Structural Integrity Assessments (SIAs) of 27 Government Facilities

Loan/Grant No.: 3877/OC-JA; GRT/ER-16412-JA

University Hospital of the West Indies

October 2021

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Preface

CONTRACT NAME:	CONTRACT FOR INDIVIDUAL CONSULTING SERVICES for Structural Integrity Assessments (SIAs) of 27 Government Facilities 3877/OC-JA LUMP-SUM PAYMENTS (IADB FINANCED)
CLIENT:	Ministry of Science, Energy and Technology
CONSULTANT:	
DOCUMENT REFERENCE:	Final Roof Structural Integrity Assessment Report

This assignment is part of the Management and Efficiency Programme (EMEP) managed by the Government of Jamaica (GOJ) through MSET with the assistance of the Inter-American Development Bank (IDB). The EMEP is receiving loan financing from the Inter-American Development Bank and Japan International Cooperation Agency (JICA) in the amount of US$30 Million and grant support from the European Union Caribbean Investment Facility (EU-CIF) in the amount of US$10 Million, to promote energy efficiency and conservation in Jamaica by reducing electricity consumption, improving traffic flows in congested road corridors in the Kingston Metropolitan Region, and enhancing the capacity of Jamaica's Ministry Science, Energy and Technology (MSET) to improve electricity sector planning.

Prepared by

…… October 28, 2021 ……..

Date

Executive Summary

The generation of electricity in Jamaica has a heavy dependency on oil, the price for which Jamaica has no control over. The Government of Jamaica (GOJ) having identified the substantial expenditure associated with the import of petroleum on an annual basis have undertaken an initiative to decrease the number of fiscal resources spent on its own electricity bill. Through the Ministry of Science Energy and Technology (MSET) in demonstration of the public sector's commitment Energy Efficiency and Conservation the Energy Management & Efficiency Programme. One of the aims of the programme is to utilize Solar Photovoltaic (PV) panels in an effort to diversify the energy mix with the readily available renewable energy source in the form of the sun and the subsequent irradiance it provides. As a part of the planning of this programme, some twenty-seven (27) GOJ Health, Education and Public Agency (HEPA) facilities island wide were shortlisted, and studies commenced to ascertain the viability of the undertaking. An important component required for the execution of this programme is Structural Integrity Assessments for which the services of myself (XXXX) has been solicited.

The Health, Education and Public Agency (HEPA) facility to which this report speaks is the University Hospital of the West Indies (UHWI), Jamaica. The facility is home to over a hundred buildings of varying types of roof construction to include: Reinforced Concrete framed flat and pitched roofs, Timber Framed flat and pitch roofs as well as steel framed roofs. This study was focused on the structures enclosed by the main oval corridor through the facility colloquially referred to as the 'ring road'. Having gone through systematic screening based on engineering and other practical considerations, of the over one hundred structures present, twenty (20 no.) were considered for a detailed analysis. Of these 20 no. structures nineteen (19no.) buildings or sections thereof appear structurally and otherwise practicably suitable for consideration for the installation of Solar PV panels under the EMEP.

Table 1: Summary of Assessment

Item No.	Building	Comment
1	Tony Thwaites Private Wing	Favourably Considered
2	ICU A	Favourably Considered
3	Operating Theatres 1-5	Favourably Considered
4	Surgical ICU (ICU B) & Operating Theatres 6-7	Favourably Considered
5	Specialty Wards	Favourably Considered
6	Psychiatry Ward	Favourably Considered
7	Accident & Emergency	Favourably Considered
8	Minor Operations & Day Surgery	Favourably Considered
9	Pharmacy	Favourably Considered
10	E.N.T & Orthopaedics	Favourably Considered
11	X Ray/Catheterization/Ultrasound	Favourably Considered
12	Ward 3	Favourably Considered
13	Ward 4	Favourably Considered

14	Ward 7	Favourably Considered
15	Ward 8	Favourably Considered
16	Administration	Favourably Considered
17	Ward 11 & 12	Favourably Considered
18	Microbiology/Pathology	Partially Considered
19	Paediatric Wards	Not Considered
20	Medical Library	Favourably Considered

Background Information

In the process of conducting the SIA the site was visited repeatedly throughout the period spanning September 21, 2021, to October 8, 2021, towards conducting an inspection of and obtaining the measurements of the salient building roof(s). During the visit, a preliminary walkthrough was conducted to further define the facility and the potential buildings for the study. Some buildings were precluded due to the state of their construction, them being built up temporary structures or in a general state of disrepair. Other practical considerations that impacted the vetting of the buildings included shadowing from taller adjacent buildings, vegetation, unfavourable orientation for the generation of solar power and the presence of equipment or other structures on the roof that would notably encroach on useable space for the solar panels.

The site for UHWI is bounded to the North by a section of John Golding Road and Old Hope Road, to the West by the Mona Heights Community, to the South by the University of the West Indies (UWI) Mona Campus and to the East by John Golding Road.

The site layout is concentric in nature where the main buildings are scattered within the "UHWI Ring Road" with structures predominantly oriented such that their lengths run in a Southwest to Northeast direction with one large relatively flat green area to the centre, that is being used at the moment for temporary structures to house Covid-19 related patients. Supplementary buildings for various administrative activities as well as numerous residences and other miscellaneous structures were located outside of the ring road. After a preliminary walkthrough scoping each of the buildings, a shortlist was created, and a detailed assessment carried out.

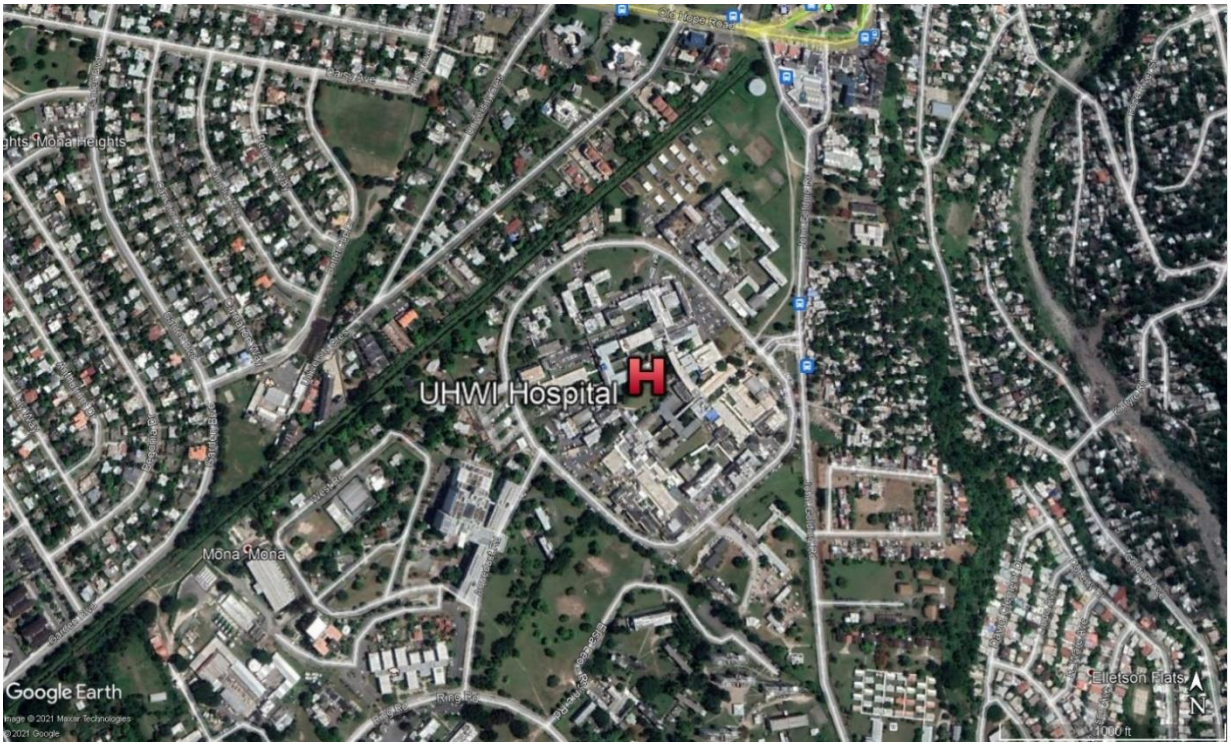

Image 1. Site Location Map

Tony Thwaite's Private Wing

This two (2) storey building houses Medical Wards Surgical Wards, Operating Theatres, Radiology and Diagnostic Imaging Services. It is an almost rectangular structure located to the south of the property and is oriented such that its length runs in a northwest to southeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a bituminous waterproofing membrane with fine gravel covering.

Image 2: Showing Tony Twaites Private Wing

ICU A

This single storey building is located to the south of the property. It is oriented such that its length runs in a northwest to southeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete waffle slab covered with a sheet based waterproofing membrane.

Image 3: Showing ICU A

Operating Theatres 1-5

This single storey building is located to the south of the property. It is oriented such that its length runs in a northwest to southeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab with different roof levels, covered with a sheet based waterproofing membrane. A section of the roof is timber framed with corrugated metal sheeting.

Image 4: Showing Operating Theatre 1-5

Surgical ICU (ICU B) & Operating Theatres 6-7

The main structure of this building is two (2) storeys high, housing the Surgical ICU, Operating Theatres 6-7. The main structure houses two further discrete projections forming a third storey, these house classrooms, and a power/equipment room respectively. The structure is located to the south of the property and is oriented such that its length runs in a southwest to northeast direction. This building was reported to have been built in 2003 making it 18 years old. The building is a composite engineered structure transmitting loads from roof to foundation utilizing a steel frame. The spaces between the columns are infilled with masonry block walls. At roof level of the building, spanning between the steel beams is a flat steel deck roof with open web steel joists as support. The surface of the roof is covered with spray foam and aggregate membrane for the main level (2nd storey roof) and sheet based weatherproofing membrane on the penthouse style projections (3rd storey roofs).

