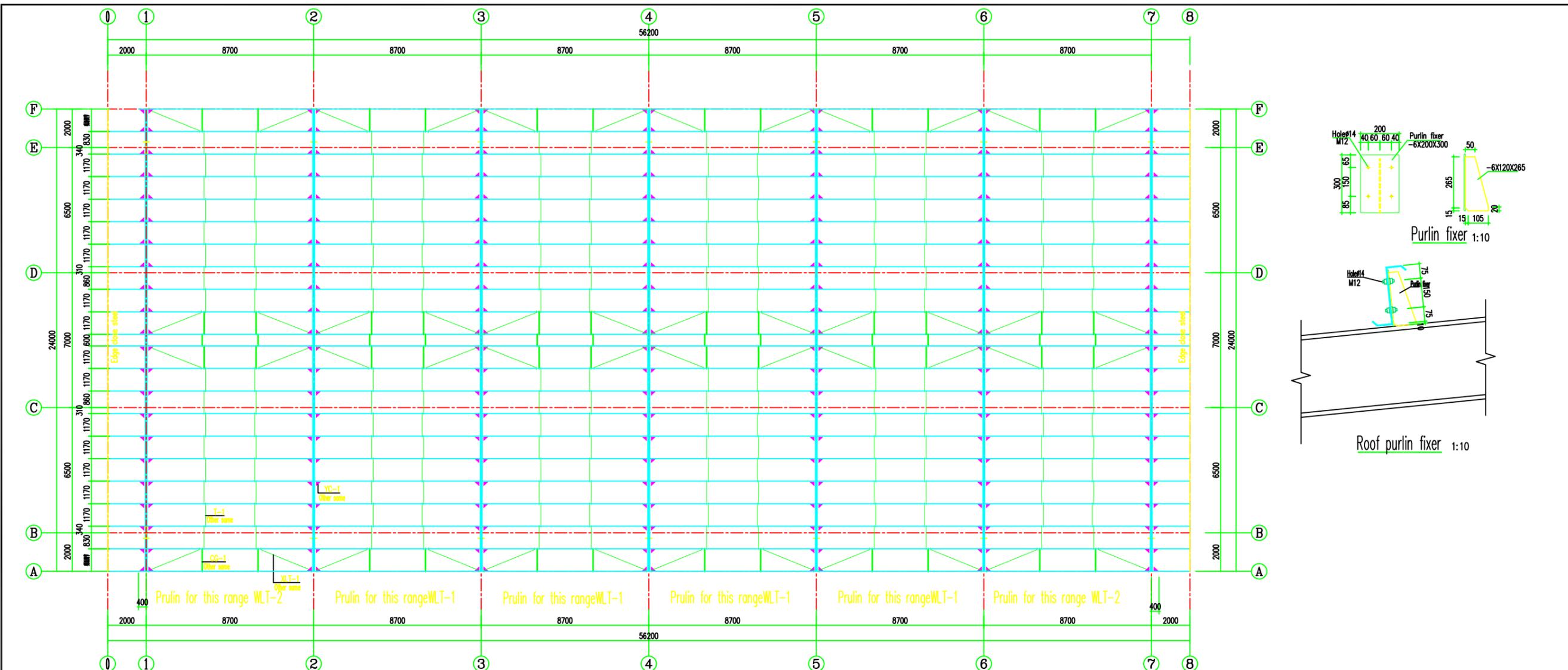
B-B 1:10



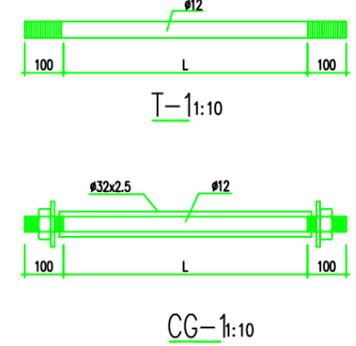
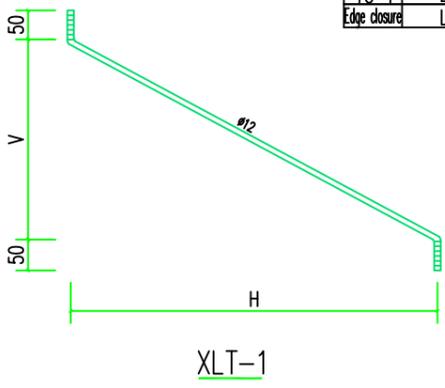
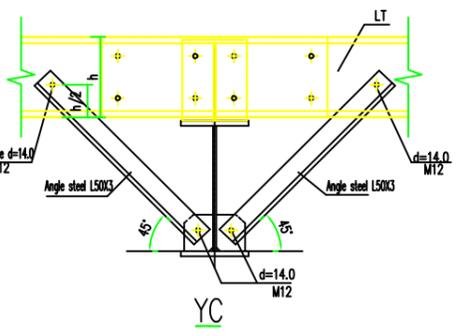
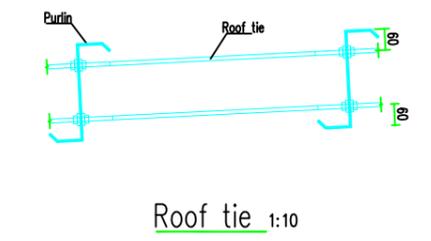
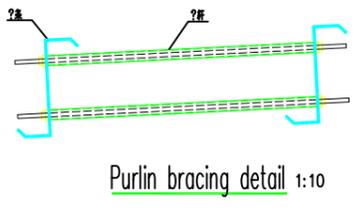
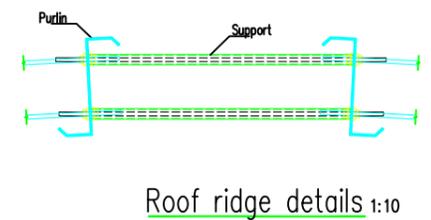
XG 1:10