Image 5: Showing ICU B

Specialty Wards

This four (4) storey building is located to the south of the property. It has a rectangular footprint and is oriented such that its length runs in a southwest to northeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a sheet based waterproofing membrane.

Image 6: Showing Specialty Wards

Psychiatry Ward (Ward 21)

This building is located south-east of the property. This building is a multi-level structure (one to two stories). It is oriented such that its length runs nearly in a southwest to northeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a sheet based bituminous waterproofing membrane.

Image 7: Showing Psychiatry Ward

Accident & Emergency

This multi-level building is located to the east of the property. It is oriented such that its length runs in a southwest to northeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a foam waterproofing membrane covered with gravel on the two (2) storey areas, and torched on bituminous waterproofing membrane on the single storey areas.

Image 8: Showing Accident and Emergency

Minor Operations and Day Surgery

This multi-level structure has minor operations on the ground floor and an equipment room on the second floor. It is located to the east of the property. It is oriented such that its length runs nearly in a northwest to southeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a torched on bituminous waterproofing membrane. It is attached to the same building that houses the Accident and Emergency facility.

Image 9: Showing Roof for Minor Operations

Pharmacy

This single storey building is located to the east of the property and is attached to the same building that houses the Accident and Emergency facility. It is oriented such that its length runs in a northwest to southeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls and has a RC cantilever slab forming a covered external corridor. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a sheet based waterproofing membrane.

Image 10: Showing the Pharmacy

E.N.T & Orthopaedics

This single storey building is located to the east of the property. It is oriented such that its length runs in a north-east to south-west direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a duo pitched reinforced concrete slab covered with a sheet based bituminous waterproofing membrane. The skylight at the centre most section has a timber framed roofing, which is also covered in bituminous waterproofing membrane.

Image 11: E.N.T & Orthopaedics

X Ray/Catheterization/Ultrasound

This multi-level structure houses the X-Ray Department, Catherization and Ultrasound. It is located to the east of the property. It is oriented such that its length runs in a northwest to southeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. The roof at the 1st storey level is further divided into three sections where two of these sections have a flat reinforced concrete slab spanning between the RC beams. The other roof section at the 1st storey level is a gable roof of timber form construction. All three of these roof sections were duly covered with a waterproofing membrane. At the upper roof level, only a flat reinforced concrete slab roof was observed with walls projecting through the slab.

Image 12: Showing X-Ray Roofing

Wards 1-8

This designation refers to a collection of eight wards spread across four buildings. Each building shares a similar geometry, orientation, and form of construction. The two-storey structures are located near the centre of the property. The wards that occupy the top floor (2nd storey) for which the roofs in question are being assessed are Wards 3, 4, 7 & 8. All four buildings are oriented such that their longer dimension runs in a southwest to northeast direction. The buildings are engineered structures transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a duo-pitched reinforced concrete slab covered with a waterproofing membrane. Each structure also housed a section with timber framed roofing, these were precluded from further consideration due to the state of their construction.

Image 13: Showing Wards 1-8

Administration

This multi-level structure is located to the east of the property. It is oriented such that its length runs in a southwest to northeast direction. The first two (2) storeys form the main building and the third storey occupies the centre most section of the building. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a sheet based waterproofing membrane.

Image 14: Showing Administration

Ward 11 & 12

This two (2) storey structure is located to the north of the property. The footprint of this structure resembles a 'C' and it is oriented such that its longer overall dimension runs in a southwest to northeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a duo-pitched reinforced concrete slab covered with a waterproofing membrane. The structures also consists of a section with timber framed roofing which was precluded from further consideration due to the state of its construction.

Image 15: Showing Ward 11 & 12

Labour Ward

This three (3) storey structure is located to the north of the property. It is oriented such that its length runs in a southwest to northeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a waterproofing membrane.

Image 16: Showing Labour Ward

Microbiology/Pathology

This two (2) storey structure is located to the north of the property. Microbiology is oriented such that its length runs nearly east-to-west. While Pathology is oriented such that its length runs in a North-northwest to a South-southeast direction. It should be noted that access to this structure was not permissible at the time of any of the multiple visits conducted to this facility. Notwithstanding, the building consisted of what appeared to be concrete walls with a timber framed gable roof, covered with a sheet based waterproofing membrane. A small section of the building has a reinforced concrete roof slab.

Image 17: Showing Microbiology/ Pathology

Paediatric Wards

This single storey structure is located to the west of the property. It is oriented such that its length runs in a southwest to northeast direction. The building consists of seemingly concrete walls with a timber framed gable roof, covered with a sheet based waterproofing membrane.

Image 18: Showing Paediatric Ward

Medical Library

This three (3) storey structure is located to the west of the property. It is oriented such that its length runs in a southwest to northeast direction. The building is an engineered structure transmitting loads from roof to foundation utilizing a reinforced concrete (RC) frame. The spaces between the RC columns are infilled with masonry block walls. At roof level of the building, spanning between the RC beams is a flat reinforced concrete slab covered with a waterproofing membrane.

Image 19. Showing Medical Library

Assessment Methodology

The approach to the structural assessment included the following on-site activities.

1. Preliminary discussions with the facility personnel on any observed structural concerns throughout the operation of the facility. This to include cracks, leaks or any other significant or superficial indications of wear.

2. A walkthrough of the buildings starting at the ground level and climbing atop all reasonably accessible roofs. This confirming:

    a. Material(s) of construction.
        i. Visual inspection
        ii. Percussion as required.

b. The structural framing.
    i. Visual inspection
    ii. Tape Measure
    iii. Laser Measure

c. The presence, nature and extent of any cracks.
    i. Visual inspection

d. General state of repair.
    i. Visual inspection

e. Condition of the surface of the roofs.
    i. Visual inspection
    ii. Targeted levelness checks to identify sagging and/or hogging.
    iii. Probing for any signs of deflection through the modelled serviceability scenario of the persons present traversing the roofs.

f. Roof Geometry.
    i. Tape Measure
    ii. Laser Measure
    iii. Drone Imagery

g. Roof Reinforcement
    i. Some exposed slab reinforcement steel was measured and extrapolated within the bounds of similar engineered structures and cross referenced against the required steel to maintain conditions consistent with those which were identified on site. These parameters were used to inform an assumption on steel size and spacing.

For confirmation of the preliminary discussions as well as to seek additional information that would be important regarding the inclusion of the University Hospital of the West Indies Facility to the implementation of the EMEP, an email was written to the University Hospital of the West Indies Plant Administrator. This correspondence sought confirmations on:

- The names or designations of the shortlisted buildings.
- Any plans that may potentially affect the availability of the currently available roof space.
- Confirmation of the age of the structures.
- Historical performance of the structures during any experienced natural disasters (Hurricanes, Earthquakes etc.)
- Any Structure that exhibits leaks during rainfall events.
- Any relevant maintenance information/records.

This correspondence awaits a formal response from the beneficiary entity. The response is expected in short order and is intended to be included as an addendum to this report. When received, this response may be considered to form a part of Appendix B – Supporting Information.

Analysis Methodology

Utilizing the information captured during the assessment related to the existing conditions an analysis was conducted on the shortlisted structures towards identifying the anticipated structural performance and capability of the respective roofs to accommodate photovoltaic panels, the buildings were analysed under practical considerations to illuminate the expectations of the system under the loading scenarios solicited by the Terms of Reference (TOR). Principles, methodologies, and theorems were utilized and/or adopted from the following Professional Standards Documents:

- ASCE/SEI 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- ASCE 41-17: Seismic Evaluation and Retrofit of Existing Buildings
- ACI 318 – 11: Building Code Requirements for Structural Concrete
- ANSI/AISC 360-16: Specification for Structural Steel Buildings
- IBC – International Building Code
- National Building Code of Jamaica
- AWC National Design Specification for Wood Construction

Gravity Loading

The gravity loading was determined in adherence with the governing building codes. The additional expected loading of the Solar Panels is incorporated as a dead load (American Society of Civil Engineers, 2016). This was combined with the self-weights and live loads in the appropriate loading combinations as specified both in the Terms of Reference as well as the respective codes.

Wind Loading

The International Building Code (IBC) refers to adherence to the ASCE/SEI 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures for the considerations of wind loads. The principles as outlined in this document were applied in the generation of the wind loads on the respective buildings. The applicable wind maps developed for use within this code consider the three-second (3s) gust speed at 33 ft (10 m) above the ground in Exposure C conditions for respective return periods, to which various factors are applied in generating the case specific loading. These wind speeds were superseded by the Terms of Reference stipulated wind speeds of “up to 157 mph - Category 5 Hurricane force wind” (MSET, 2021) and applied similarly. The procedures within this code include restrictions which are further outlined in the Conclusion and Recommendations. Any deviation from these restrictions would preclude the modelling scenarios accommodated for in this code and would require a discreet wind tunnel exercise for the determination of the expected loads.

Seismic Loading

Addition of solar PV panels will not cause any notable increase to the seismic force based on its relative value to the effective mass participation nor are they considered a part of the seismic force-resisting system. Considering factors such as the range of weights of the solar panels currently available on the market, all rooftop solar panels for pitched roofs being positively attached, the layout recommendations noted in the latter part of this document appropriately curtail the for the consideration of the seismic design requirements for non-structural components of the ASCE/SEI 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Detailing requirements and limitations as prescribed in ASCE 7-16 Chapter 13 shall apply for anchorage and other applicable connections.

Findings

The structural assessment yielded necessary information for the subsequent modelling of the building roofs for the anticipated structural performance. The information acquired was documented and utilized for various quantitative analyses returning findings for the respective buildings as detailed below. An important note is that for the building with dropped ceiling visual access was achieved through a ceiling tile allowing for isolated observations of the roof's structure. The condition of the entire roof structure was not able to be confirmed. The observations are further illuminated in a series of photographs in Appendix A – Photos. The critical loading scenarios were isolated for the purpose of analyses. Each structure was then checked to ensure that their anticipated structural performance is satisfactory. An extract from the overall showing typical calculations for each roof type is enclosed in Appendix C.

Tony Thwaites Private Wing

Limited access was granted due to sensitive operations of the hospital. Thus, a thorough inspection of the roof slab soffit was not possible. Notwithstanding, the general condition of Tony Thwaites Private Wing is Fair. The building showed no adverse signs of deterioration and wear throughout the structure. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the anticipated structural performance of the building roof is shown in Table 2: Findings for Tony Thwaites Private Wing Roof. below.

Table 2: Findings for Tony Thwaites Private Wing Roof.

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Bituminous Layer + Aggregate Layer	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	20 ft (6,096m) Main Structure	
Roof Area	16,007 ft^2 (1,487 m^2)	
Obstructions on roof	YES	HVAC Equipment
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

ICU A

Limited access was granted due to sensitive operations of the hospital. Thus, a thorough inspection of the roof slab soffit was not possible. Notwithstanding, the general condition of ICU A is Fair. The building showed no adverse signs of deterioration and wear throughout the structure. Additionally, the suspended ceiling appeared to be in good condition. Access to the soffit of the roof slab, through the ceiling, was possible through a suspended ceiling tile that revealed a grid of reinforced concrete beams in good condition. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the anticipated structural performance of the building roof is shown in Table 3: Findings for ICU A Roof below.

Table 3: Findings for ICU A Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	16 ft (4,876m)	
Roof Area	5,422ft^2 (503m^2)	
Obstructions on roof	YES	HVAC Equipment
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load	PASS	

+ PV panel added Dead Load + Downwards Wind Force.		
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Operating Theatres 1-5

The general condition of the Operating Theatres 1-5 is Fair. The building showed no adverse signs of deterioration or wear to the structurally relevant components. The walls showed moderate signs of deterioration and wear in the form of microcracks scattered throughout the structure which appeared to be mainly superficial. There were signs on water intrusion on the underside of the roof slab in one area. The suspended ceiling had light signs of wear and deterioration in some areas. Limited access was granted to some areas due to sensitive operations of the hospital. Thus, a thorough inspection of the roof's soffit was not possible in these areas. These observations are further illuminated in Appendix A – Photos. The salient information is shown in Table 4: Findings for the Operating Theatres 1-5 Roof below.

Table 4: Findings for the Operating Theatres 1-5 Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	10 ft (3,048 mm)	
Roof Area	14,890ft^2 (1,383m^2)	
Obstructions on roof	YES	HVAC Equipment
Added weight of Solar PV Panels	PASS	

Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Surgical ICU (ICU B) & Operating Theatres 6-7

The Surgical ICU (ICU B) & Operating Theatres 6-7 building is in poor condition. The building showed severe signs of deterioration and wear in the form of cracks scattered throughout the structure. The roof showed signs of water intrusion from the underside. In Ward 1, though no cracks were seen, there was ponding on the roof. Isolated locations of spalling could also be identified. The suspended ceiling showed moderate signs of deterioration. Advanced signs of wearing were observed at a section of the foam and aggregate roof waterproofing membrane. It was generally in fair condition. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the anticipated structural performance of the building roof is shown in Table 5: Findings for Surgical ICU (ICU B) & Operating Theatres 6-7 Roof below.

Table 5: Findings for Surgical ICU (ICU B) & Operating Theatres 6-7 Roof

Item	Findings	Comments
Type of Roof	Steel Deck	Condition Fair

Roof Thickness	5" (127mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on Beams	
Roof Membrane	Foam & Asphalt based Waterproofing Membrane	Condition Fair
Membrane Thickness	≅ 1/8" (3mm)	
Building Height	20ft (6,096mm)	
Roof Area	13,382ft^2 (1,243m^2)	
Obstructions on roof	YES	HVAC Units
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Specialty Wards

The Specialty Wards is in a fair condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in Table 6: Showing Findings for Specialty Wards Roof below.

Table 6: Showing Findings for Specialty Wards Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	8" (200mm)	20mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Bituminous Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	40ft (12,192mm)	
Roof Area	7,081ft^2 (657m^2)	
Obstructions on roof	YES	Five (5) Metal grids
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Psychiatry Ward

The Psychiatry Ward Building is in Fair condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. The waterproofing membrane was in fair condition. The roof of the single storey section has seemingly stub columns, indicating plans for future vertical expansion in that area. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in Table 7: Findings for Psychiatry Ward Roof below.

Table 7: Findings for Psychiatry Ward Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	8" (203mm)	20mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	10 ft (3,048 mm) - 20ft (6,096mm)	
Roof Area	11,743ft^2 (1,090m^2)	
Obstructions on roof	YES	Stub Columns
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	

Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Accident & Emergency

The Accident & Emergency appears to be in relatively good condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. The two roof levels were in fair condition, including the waterproofing membranes on each. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the anticipated structural performance of the building roof is shown in Table 8: Findings for Accident & Emergency Roof below.

Table 8: Findings for Accident & Emergency Roof (Slab Section)

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Foam + Aggregate Torched On Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	10ft-14 ft (3,048 mm-4,267mm)	
Roof Area	9,842ft^2(914m^2)	
Obstructions on roof	YES	AC units

Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Minor Operations & Day Surgery

The Minor Operations & Day Surgery building appears to be in a relatively good condition. The building showed moderate signs of deterioration and wear in the form of isolated cracks and micro cracks scattered throughout the structure. The roof showed signs of water intrusion from the underside. Isolated locations of spalling could also be identified on the underside of the roof slab. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the anticipated structural performance of the building roof is shown in Table 9. Findings for Minor Operations & Day Surgery Roof. below.

Table 9. Findings for Minor Operations & Day Surgery Roof.

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	10" (254mm)	20mm Ø Bars @ 200mm (Assumed)
Roof Framing	Slab	

Roof Membrane	Torched On Bituminous Membrane	Condition Fair
Membrane Thickness	≅ 1/8" (3mm)	
Building Height	10ft-14 ft (3,048 mm-4,267mm)	
Roof Area	7,728ft^2 (718m^2)	
Obstructions on roof	NO	
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Pharmacy

The Pharmacy building appears to be in a fair condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure. The two roof levels were in fair condition, including the waterproofing membranes on each. These observations are further illuminated in Appendix A – Photos. The salient information is shown in Table 10: Findings for the Pharmacy Roof below.

Table 10: Findings for the Pharmacy Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	10ft-14 ft (3,048 mm-4,267mm)	
Roof Area	12,479ft^2 (1,159m^2)	
Obstructions on roof	YES	Several plinths
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

E.N.T & Orthopaedics

The E.N.T & Orthopaedics Department is in Fair condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. At the roof level of the building, a duo pitched reinforced concrete slab with a sheet- based membrane was observed. The skylight running along the centre of the roof was at a higher elevation with a timber framed gable roof, both covered with a sheet-based waterproofing membrane. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the anticipated structural performance of the building roof is shown in Table 11: Findings for Paediatric Roof below. The information shown will focus on the slab sections of the roof, as the only sections seeming practical for consideration.

Table 11: Findings for Paediatric Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	One-Way Slab on Beams	
Roof Membrane	Sheet based membrane	Condition Fair
Membrane Thickness	≅ ¼"(6mm)	
Building Height	12 ft (3,657m^2)	
Roof Area	21,774ft^2 (2,022m^2)	
Obstruction on Roof	NO	
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt	PASS	

equal to 20 °		
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

X Ray/Catheterization/Ultrasound

The X Ray/Catheterization/Ultrasound building is in Fair condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. One section however, showed a seemingly structural crack in the wall which was not far advanced. At the lower roof level of the building, spanning between the RC beams is a flat reinforced concrete slab and a timber framed gable roof, both covered with a sheet-based waterproofing membrane. At the upper roof level, the flat reinforced concrete slab roof is covered with a foam-based membrane with aggregate which showed signs of deterioration. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in Table 12: Findings for X Ray/Catheterization/Ultrasound Roof below. The information shown will focus on the slab sections of the roof, as the only sections seeming practical for consideration.