Size of component				
Code	Name	Section	Material	Mark
SC1	Roof ties	∅2	Q235	Tension
ZC-1	Column ties	∅2	Q235	Tension
XG1	Roof support	#130X3	Q235	

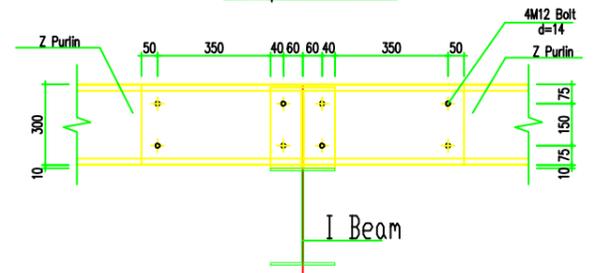
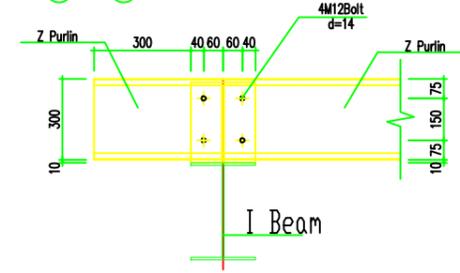
CONTRACTOR 中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker Insaan Waheed	Architect LIU QI JUN	Project Name Thilafushi C&D Plant	Scale 1:100
	Structure Checker Insaan Waheed	Engineer KANG JIE	Item Name Structure Design	Date 2024/1/2
		Design Manager MA PING	Drawing Name Steel Structure	Number CND-S-5
				Version V02



Roof purlin and tie plan 1:100



List			
Code	Section	Material	Mark
WL-T1	XZ300X80X20X3.0	Q355B	Purlin
WL-T2	XZ300X80X20X3.5	Q355B	Purlin
ZLT-1	∅12	Q235B	Tie
XLT-1	∅12	Q235B	Tie
CG-1	∅32x2.5 pipe+∅12	Q235B	Support
YC-1	L50X3.0 Angle steel	Q235B	Support
Edge closure	L50X3.0 Angle steel	Q235B	Support



Roof purlin details 1:10

Roof purlin details 1:10

CONTRACTOR

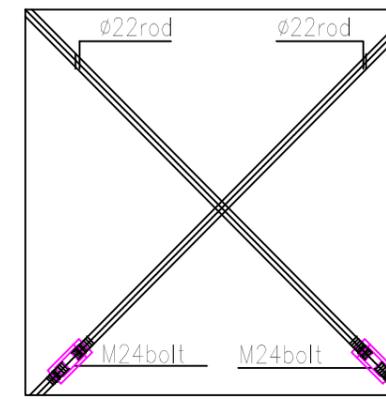
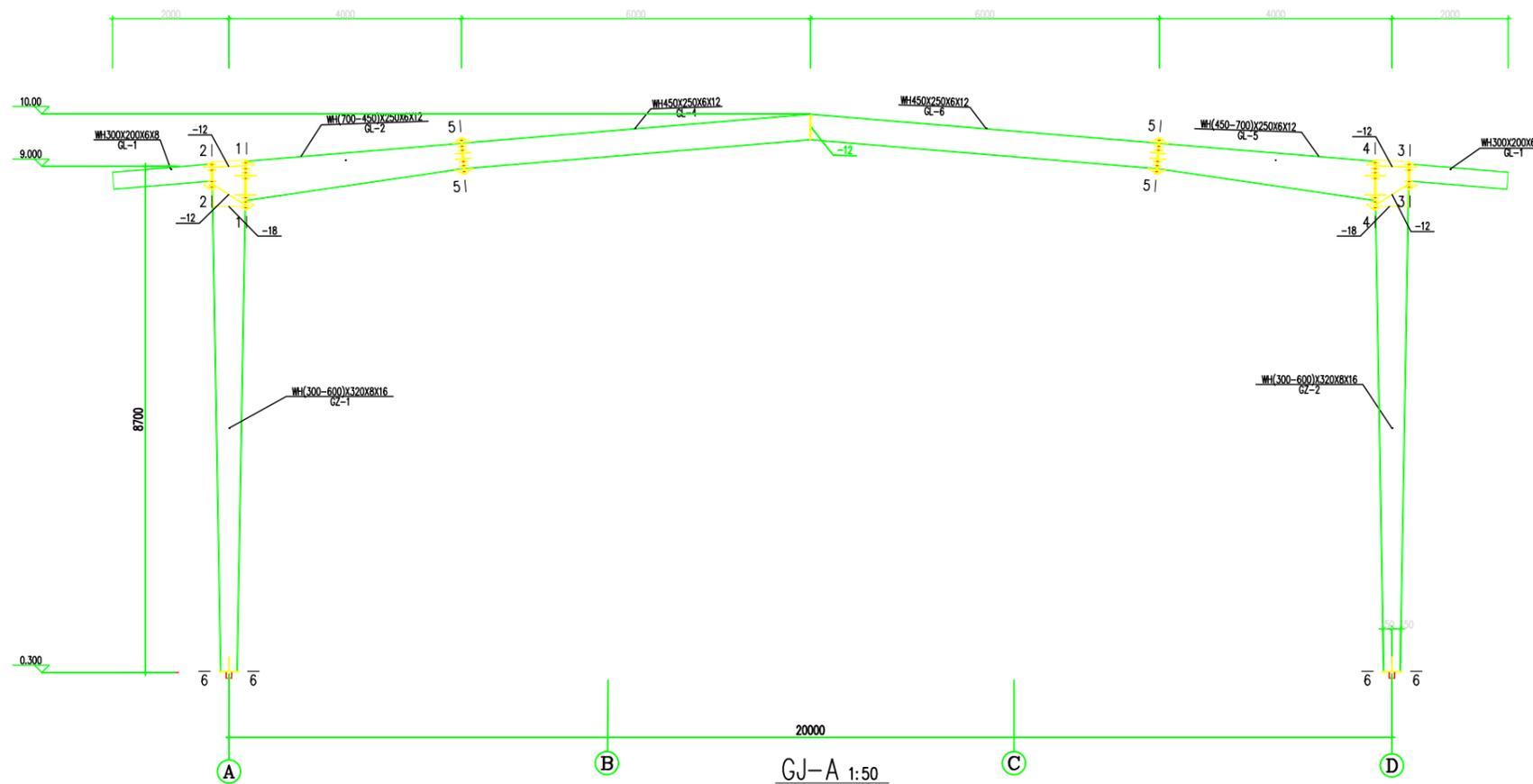
 中国建筑股份有限公司
 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.