Table 12: Findings for X Ray/Catheterization/Ultrasound Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	One-Way Slab on Beams	
Roof Membrane	Foam + Aggregated at upper level Sheet based membrane at lower level	In need of remediation
Obstructions on roof	YES	Concrete Upstand Beams

Membrane Thickness	≅1/2" (25mm)	
Building Height	12 ft (3,657mm)	
Roof Area	7,653ft^2 (710m^2)	
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Item	Findings	Comments
Type of Roof	Timber Framed Gable Roof	Condition Fair – Duo-Pitched - 10^0
Roof Thickness	N/A	
Roof Framing	Timber	Rafters 50mm x 200mm
Roof Membrane	Sheet based membrane	Condition Fair
Obstructions on roof	NO	
Membrane Thickness	≅1/2" (25mm)	
Building Height	12 ft (3,657mm)	

Roof Area	6,314ft^2 (586m^2)	
Added weight of Solar PV Panels	FAIL	
Wind Uplift with angle of tilt equal to 5 °	NOT RECOMMENDED	It is recommended that the installed solar PV panels if considered rest flat in accordance with the roof pitch
Wind Uplift with angle of tilt equal to 10 °	NOT RECOMMENDED	It is recommended that the installed solar PV panels if considered rest flat in accordance with the roof pitch
Wind Uplift with angle of tilt equal to 15 °	NOT RECOMMENDED	It is recommended that the installed solar PV panels if considered rest flat in accordance with the roof pitch
Wind Uplift with angle of tilt equal to 20 °	NOT RECOMMENDED	It is recommended that the installed solar PV panels if considered rest flat in accordance with the roof pitch
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	FAIL	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	FAIL	

Wards 1-8

The Wards 1 – 8 are in a poor condition. The buildings showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. The timber section of Ward 4 was reported to have leaks. At roof level, the duo pitch reinforced concrete slabs of Wards 7 and 8 were covered with bituminous water proofing membrane with aggregates. While the duo pitch reinforced concrete slabs of Wards 3 and 4 were covered with a sheet-based water proofing membrane, all in fair condition. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in the Table below.

Table 13: Findings for the Wards 3, 4, 7, 8 Roofs

Item	Findings	Comments
Type of Roof	Slab	Condition Fair Duo-Pitched - 2^0 slope
Roof Thickness	4" (100mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	One-Way Slab on Beams	
Roof Membrane	Bituminous +aggregate on Wards 7 & 8 Sheet-based membrane on Wards 3 & 4	Condition Fair Condition Fair
Obstructions on roof	NO	
Membrane Thickness	≅1/2" (25mm)	
Building Height	20 ft (6,096mm)	
Roof Area	12,249ft^2 (1,138m^2)	
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	

Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Administration

The Administration building is in a Fair condition. The building showed moderate signs of deterioration and wear. The drop ceiling panels showed signs of water intrusion from the underside of roof slab. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in below. Table 14: Findings for the Administration Roof.

Table 14: Findings for the Administration Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	20ft (6,096 mm) 30ft (9,144mm)	General height of building To the top of board room at centre of building
Roof Area	8,649ft^2 (803m^2)	
Obstructions on roof	YES	AC Units, HVAC system
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	

Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Ward 11 & 12

Wards 11 & 12 are in a Fair condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in Table 14: Findings for the Administration Roof below.

Table 15: Findings for Wards 11 & 12 Roof

Item	Findings	Comments
Type of Roof	Slab	Duo-Pitched – 2^0 slope Condition Fair
Roof Thickness	4" (100mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	20 ft (6,096 mm)	
Roof Area	6,334ft^2 (588m^2)	

Obstructions on roof	NO	
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Labour Ward

The Labour Ward is in a Fair condition. The building showed moderate signs of deterioration and wear in the form of micro cracks scattered throughout the structure which appeared to be mainly superficial. The roof showed signs of water intrusion from the underside. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in Table 14: Findings for the Administration Roof below.

Table 16: Findings for the Labour Ward Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	10" (250mm)	20mm Ø Bars @ 200mm (Assumed)
Roof Framing	Continuous Slab on	Condition Fair

	beams	
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	30 ft (9,144 mm)	
Roof Area	8,098ft^2 (752m^2)	
Obstructions on roof	YES	4# AC condenser units
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Microbiology/Pathology

No access was granted to interior of this building during any of the site visits conducted. Thus, a thorough inspection of the roof soffit was not possible. Notwithstanding, the Microbiology/ Pathology building appears to be in fair condition. The building showed moderate signs of deterioration observed throughout the exterior of the structure, which appeared to be mainly superficial. The reinforced concrete slab section showed spalling and peeling on the soffit of the roof overhang, suggesting possible water intrusion. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated

structural performance of the building roof is shown in Table 14: Findings for the Administration Roof below. The information shown will focus on the slab roof as the only section seeming practical for consideration.

Table 17: Findings for the Microbiology/ Pathology Roof

Item	Findings	Comments
Type of Roof	Slab and timber framed	Condition Fair
Roof Thickness	8" (200mm)	20mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams Timber	Condition Fair Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	20ft (6,096mm)	
Roof Area	2,073ft^2 (192m^2) 14,209ft^2 (1,320m^2)	Slab section Timber frame section
Obstructions on roof	YES	3# HVAC units. No obstruction observed on recommended Slab section.
Added weight of Solar PV Panels	PASS	Slab section only
Wind Uplift with angle of tilt equal to 5 °	PASS	Slab section only
Wind Uplift with angle of tilt equal to 10 °	PASS	Slab section only
Wind Uplift with angle of tilt equal to 15 °	PASS	Slab section only
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards	PASS	Slab section only

Wind Force.		
Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	Slab section only

Paediatric Wards

The Paediatric Ward is in a poor condition. The building showed moderate signs of deterioration and wear. The timber roof framing showed signs of rotting and evidence of termite infestation. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in Table 14: Findings for the Administration Roof below.

Table 18: Findings for the Paediatric Ward Roof

Item	Findings	Comments
Type of Roof	Timber Framed Gable Roof	Condition Poor
Roof Thickness	N/A	Metal Gauge
Roof Framing	Timber Rafters	Condition Poor
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	N/A	
Building Height	10 ft (3,048 mm)	
Roof Area	17,832 ft^2 (1,656m^2)	
Obstructions on roof	NO	
Loading Scenarios	N/A	Not Recommended for PV installation

Medical Library

The Medical Library is in a Fair condition. The building showed moderate signs of deterioration and wear observed throughout the exterior of the structure which appeared to be mainly superficial. No access was granted to interior of this building during any of the site visits

conducted. These observations are further illuminated in Appendix A – Photos. The salient information as well as a cursory depiction of the Anticipated structural performance of the building roof is shown in Table 14: Findings for the Administration Roof below.

Table 19: Findings for the Medical Library Roof

Item	Findings	Comments
Type of Roof	Slab	Condition Fair
Roof Thickness	6" (152mm)	12mm Ø Bars @ 225mm (Assumed)
Roof Framing	Continuous Slab on beams	Condition Fair
Roof Membrane	Sheet Based Membrane	Condition Fair
Membrane Thickness	≅ 1/4 (6mm)	
Building Height	30 ft (9,144 mm)	
Roof Area	4,935ft^2 (458m^2)	
Obstructions on roof	YES	3# AC Condenser units, 2# HVAC units
Added weight of Solar PV Panels	PASS	
Wind Uplift with angle of tilt equal to 5 °	PASS	
Wind Uplift with angle of tilt equal to 10 °	PASS	
Wind Uplift with angle of tilt equal to 15 °	PASS	
Wind Uplift with angle of tilt equal to 20 °	PASS	
Roof Dead Load + PV panel added Dead Load + Downwards Wind Force.	PASS	

Roof Dead Load + added Dead Load + 75% Downwards Wind Force.	PASS	

Conclusion and Recommendations

The recommendation(s) considering the structural integrity of the respective structures and any other practical limitations the recommendations are captured herein. In addition to the discreet recommendations listed further below it is important to note that subject to the final feasibility deliberations of the salient stakeholders and the designer of the Photovoltaic Array(s) that the following be considered for the roofs on which Photovoltaic Panels will be installed.

1. Installation should be planned to coincide with the plans of the facility coordination personnel to ensure that inter alia, any existing or incumbent weatherproofing is not compromised by the installation of the solar panels.
2. The Solar Panels are to be set back a minimum horizontal distance of 4ft (1,219 mm) from the roof's edge (and peak in the case of a pitched roof).
3. Solar Panels arrays are to be spaced such that the minimum horizontal distance between adjacent array groups is 4ft (1,219 mm) except for those panels mounted flush.
4. Solar Panels considered for pitched roofs of slopes greater than 2◦ should be mounted flush, consistent with the slope of the roof.
5. The maximum height of the Solar Panels should not exceed 4ft (1,219 mm) above the roof's surface.
6. Where practicable during implementation invasive testing to confirm any design assumptions should be carried out.
7. A maintenance plan should be developed to ensure that the building roofs are kept in a good state of repair and any signs of weathering and addressed routinely.
8. Weatherproofing membranes to the slabs should be made good or replaced prior to or in conjunction with any solar photovoltaic panel installation.
9. Detailing requirements and limitations prescribed in ASCE 7-16 Chapter 13 or equivalent shall apply for anchorage and other applicable connections.
10. Confirmation of consistent configuration and conditions throughout the roof structures for which full visual access was obscured by dropped ceilings should be conducted prior to any installation activities.

Tony Thwaites Private Wing

This building's structure and slab roof seem to be in fairly good condition overall and is therefore worthy of consideration for the installation of solar panels under the EMEP. Considering the

variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

ICU A

This building's structure and slab roof seem to be in fairly good condition overall and is therefore worthy of consideration for the installation of solar panels under the EMEP. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Operating Theatres 1-5

This building's structure and slab roof seemed to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which, though do not appear to be of structural significance, should be monitored and arrested using appropriate localized concrete repair products and methodologies. Notwithstanding the above, the structure is worthy of consideration for the installation of solar panels under the EMEP. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Surgical ICU (ICU B) & Operating Theatres 6-7

The structure houses two discreet hospital operations, coincidentally the conditions of the two areas though as a part of the same structure are contrasting in nature. The identified deterioration throughout the Surgical ICU (ICU B) & Operating Theatres 6-7 structure is approaching a level of concern left alone the conditions will continue to deteriorate. Many cracks and signs of water intrusion were identified throughout this structure, some of the cracks appearing to extend through to the foundation level. Patches were also observed to the underside of the roof slab implying long standing issues. Both for the aesthetics and to mitigate against further compromise to the structural integrity, the cracking needs to be addressed using appropriate localized concrete repair products and methodologies. Remedial work is required to the weatherproofing membrane. It is recommended that substructure investigations be conducted to confirm the extents of the damage to this structure. It is not recommended that this structure be considered for the installation of Solar PV panels.

Ward 1 shows much less signs of concern and it expected to perform favourably through the salient loading scenarios however considering the structure is adjacent to the Surgical ICU (ICU B) & Operating Theatres 6-7 Structure even sharing a common wall it is recommended that rectification of the deep-rooted defect of the Surgical ICU (ICU B) & Operating Theatres 6-7 structure be addressed prior to consideration of the use of Ward 1. As a discrete item, the weatherproofing to the Ward 1 roof slab requires remediation as the condition is poor and evidence of ponding was observed at the roof level.

Specialty Wards

This building's structure and slab roof seem to be in fairly good condition overall and is therefore worthy of consideration for the installation of solar panels under the EMEP. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Psychiatry Ward

This building's structure and slab roof seem to be in fairly good condition overall and is therefore worthy of consideration for the installation of solar panels under the EMEP. Discussions with the facility personnel will be required regarding planning for the one storey roof section, as there appears to be plans to add more floors to one section. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Accident & Emergency

This building's structure and slab roof seem to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. This building is worthy of consideration for the installation of solar panels under the EMEP. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Minor Operations & Day Surgery

This building's structure and slab roof that seemed to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. Isolated instances of spalling of concrete from the underside of the roof slab was also identified which would suggest water intrusion. Both for the aesthetics and to mitigate against future compromise to the structural integrity, the cracking and spalling should be addressed using appropriate localized concrete repair products and methodologies. Notwithstanding the above, the structure is worthy of consideration for the installation of solar panels. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Pharmacy

This building's structure and slab roof seem to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. This building is worthy of consideration for the installation of solar panels under the EMEP. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

E.N.T & Orthopaedics

This building's structure and slab roof seem to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. The main roof area of the building is worthy of consideration for the installation of solar panels under the EMEP. The roof of the skylight section should not be considered for installation of solar panels. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

X Ray/Catheterization/Ultrasound

Of the many varying types of roofs of which this building is comprised, all sections were practically considered. The sections which are anticipated to perform adequately structurally, are all the concrete slab sections. The upper level, however, would require a slightly more proprietary approach as the roof's surface is not completely flat accounting for the upstanding beams. Should this roof be considered it is recommended that the solar PV system be mounted such that it spans

across the upstands and be coordinated such that the waterproofing membrane is not compromised. Remedial work required for the weathering of the waterproofing membrane should be carried out prior to installation of solar panels in that area. Subject to these considerations, this roof may be favourably considered for the installation of Solar PV Panels under the EMEP. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Wards 1-8

Of the varying types of roofs of which this set of buildings is comprised, many of the sections were practically or otherwise precluded. The roofs which are anticipated to perform adequately structurally are the concrete slab roofs of Wards 3, 4, 7 and 8 only. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. Subject to these considerations this roof may be favourably considered for the installation of Solar PV Panels under the EMEP. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Administration

This building's structure and slab roof that seemed to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. Isolated instances of spalling of concrete from the underside of the roof slab was also identified which would suggest water intrusion, this in addition to water marks on the suspended ceiling. Both for the aesthetics and to mitigate against future compromise to the structural integrity, the cracking and spalling should be addressed using appropriate localized concrete repair products and methodologies. Notwithstanding the above, the structure is worthy of consideration for the installation of solar panels. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Ward 11 & 12

This building's structure and slab roof that seemed to be in fairly good condition. Isolated cracks were identified throughout the structure which though do not appear to be of structural significance these should be monitored and arrested. Both for the aesthetics and to mitigate against future compromise to the structural integrity, the cracking observed should be addressed

using appropriate localized concrete repair products and methodologies. Notwithstanding the above, the concrete roof slab is worthy of consideration for the installation of solar panels. The timber framed roof section should not be considered given its inability to bear additional weight from solar panels with its current construction. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Labour Ward

This building's structure and slab roof that seemed to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. Peeling observed on the soffit of the roof slab show water intrusion. Both for the aesthetics and to mitigate against future compromise to the structural integrity, the cracking and peeling should be addressed using appropriate localized concrete repair products and methodologies. Notwithstanding the above, the structure is worthy of consideration for the installation of solar panels. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Microbiology/Pathology

This building's structure and slab roof that seemed to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. Isolated instances of spalling of concrete from the underside of the roof slab was also identified which would suggest water intrusion. Both for the aesthetics and to mitigate against future compromise to the structural integrity, the cracking and spalling should be addressed using appropriate localized concrete repair products and methodologies. Notwithstanding the above, the concrete slab is worthy of consideration for the installation of solar panels. However, it should be noted that the Labour Ward located to the west of this roof is a higher building which may cause a shadow over this roof slab at certain times. The timber framed sections of the roof should not be considered for installation of solar panels as their construction would not be able to uphold additional weight from the panels. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

Paediatric Wards

This roofing element of this structure showed advance signs of deterioration which precluded the structure from further structural consideration. This structure is not recommended for the installation of Solar PV Panels under the EMEP.

Medical Library

This building's structure and slab roof that seemed to be in fairly good condition. Isolated hairline cracks were identified throughout the structure which though do not yet appear to be of structural significance these should be monitored and arrested. Should this roof be considered it is recommended that the solar PV system be mounted such that it spans across the upstands and be coordinated such that the waterproofing membrane is not compromised. Notwithstanding the above, the structure is worthy of consideration for the installation of solar panels. Considering the variability of PV equipment available on the market, restraining the combined weight of the racking, cables and ballasts (where applicable) do not exceed 8 lb/ft^2 (39 kg/m2) the mounting type and configuration is at the discretion of the design/implementation entity.

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Appendix A – Photos

Tony Thwaites Private Wing

Image 20: Showing Tony Thwaites Private Wing Building.

Image 21: Tony Thwaites Private Wing Building Roof.

ICU A

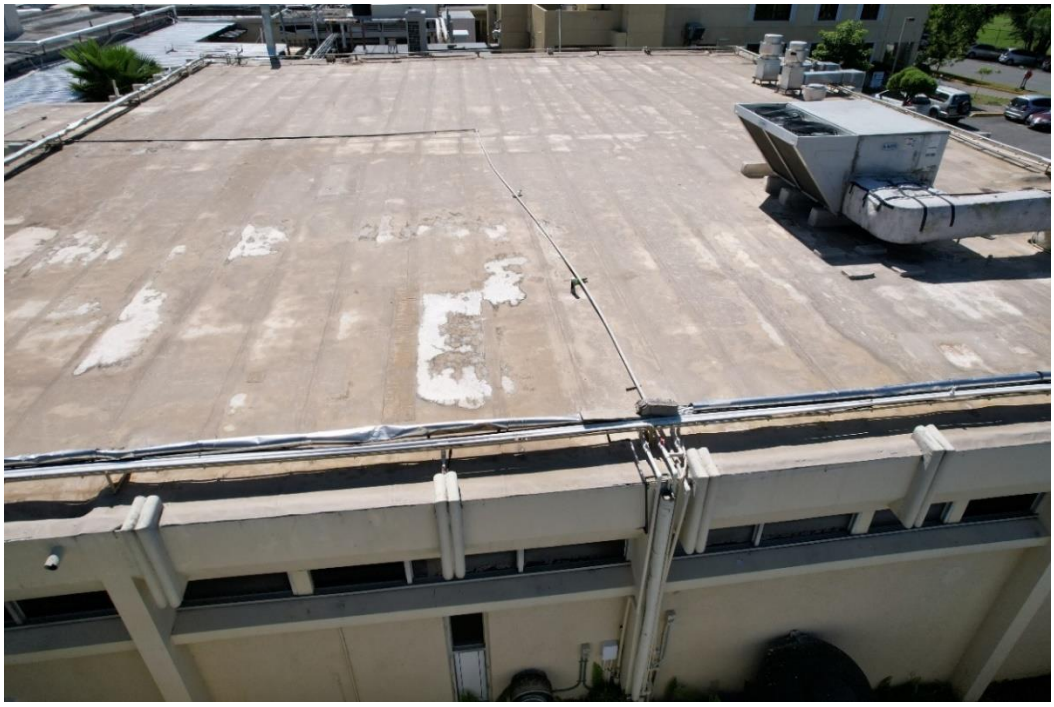


Image 22: Showing ICU A roof.

Image 23: Showing ICU A Roof

Image 24: Showing ICU A Roof Slab Soffit

Operating Theatres 1-5

Image 25: Showing Operating Theatre 1-5 Roof

Image 26: Showing Operating Theatre 1-5 Walkway Soffit

Image 27: Along external facade of Operating Theatres 1-5

Image 28: Showing Operating Theatre Roof

Image 29: Showing Operating Theatre 1-5 Ceiling.

Surgical ICU (ICU B) & Operating Theatre 6-7

Image 30: Inside of ICU B

Image 31: Showing Damage to the ceiling of ICU B.