Architect Checker
 Structure Checker
 Ihsaan Waheed

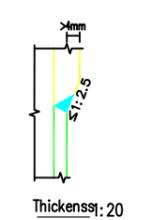
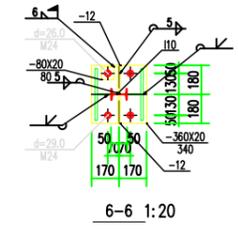
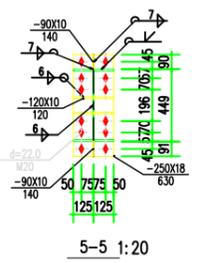
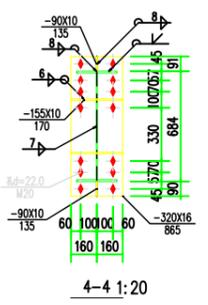
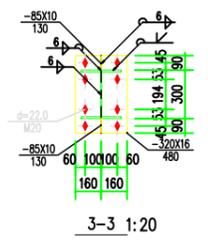
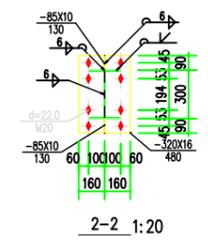
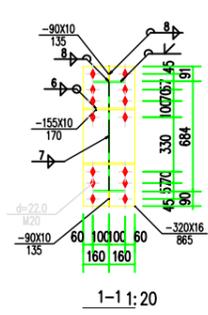
Architect
 Engineer
 Design Manager
 LIU QI JUN
 KANG JIE
 MA PING

Project Name
 Item Name
 Drawing Name
 Thilafushi C&D Plant
 Structure Design
 Roof Purlin

Scale
 Date
 Number
 Version
 1:100
 2024/1/2
 CND-S-6
 V02



- Label
- ◆ High-strength bolt
 - ◇ Permanent bolt
 - ♦ Installation bolt
 - Bolt hole



CONTRACTOR  中国建筑股份有限公司 CHINA STATE CONSTRUCTION ENGINEERING CORPORATION LTD.	Architect Checker 	Architect LIU QI JUN	Project Name Thilafushi C&D Plant
	Structure Checker Ihsaan Waheed	Engineer KANG JIE	Item Name Structure Design
		Design Manager MA PING	Drawing Name Section and Details

APPENDIX 2: DUST ASSESSMENT

Dust assessment of C&D plant

Table of Content

1. Introduction.....	1
2. General Data.....	1
3. Site location.....	2
4. Plant layout and key elements.....	4
5. Impact assessment and mitigation measures.....	6
6. General and additional mitigation measures.....	12
7. Costs of additional measures.....	15
8. Future measures.....	15

1. Introduction

This document provides a detailed dust assessment for a construction and demolition (C&D) waste processing plant located in Thilafushi, with a focus on operational capacity, layout, dust impact analysis, and dust mitigation strategies. Designed to process mixed and mono-fraction waste, the plant operates within an industrial area where unpaved surfaces contribute to a naturally dusty environment. Through a structured assessment, each component of the processing line—from conveyors and crushers to manual sorting platforms—is analysed for its potential to generate dust, and corresponding mitigation measures are outlined to reduce dust exposure.

The document includes general measures such as water spraying, encapsulated systems, and specific protective equipment for workers, in addition to future monitoring recommendations. These are tailored to accommodate the plant's open layout and the variability in dust generation due to factors like wind and waste composition. The assessment aims to provide a balance between cost-effective design and the need for environmental compliance, positioning the plant to adapt to future regulatory or environmental changes while safeguarding worker health and minimizing dust emissions.

2. General Data

Capacity	~100 t/hr
Input 1	Comingled/mixed C&D waste (concrete, bricks, packaging, bags, metal, etc.)
Input 2	Mono-fractions : Concrete
Shift (planned)	1 (in case of increasing C&D waste, shift can be increased to 2)
Working hrs	6-8 hrs/day (with legal break times)
Staff/mobile equipment	Minimum: 1-2 wheel loader(s) (1 input area/1 output area) Pre sorting and water spraying : 2 (mainly full time)

	<p>Overall operators: 2 (in the vicinity of the site but not permanently on the working area)</p> <p>Manual sorting platform: 4 (full time)</p> <p>Maintenance staff: 2 (periodically, not permanently working on the operation area)</p> <p>Total (min): 12</p> <p>Thereof : 8 working/exposed permanently on the site</p>
Power consumption	800 kW (approx..)