Image 32: Showing ICU B roof

Speciality Wards

Image 33: Showing Specialty Ward Roof

Image 34: Showing Specialty Wards

Image 35: Showing Speciality Wards

Psychiatry Ward

Image 36: Showing Psychiatry Ward

Image 37: Showing Psychiatry Ward Roof

Image 38: Showing Psychiatry Ward Roof

Accident & Emergency

Image 39: Showing Accident and Emergency Roof

Image 40: Showing Accident and Emergency Roof

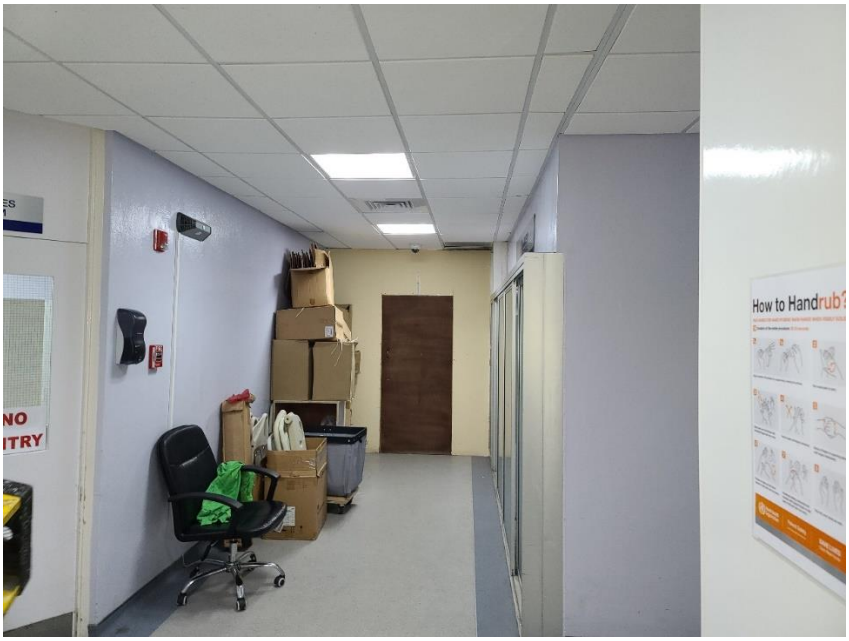


Image 41: Showing Accident and Emergency Ceiling.

Image 42: Showing Accident and Emergency Roof

Minor Operations

Image 43: Showing Minor Operations Roof

Image 44: Showing Minor Operations Soffit showing peeling.

Image 45: Showing Minor Operations Soffit.

Pharmacy

Image 46: Showing the Pharmacy roof

Image 47: Showing the Pharmacy Roof

Image 48: Showing the Pharmacy Roof

Image 49: Showing the Pharmacy Roof

E.N.T and Orthopaedics

Image 50: Showing E.N.T. & Orthopaedic Roof

Image 51: E.N.T & Orthopaedic Roof

X Ray/Catheterization/ Ultrasound

Image 52: Showing X-Ray Roof

Image 53: Showing X-Ray Roof

Image 54: Showing X-Ray Soffit

Image 55: Showing Crack in Wall at X-Ray

Image 56: Showing X-Ray Soffit

Wards 1-8

Image 57: Showing Wards 1-8

Image 58: Showing Wards 1-8 Roof

Image 59: Showing Wards 1-8 Roof

Image 60: Showing Wards 1-8 Roof

Administration

Image 61: Showing Administration Building Roof

Image 62: Showing Administration Soffit

Image 63: Showing signs of leakage in Administration Building Ceiling

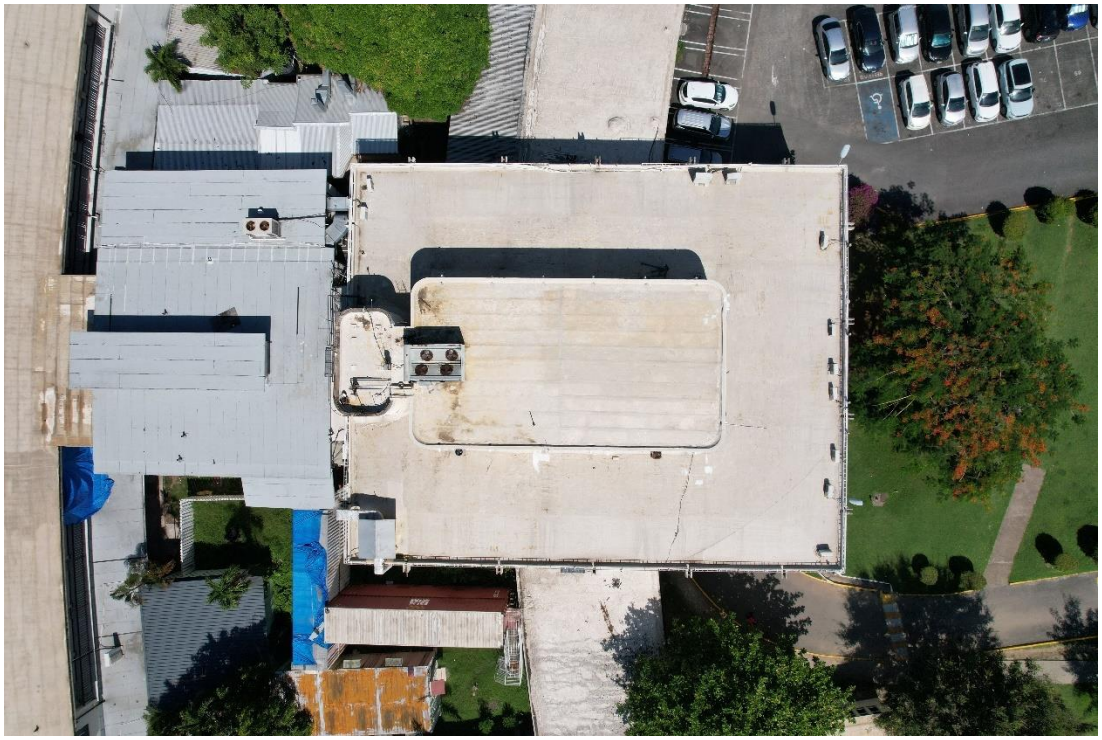


Image 64: Showing Administration building Roof

Image 65: Showing Administration building

Wards 11 & 12

Image 66: Showing Wards 11 & 12 Soffit

Image 67: Showing Wards 11 & 12 Soffit

Image 68: Showing Wards 11 & 12 Soffit

Image 69: Showing Wards 11 & 12

Image 70: Showing Wards 11 & 12 Roof

Labour Ward

Image 71: Showing Labour Ward Roof

Image 72: Showing Damaged Soffit at Labour Ward

Image 73: Showing Labour Ward Roof.

Microbiology/ Pathology

Image 74: Showing Microbiology/ Pathology

Image 75: Showing Microbiology/ Pathology Roof Slab

Image 76. Showing Microbiology/ Pathology

Image 77Showing Microbiology/ Pathology Roof

Paediatric Ward

Image 78: Showing Paediatric Ward

Image 79: Showing Paediatric Ward Roof

Medical Library

Image 80: Showing Medical Library Roof

Image 81: Showing Medical Library Roof

Appendix B – Supporting Information

Gmail

Michael Faulknor <michael.faulknor@gmail.com>

UHWI - MSET EMEP SIA Confirmations

Tue, Sep 14, 2021 at 12:54 PM

To: fitzgerald.mitchell@uhwi.gov.jm
Cc: lynden.williams@uhwi.gov.jm, Charles Koomson <chkoomson@mset.gov.jm>

Good Morning Mr. Mitchell,

As a follow up to the email sent earlier today requesting accommodation of a visit to the University Hospital of the West Indies (UHWI) toward conduction Structural Integrity Assessments (SIA's) on select building roofs.

In preparation for the site visit and also to assist the Ministry of Science, Energy and Technology (MSET) with making their final decisions on the best way(s) your facility may be included in as a part of the Energy Management and Efficiency Programme (EMEP). A, I would like to seek some confirmations. Kindly confirm:

1. The designations of the buildings in the attached graphic as correct and/or appropriate.
2. Any plans for further development of the buildings on the facility (attention drawn to the buildings called out in the attached graphic). This to include inter alia: expansion (vertically/horizontally), Rooftop Equipment (Water Tanks, Water Heaters, Air Conditioning, etc. or any plans to change or resurface any of the roofs.
3. The age of the buildings to the best of your knowledge, as well as whether different sections of the buildings were constructed at different times.
4. Whether the building shown signs of potential failure during past natural disasters (Hurricanes, Seismic Activity)?
5. Whether there is any area of the roof of the buildings that currently leaks during rainfall events?
6. Are any records kept for the structural maintenance of the buildings? If so, could these records kindly be made available?
7. Whether there been any repairs to cracks (taken as superficial or otherwise) throughout the maintenance of the facility that would now be obscured from view? If so, please assist us in identifying the location(s)?
8. Are there any Engineering drawings available for the buildings? If so, could they be kindly shared?

The responses to the above inquiries may me enclosed on the facility's letterhead and addressed to Mr. Koomson of the MSET and copied to myself for ease of reference. It would be of great help to the project's programme if these confirmations would be able to be made by September 17, 2021. Many thanks in advance for your assistance. Please do not hesitate to reach out should you require any further clarification

Kind Regards

Civil/Structural Engineer | Project Manager

"If you can't explain it simply, you don't understand it well enough."
~Albert Einstein

UHWI - Inquiry Graphic.pdf
6378K

Appendix C – Typical Calculations

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	1
STRUCTURE:	UHWI Hospital - Specialty Ward		
DONE BY:		CHECKED BY:	

Determination of Wind Loads on MWFRS Rooftop Equipment

				REFERENCE	
				ASCE 7-16	Chapter 29
Eave Height (h)	=	40	ft	Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft	Assumed	
Perpendicular distance between Rooftop and Panel Bottom (h_1)	=	1	ft	Assumed	
Perpendicular distance between Rooftop and Panel Top (h_2)	=	1.52	ft	Assumed	
Panel Chord Length (L_p)	=	6	ft	Assumed	
Roof Slope (θ)	=	0	°	Existing Conditions	
Panel angle of Tilt	=	5	°	Terms of Reference	
Mean Height (h)	=	40.5	ft	Existing Conditions	
Bulding Length (W_L)	=	183	ft		
Building Width (W_s)	=	39	ft		
Risk Category	=	III		ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85		ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C		ASCE 7-16	26.7.2
Exposure Category	=	C		ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1		ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1		ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94		ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph	Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$		ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2		
Υ_p	=	0.93		ASCE 7-16	29.4.3
Υ_c	=	0.96		ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5		ASCE 7-16	29.4.3
Effective Wind area (A)		7137	ft^2		
(L_b)		39	ft		
Normalized Wind Area (A_N)		4692			
$(GC_{rn})_{nom}$	=	0.1		ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$		ASCE 7-16	Eq 29.4-6
	=	0.13			
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$		ASCE 7-16	Eq 29.4-5
	=	6.72	lb/ft^2		

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	2
STRUCTURE:	UHWI Hospital - Specialty Ward		
DONE BY:		CHECKED BY:	

Determination of Wind Loads on MWFRS Rooftop Equipment

					REFERENCE	
					ASCE 7-16	Chapter 29
Eave Height (h)	=	40	ft		Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Bottom (h_1)	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Top (h_2)	=	2.04	ft		Assumed	
Panel Chord Length (L_p)	=	6	ft		Assumed	
Roof Slope (θ)	=	0	°		Existing Conditions	
Panel angle of Tilt	=	10	°		Terms of Reference	
Mean Height (h)	=	40.5	ft		Existing Conditions	
Bulding Length (W_L)	=	183	ft			
Building Width (W_s)	=	39	ft			
Risk Category	=	III			ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85			ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C			ASCE 7-16	26.7.2
Exposure Category	=	C			ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1			ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1			ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94			ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph		Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$			ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2			
Υ_p	=	0.93			ASCE 7-16	29.4.3
Υ_c	=	0.96			ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5			ASCE 7-16	29.4.3
Effective Wind area (A)		7137	ft^2			
(L_b)		39	ft			
Normalized Wind Area (A_N)		4692				
$(GC_{rn})_{nom}$	=	0.2			ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$			ASCE 7-16	Eq 29.4-6
	=	0.27				
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$			ASCE 7-16	Eq 29.4-5
	=	13.43	lb/ft^2			

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	3
STRUCTURE:	UHWI Hospital - Specialty Ward		
DONE BY:		CHECKED BY:	

Determination of Wind Loads on MWFRS Rooftop Equipment				REFERENCE	
				ASCE 7-16	Chapter 29
Eave Height (h)	=	40	ft	Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft	Assumed	
Perpendicular distance between Rooftop and Panel Bottom (h_1)	=	1	ft	Assumed	
Perpendicular distance between Rooftop and Panel Top (h_2)	=	2.55	ft	Assumed	
Panel Chord Length (L_p)	=	6	ft	Assumed	
Roof Slope (θ)	=	0	°	Existing Conditions	
Panel angle of Tilt	=	15	°	Terms of Reference	
Mean Height (h)	=	40.5	ft	Existing Conditions	
Bulding Length (W_L)	=	183	ft		
Building Width (W_s)	=	39	ft		
Risk Category	=	III		ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85		ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C		ASCE 7-16	26.7.2
Exposure Category	=	C		ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1		ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1		ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94		ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph	Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$		ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2		
Υ_p	=	0.93		ASCE 7-16	29.4.3
Υ_c	=	0.96		ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5		ASCE 7-16	29.4.3
Effective Wind area (A)		7137	ft^2		
(L_b)		39	ft		
Normalized Wind Area (A_N)		4692			
$(GC_{rn})_{nom}$	=	0.3		ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$		ASCE 7-16	Eq 29.4-6
	=	0.40			
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$		ASCE 7-16	Eq 29.4-5
	=	20.15	lb/ft^2		

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	4

STRUCTURE: UHWI Hospital - Specialty Ward

DONE BY: CHECKED BY:

Determination of Wind Loads on MWFRS Rooftop Equipment				REFERENCE	
				ASCE 7-16	Chapter 29
Eave Height (h)	=	40	ft	Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft	Assumed	
Perpendicular distance between	=	1	ft	Assumed	
Perpendicular distance between	=	3.05	ft	Assumed	
Panel Chord Length (L_p)	=	6	ft	Assumed	
Roof Slope (θ)	=	0	°	Existing Conditions	
Panel angle of Tilt	=	20	°	Terms of Reference	
Mean Height (h)	=	40.5	ft	Existing Conditions	
Bulding Length (W_L)	=	183	ft		
Building Width (W_s)	=	39	ft		
Risk Category	=	III		ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85		ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C		ASCE 7-16	26.7.2
Exposure Category	=	C		ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1		ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1		ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94		ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph	Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$		ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2		
Υ_p	=	0.93		ASCE 7-16	29.4.3
Υ_c	=	0.96		ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5		ASCE 7-16	29.4.3
Effective Wind area (A)		7137	ft^2		
(L_b)		39	ft		
Normalized Wind Area (A_N)		4692			
$(GC_{rn})_{nom}$	=	0.3		ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$		ASCE 7-16	Eq 29.4-6
	=	0.40			
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$		ASCE 7-16	Eq 29.4-5
	=	20.15	lb/ft^2		

CLIENT:	Ministry of Science Energy and Technology (MSET)	PUBLISHED DATE:	10/21/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	1
STRUCTURE:	UHWI Hospital - Specialty Ward		
DONE BY:		**CHECKED BY:**	

REFERENCE

Roof Slab Structural Analysis

Analysis undertaken to deduce the anticipated structural performance of the roofs at the above cpationed Facility. This towards identifying the capability of the roofs to accommodate Solar PhotoVoltaic Panels.

Design Material Properties

Concrete Cubic Compressive Strength (f'_c)	=	3,750	lb/in^2	263.65	kg/cm^2	Assumed
Concrete Cylindrical Compressive Strength (f'_c)	=	3,000	lb/in^2	210.92	kg/cm^2	
Steel Yield Strength (f_y)	=	40,000	lb/in^2	2,812.28	kg/cm^2	Assumed
Concrete Unit Weight (Υ_c)	=	150	lb/ft^3	2403	kg/m^3	Assumed

Slab Geometry

Overall Depth (h)	=	8.00	in	=	203	mm	Extg. Conditions
Clear Cover (c)	=	1.50	in	=	38	mm	Assumed
Reinforcing Bar	=	#6	=	0.75	in	=	19	mm	Assumed
Effective Depth (d)	=	6.13	in	=	156	mm	
Critical Span (l)	=	20.00	ft	=	6,096	mm	Extg. Conditions
Bar Spacing (s)	=	9.00	in	=	229	mm	Assumed
Resulting Area of Steel (A_s)	=	0.59	in^2/ft	=	1,242	mm2/m	Assumed

Slab Loading

Roof Live Load (L_r)	=	20	lb/ft^2	97.65	kg/m^2	ASCE 7-16 Table 4.3-1
Self Weight	=	100	lb/ft^2	488.24	kg/m^2	
Solar Panel System = Ballast	=	10	lb/ft^2	50.00	kg/m^2	
Total Dead Load (D)	=	110	lb/ft^2	538.24	kg/m^2	
Gross Wind Pressure	=	21	lb/ft^2	100.33	kg/m^2	Calculated
Maximum Anticipated Downward Wind Load (W)	=	20	lb/ft^2	96.92	kg/m^2	

Minimum allowable Area of Steel = = 0.3675 in^2/ft OKAY

Reinforcement Ratio (ρ) = A_s / bd = 0.0080

Strain (ϵ_t) = - 0.003 = 0.0174 where β_1 = 0.85

Coefficient of Resistance () = 0.2999 kip/in^2 RCD Aghayere Table A-7

CLIENT:	Ministry of Science Energy and Technology (MSET)	PUBLISHED DATE:	10/21/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	2
STRUCTURE:	UHWI Hospital - Specialty Ward		
DONE BY:		**CHECKED BY:**	

						REFERENCE
Practical Moment Strength (ϕM_n)	=	)	= 121.51	kip-in		
			= 10.13	kip-ft		
Design Load (W_u)	=		= 174.21	lb/ft^2	Scenario 1	ASCE 7-16 2.3.1 Eqn 3
			= 162.14	lb/ft^2	Scenario 2	ASCE 7-16 2.3.1 Eqn 4
Design Moment (M_u)	=		= 8710.69	lb-ft	Scenario 1	
			= 8.71	kip-ft	OKAY	
			= 8106.94	lb-ft	Scenario 2	
			= 8.11	kip-ft	OKAY	

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	1
STRUCTURE:	UHWI Hospital - Wards 11 & 12		
DONE BY:		CHECKED BY:	