3. Site location

The site is located in Thilafushi :

- on the south side of the actual controlled dumpsite
- Easterly to the waste bale storage and the future WtE plant
- Westerly to some industrial areas (Parley recycling facilities)

The environment and the vicinity of the site can already be characterised as an industrial development area with unpaved surfaces leading already to a dusty environment

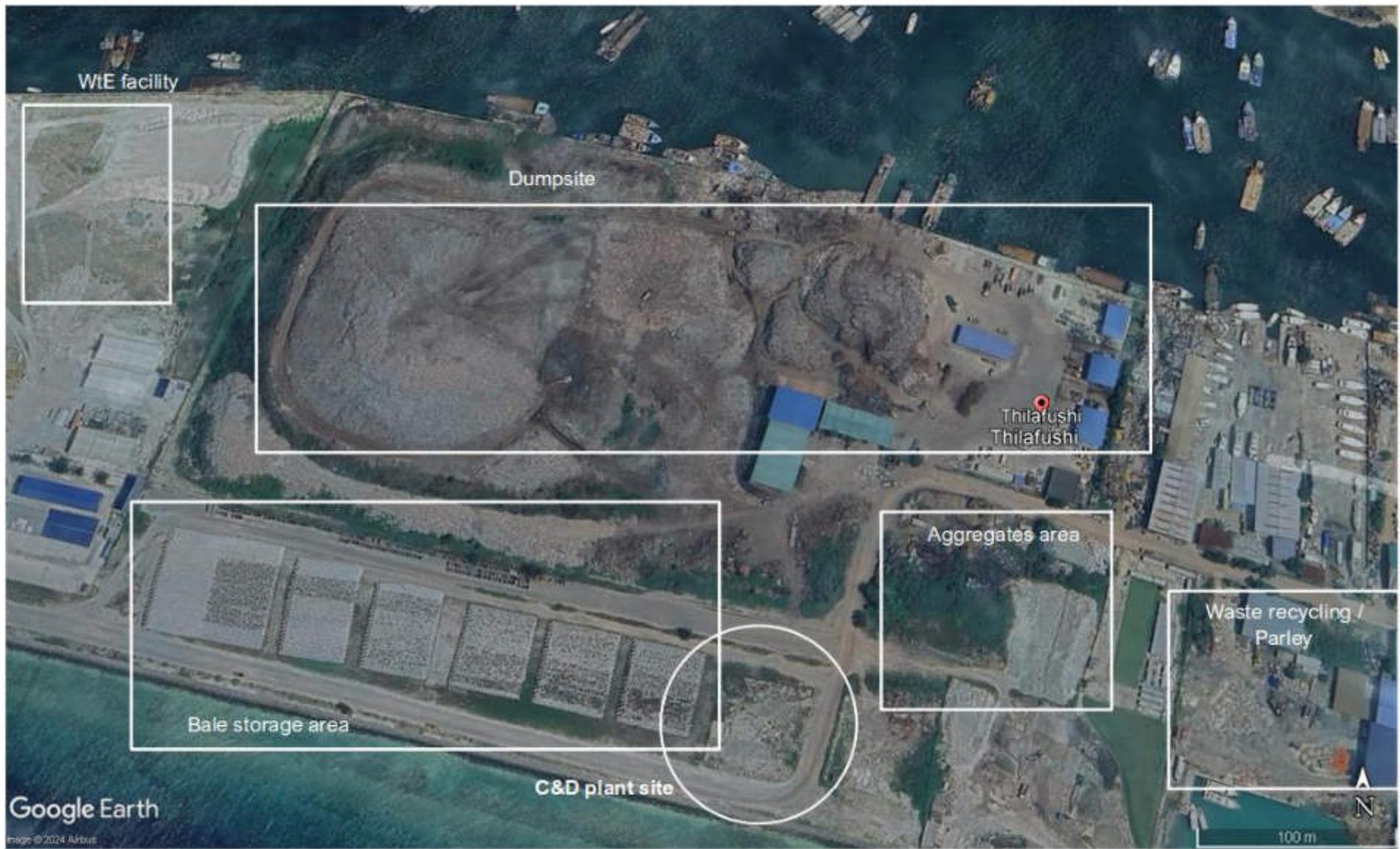


Figure 1: Site location

4. Plant layout and key elements

This chapter describes the layout and workflow of the plant, detailing the processes for mixed and mono-fraction C&D waste. The plant's first line handles mixed waste, separating materials through shredding, magnetic separation, and screening. The second line processes concrete waste, primarily through crushing, and merges with the first line for further manual sorting and refining. The setup aims to ensure a continuous and efficient workflow while minimizing dust exposure.

Process description:

First line : Mixed C&D waste is dumped and charged into the feeding conveyor (input 1), the waste is shredded, then metal parts will be removed (magnetic separation) and screened (trommel screening), light parts (plastic, packaging etc.) will be removed through windshifting, heavy parts will be conveyed to the second line for further sorting and refining

Second line: Mono fractions (concrete) will be dumped and charged into the feeding conveyor and crushed (jaw crusher). After the crushing the material is transported with the material from the 1st line to the manual sorting platform for removal of impurities (small plastic parts, small metal parts etc.). After the sorting line the material is conveyed for further crushing, screening according to the requirements

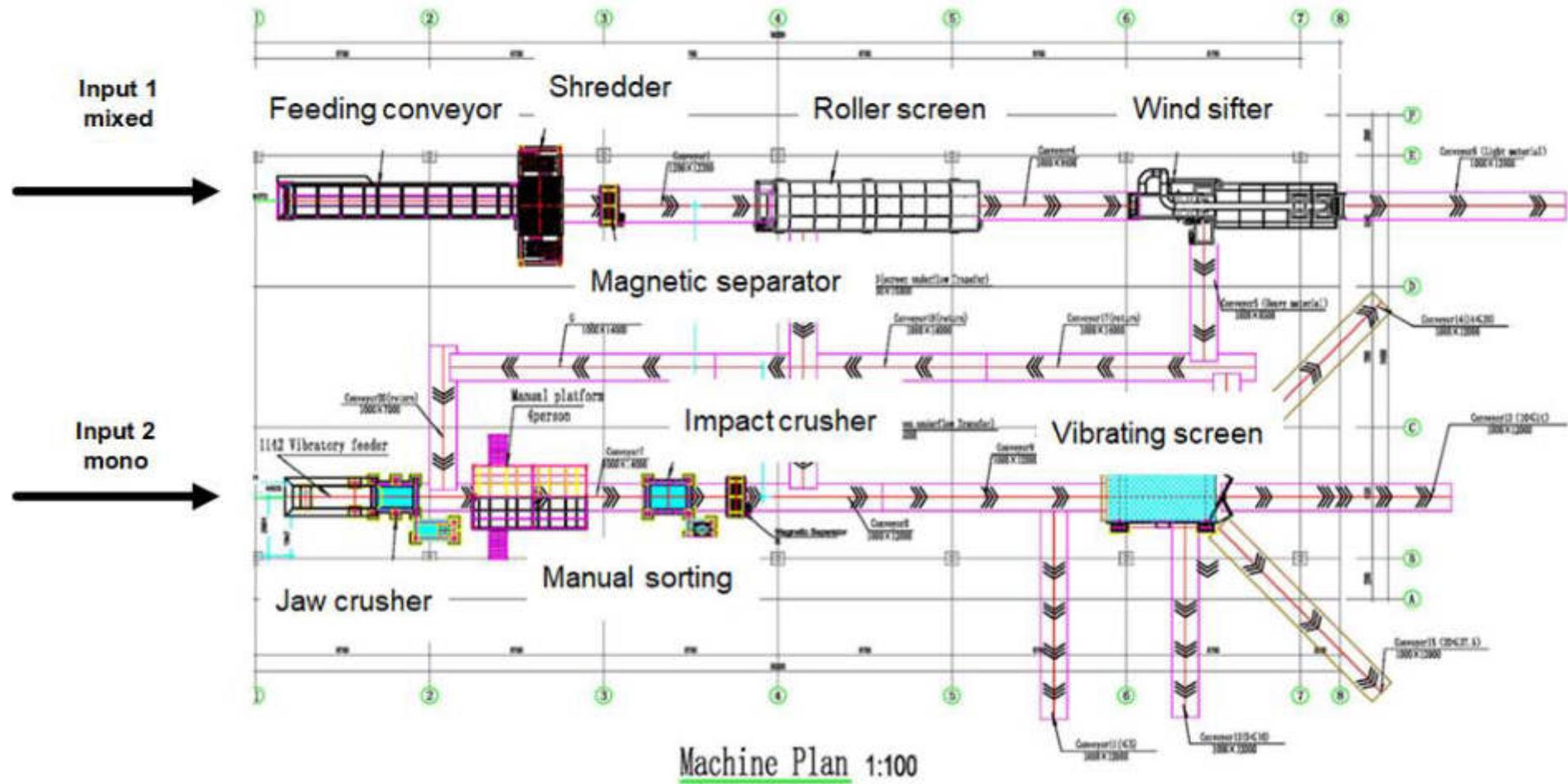


Figure 2: system overview and key elements

5. Impact assessment and mitigation measures

Each component of the plant, from feeding conveyors to crushers and sorting platforms, is evaluated for dust impact. The chapter identifies areas with moderate to high dust levels, such as open systems, crushers, and screens. Mitigation strategies, including water spraying, encapsulation, and PPE (personal protective equipment) for workers, are proposed. Encapsulated systems and water hoses are intended to reduce dust during critical processes.

All pictures are the original elements of the plan (pictures taken during the factory acceptance visit)

a) Feeding conveyor

	Purpose	Material feeding (continuous and uniform)		
	Dust Impact			
	No	Low	Moderate	High
			X	
	Reason	Dumping from height into an open system		
	Mitigation	Water spraying on the dumping area, to reduce the dust development		
Equipment & Costs	Hose with spraying device (costs see chapter below)			

b) Magnetic separator

	Purpose	Iron removal		
	Dust Impact			
	No	Low	Moderate	High
	X			
	Reason	No dust development expected, iron will be removed by the magnet		
	Mitigation	N/A		
Equipment & Costs	N/A			

c) Roller screen/Trommel screen

	Purpose	Screening of material, Separation of material < 80 mm		
	Dust Impact			
	No	Low	Moderate	High
			X	
	Reason	Rotary movement of the material in the screen		
	Mitigation	The system is an encapsulated closed, fully automatic system (no presence of staff)		
Equipment & Costs	The encapsulation is part of the system			

d) Wind shifter

	Purpose	Separation of light material from heavy material		
	Dust Impact			
	No	Low	Moderate	High
			X	
	Reason	Wind blowing		
	Mitigation	The system is an encapsulated closed, fully automatic system (no presence of staff)		
Equipment & Costs	The encapsulation is part of the system (no additional costs)			

e) Vibrating screen

	Purpose	Screening/refining of the material		
	Dust Impact			
	No	Low	Moderate	High
				X
	Reason	Dynamic movement, open system		
	Mitigation	Water spraying/dust monitoring for further measures		
Equipment & Costs	Hose with spraying device (costs see chapter below)			

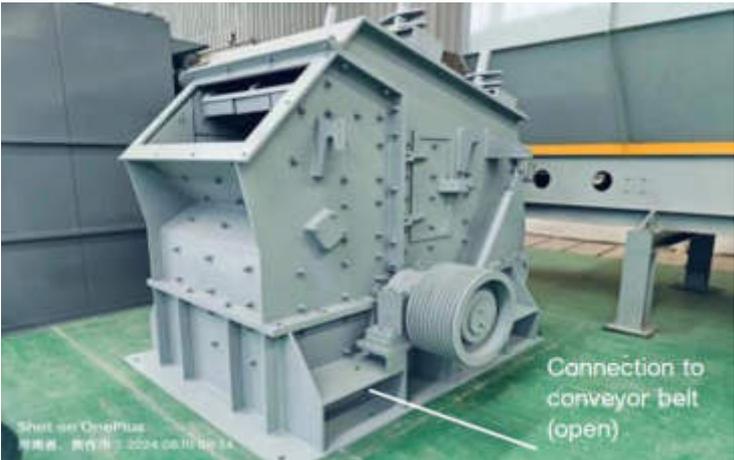
f) Jaw crusher

	Purpose	Crushing of concrete pieces (input 2)		
	Dust Impact			
	No	Low	Moderate	High
				X
	Reason	Crushing movement		
	Mitigation	The system is an encapsulated closed, fully automatic system (no immediate presence of staff)		
Equipment & Costs	The encapsulation is part of the system (no additional costs)			

g) Manual sorting platform

	Purpose	Sorting out of impurities (small pieces of plastics, packaging, metal etc..)		
	Dust Impact			
	No	Low	Moderate	High
	X			
	Reason	Static movement (flat conveyor belt), no or low dust development expected		
	Mitigation	PPE and Plastic slatted curtain		
Equipment & Costs	See below			

h) Impact crusher

	Purpose	Crushing/refining of material		
	Dust Impact			
	No	Low	Moderate	High
				X
	Reason	Crushing movement		
	Mitigation	The system is an encapsulated closed, fully automatic system (no immediate presence of staff)		
Equipment & Costs	The encapsulation is part of the system (no additional costs)			

i) Vibrating screen

	Purpose	Screening, refining material for output		
	Dust Impact			
	No	Low	Moderate	High
				X
	Reason	Dynamic movement, open system		
	Mitigation	Water spraying/dust monitoring for further measures		
Equipment & Costs	Hose with spraying device (costs see chapter below)			

Summary/overview of the dust impact in the system

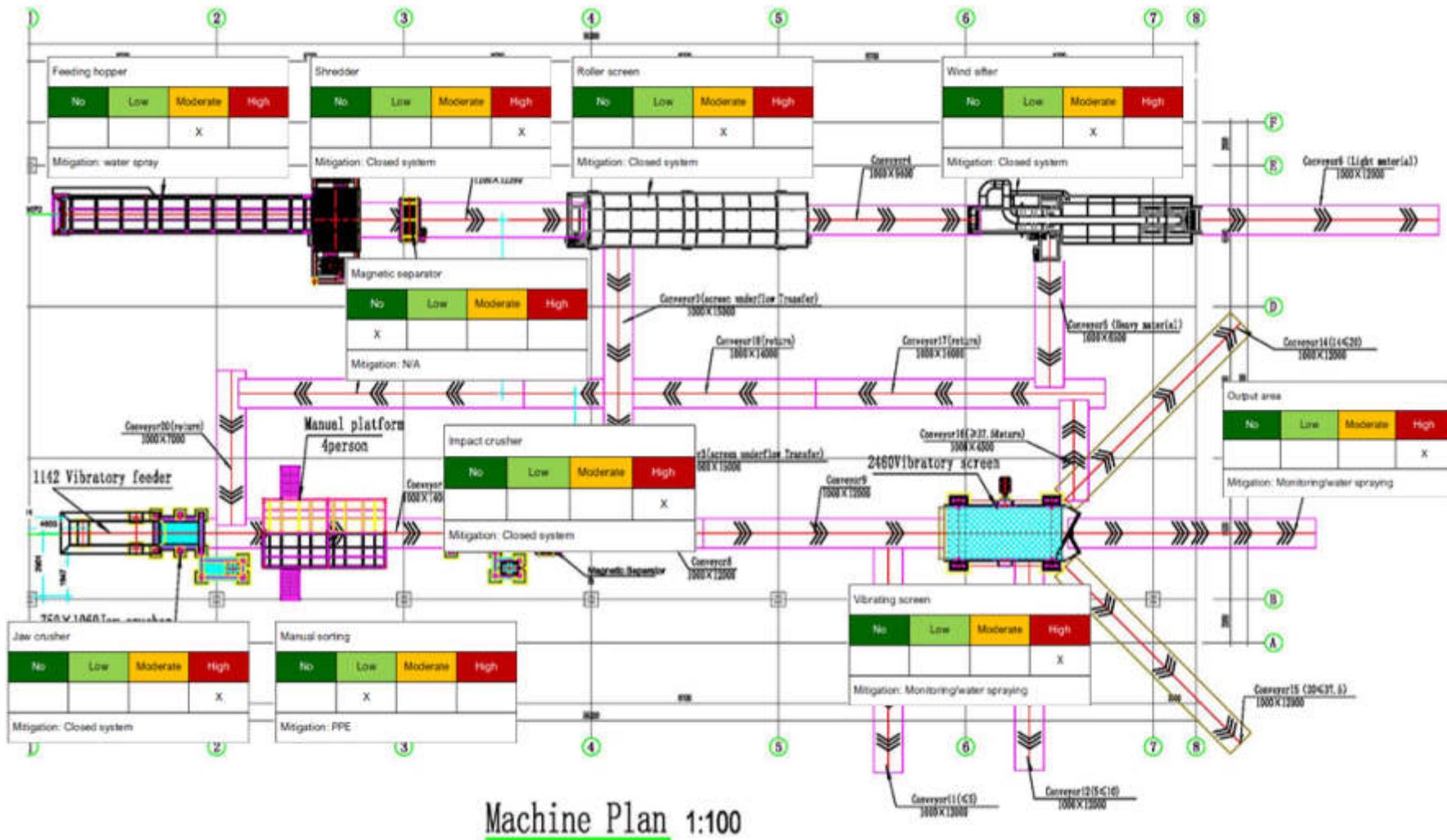


Figure 3: Overview of impacts and mitigationa

6. General and additional mitigation measures

In addition to process-specific mitigations, general measures like paving the site's area, using water taps for spraying, and enclosing wheel loader cabins are recommended. For the sorting platform, a plastic slatted curtain is suggested to limit dust dispersion. The design accommodates passive air circulation through an open shed construction to enhance natural ventilation.

As part of the project the following measures have been designed:

- Paved area whenever possible to reduce the dust development
- Water connection for spraying hose (water spray): 2 water tabs

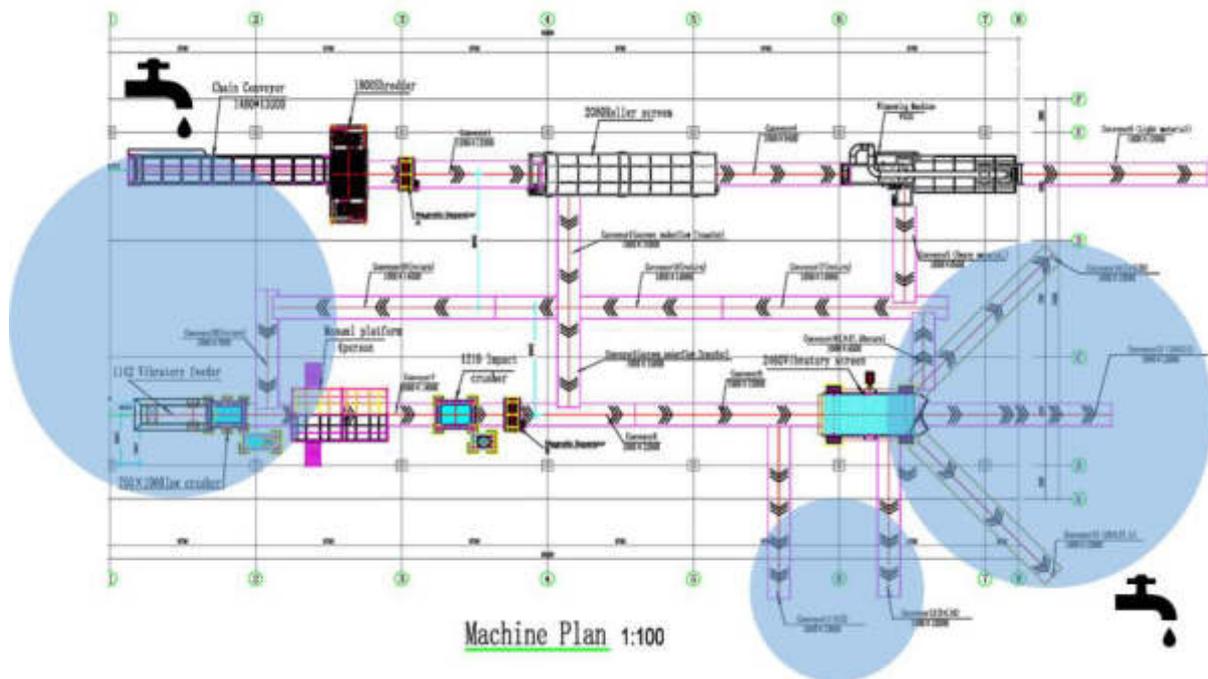
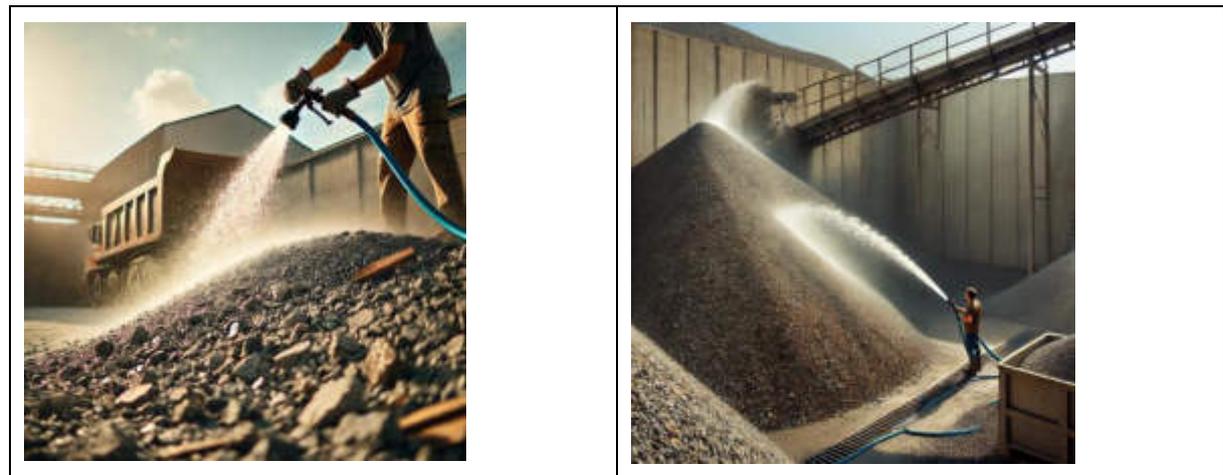


Figure 4: location of water tabs for spraying



All Generated pictures only for information and visual purposes

- Wheel loader cabin : closed and aerated
- Sorting platform : PPE for sorting staff

Additional measures: For the sorting platform an additional plastic slatted curtain shall be foreseen to avoid any dust deployment from the system and the elements nearby with an higher impact



- The area where staff is working is limited to a maximum : input area, manual sorting, output area

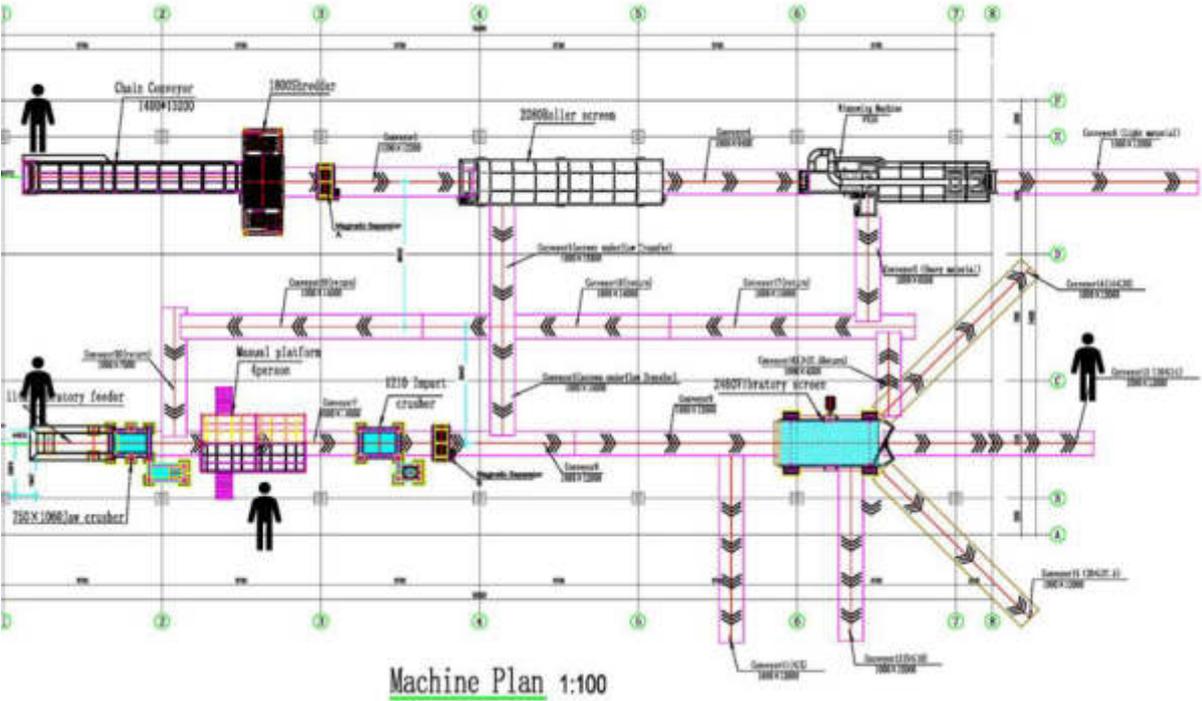
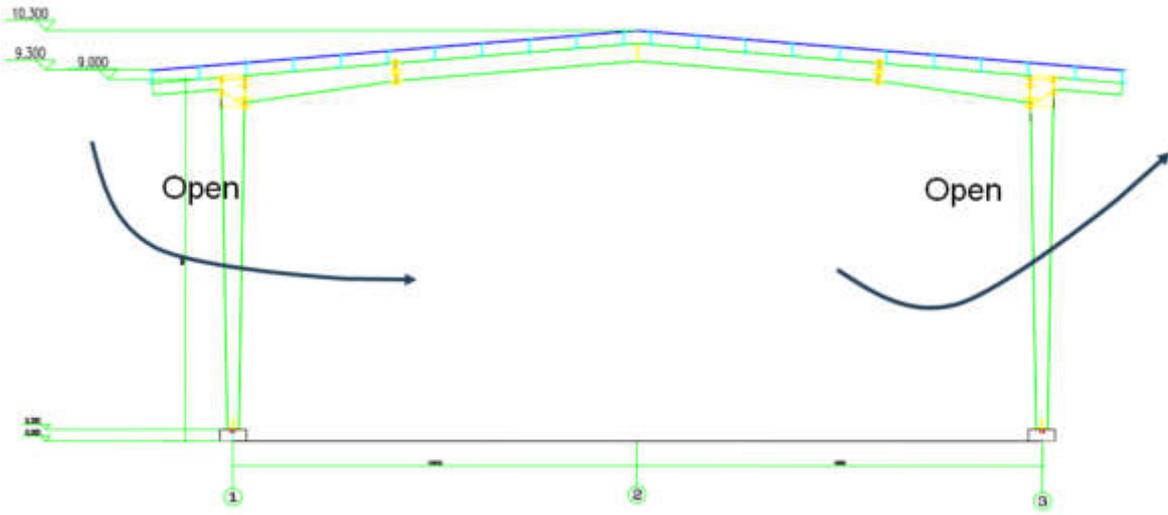


Figure 5: area where the staff is working

- Open shed construction allows an passive aeration and air circulation



7. Costs of additional measures

Item	units	Unit costs in USD	Total costs
Hose with sprayer device Hose : ½ inch, 50 m Spraying device	4 (2 + 2 spare)	50-60 USD	200 USD
Plastic slatted curtain (approx. 50 m with metal supporting structure)	Pc/LS	3000-3500 USD	3000-3500 USD

8. Future measures

Recognizing the variability in dust generation due to climatic conditions and waste composition, the chapter discusses future enhancements. These include regular dust monitoring at critical points (such as crushers and screens), creating a baseline for emissions, and potentially adopting passive dust removal systems if emissions exceed international standards. The recommendations are tailored to the plant's open layout, balancing cost-efficiency with dust management.

The plant was designed as a very simple mechanical plant avoiding a lot of maintenance to a reasonable costs. The dust development is highly dependent from:

- The climatic conditions (wind, humidity etc.)
- And the C&D waste composition

As there are no benchmarks in the country the system is kept simple for the moment avoiding high tech and cost and power intensive dust removal system (like automatic water spraying machine or passive dust removal system)

	
Automatic spraying system	Passive dust removal system

However, for future measures it is recommended to:

- Have a periodical and closed monitoring of dust emission at the critical spots (crushers and screens)
- Develop a baseline
- And in case of exceeding international norms and limits to foresee additional measures in form of a passive dust removal system (aeration system).

It must be said that these measures are mainly foreseen for closed plants (in a closed hall). The plant in Thilafushi is an open construction with a shed (to protect the workers and the equipment from heavy rain). This is favourable for a good air circulation and dust abatement within reasonable costs