					REFERENCE	
Determination of Wind Loads on MWFRS Rooftop Equipment					ASCE 7-16	Chapter 29
Eave Height (h)	=	20	ft		Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Bottom (h_1)	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Top (h_2)	=	1.52	ft		Assumed	
Panel Chord Length (L_p)	=	6	ft		Assumed	
Roof Slope (θ)	=	2	°		Existing Conditions	
Panel angle of Tilt	=	5	°		Terms of Reference	
Mean Height (h)	=	20.5	ft		Existing Conditions	
Bulding Length (W_L)	=	183	ft			
Building Width (W_s)	=	99	ft			
Risk Category	=	III			ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85			ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C			ASCE 7-16	26.7.2
Exposure Category	=	C			ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1			ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1			ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94			ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph		Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$			ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2			
Υ_p	=	0.95			ASCE 7-16	29.4.3
Υ_c	=	0.96			ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5			ASCE 7-16	29.4.3
Effective Wind area (A)		18117	ft^2			
(L_b)		20	ft			
Normalized Wind Area (A_N)		45293				
$(GC_{rn})_{nom}$	=	0.1			ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$			ASCE 7-16	Eq 29.4-6
	=	0.14				
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$			ASCE 7-16	Eq 29.4-5
	=	6.90	lb/ft^2			

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	2
STRUCTURE:	UHWI Hospital - Wards 11 & 12		
DONE BY:		CHECKED BY:	

					REFERENCE	
Determination of Wind Loads on MWFRS Rooftop Equipment					ASCE 7-16	Chapter 29
Eave Height (h)	=	20	ft		Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Bottom (h_1)	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Top (h_2)	=	2.04	ft		Assumed	
Panel Chord Length (L_p)	=	6	ft		Assumed	
Roof Slope (θ)	=	2	°		Existing Conditions	
Panel angle of Tilt	=	10	°		Terms of Reference	
Mean Height (h)	=	20.5	ft		Existing Conditions	
Bulding Length (W_L)	=	183	ft			
Building Width (W_s)	=	99	ft			
Risk Category	=	III			ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85			ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C			ASCE 7-16	26.7.2
Exposure Category	=	C			ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1			ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1			ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94			ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph		Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$			ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2			
Υ_p	=	0.95			ASCE 7-16	29.4.3
Υ_c	=	0.96			ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5			ASCE 7-16	29.4.3
Effective Wind area (A)		18117	ft^2			
(L_b)		20	ft			
Normalized Wind Area (A_N)		45293				
$(GC_{rn})_{nom}$	=	0.2			ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$			ASCE 7-16	Eq 29.4-6
	=	0.27				
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$			ASCE 7-16	Eq 29.4-5
	=	13.79	lb/ft^2			

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	3
STRUCTURE:	UHWI Hospital - Wards 11 & 12		
DONE BY:		CHECKED BY:	

					REFERENCE	
Determination of Wind Loads on MWFRS Rooftop Equipment					ASCE 7-16	Chapter 29
Eave Height (h)	=	20	ft		Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Bottom (h_1)	=	1	ft		Assumed	
Perpendicular distance between Rooftop and Panel Top (h_2)	=	2.55	ft		Assumed	
Panel Chord Length (L_p)	=	6	ft		Assumed	
Roof Slope (θ)	=	2	°		Existing Conditions	
Panel angle of Tilt	=	15	°		Terms of Reference	
Mean Height (h)	=	20.5	ft		Existing Conditions	
Bulding Length (W_L)	=	183	ft			
Building Width (W_s)	=	99	ft			
Risk Category	=	III			ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85			ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C			ASCE 7-16	26.7.2
Exposure Category	=	C			ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1			ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1			ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94			ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph		Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$			ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2			
Υ_p	=	0.95			ASCE 7-16	29.4.3
Υ_c	=	0.96			ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5			ASCE 7-16	29.4.3
Effective Wind area (A)		18117	ft^2			
(L_b)		20	ft			
Normalized Wind Area (A_N)		45293				
$(GC_{rn})_{nom}$	=	0.3			ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$			ASCE 7-16	Eq 29.4-6
	=	0.41				
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$			ASCE 7-16	Eq 29.4-5
	=	20.69	lb/ft^2			

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	4

STRUCTURE: UHWI Hospital - Wards 11 & 12

DONE BY: CHECKED BY:

Determination of Wind Loads on MWFRS Rooftop Equipment

				REFERENCE	
				ASCE 7-16	Chapter 29
Eave Height (h)	=	20	ft	Existing Conditions	
Eave to Panel Height (h_{pt})	=	1	ft	Assumed	
Perpendicular distance between	=	1	ft	Assumed	
Perpendicular distance between	=	3.05	ft	Assumed	
Panel Chord Length (L_p)	=	6	ft	Assumed	
Roof Slope (θ)	=	2	°	Existing Conditions	
Panel angle of Tilt	=	20	°	Terms of Reference	
Mean Height (h)	=	20.5	ft	Existing Conditions	
Bulding Length (W_L)	=	183	ft		
Building Width (W_s)	=	99	ft		
Risk Category	=	III		ASCE 7-16	Table 1.5-1
Wind Directionality Factor (K_d)	=	0.85		ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	C		ASCE 7-16	26.7.2
Exposure Category	=	C		ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1		ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1		ASCE 7-16	Table 26.9-1
Velocity Pressure Co-Efficient (K_z)	=	0.94		ASCE 7-16	Table 26.10-1
Basic Wind Speed (V)	=	157	mph	Terms of Reference	
Velocity Pressure (q_h)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$		ASCE 7-16	Eq 26.10-1
	=	50.42	lb/ft^2		
Υ_p	=	0.95		ASCE 7-16	29.4.3
Υ_c	=	0.96		ASCE 7-16	29.4.3
Array edge factor (Υ_E)	=	1.5		ASCE 7-16	29.4.3
Effective Wind area (A)		18117	ft^2		
(L_b)		20	ft		
Normalized Wind Area (A_N)		45293			
$(GC_{rn})_{nom}$	=	0.3		ASCE 7-16	FIG. 29.4-7
Net Pressure Coefficient (GC_{rn})	=	$(\Upsilon_p)\ (\Upsilon_c)\ (\Upsilon_E)\ (GC_{rn})_{nom}$		ASCE 7-16	Eq 29.4-6
	=	0.41			
Design Panel Wind Pressure (p)	=	$q_h\ (GC_{rn})$		ASCE 7-16	Eq 29.4-5
	=	20.69	lb/ft^2		

CLIENT:	Ministry of Science Energy and Technology (MSET)	PUBLISHED DATE:	10/21/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	1
STRUCTURE:	UHWI Hospital - Wards 11 & 12		
DONE BY:		**CHECKED BY:**	

Roof Slab Structural Analysis

Analysis undertaken to deduce the anticipated structural performance of the roofs at the above cpationed Facility. This towards identifying the capability of the roofs to accommodate Solar PhotoVoltaic Panels.

Design Material Properties

							REFERENCE
Concrete Cubic Compressive Strength (f'_c)	=	3,750	lb/in^2	263.65	kg/cm^2		Assumed
Concrete Cylindrical Compressive Strength (f'_c)	=	3,000	lb/in^2	210.92	kg/cm^2		
Steel Yield Strength (f_y)	=	40,000	lb/in^2	2,812.28	kg/cm^2		Assumed
Concrete Unit Weight (Υ_c)	=	150	lb/ft^3	2403	kg/m^3		Assumed

Slab Geometry

Overall Depth (h)	=	4.00	in	=	102	mm			Extg. Conditions
Clear Cover (c)	=	1.50	in	=	38	mm			Assumed
Reinforcing Bar	=	#4	=	0.50	in	=	13	mm	Assumed
Effective Depth (d)	=	2.25	in	=	57	mm			
Critical Span (l)	=	10.00	ft	=	3,048	mm			Extg. Conditions
Bar Spacing (s)	=	9.00	in	=	229	mm			Assumed
Resulting Area of Steel (A_s)	=	0.27	in^2/ft	=	564	mm2/m			Assumed

Slab Loading

Roof Live Load (L_r)	=	20	lb/ft^2	97.65	kg/m^2			ASCE 7-16 Table 4.3-1
Self Weight	=	50	lb/ft^2	244.12	kg/m^2			
Solar Panel System = Ballast	=	10	lb/ft^2	50.00	kg/m^2			
Total Dead Load (D)	=	60	lb/ft^2	294.12	kg/m^2			
Gross Wind Pressure	=	21	lb/ft^2	100.33	kg/m^2			Calculated
Maximum Anticipated Downward Wind Load (W)	=	20	lb/ft^2	96.92	kg/m^2			

Minimum allowable Area of Steel	=	=	0.135	in^2/ft	OKAY		
Reinforcement Ratio (ρ)	=	A_s / bd	=	0.0099			
Strain (ϵ_t)	=	- 0.003	=	0.0135	where β_1 =	0.85	
Coefficient of Resistance ()			=	0.4053	kip/in^2		RCD Aghayere Table A-7

CLIENT:	Ministry of Science Energy and Technology (MSET)	PUBLISHED DATE:	10/21/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	2
STRUCTURE:	UHWI Hospital - Wards 11 & 12		
DONE BY:		**CHECKED BY:**	

						REFERENCE
Practical Moment Strength (ϕM_n)	=	)	= 22.16	kip-in		
			= 1.85	kip-ft		
Design Load (W_u)	=		= 114.21	lb/ft^2	Scenario 1	ASCE 7-16 2.3.1 Eqn 3
			= 102.14	lb/ft^2	Scenario 2	ASCE 7-16 2.3.1 Eqn 4
Design Moment (M_u)	=		= 1427.67	lb-ft	Scenario 1	
			= 1.43	kip-ft	OKAY	
			= 1276.73	lb-ft	Scenario 2	
			= 1.28	kip-ft	OKAY	

CLIENT:	Ministry of Science Energy and Technology (MSET)	DATE PUBLISHED :	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	1
STRUCTURE:	UHWI Hospital - X-RAY		
DONE BY:		CHECKED BY:	

Determination of Wind Loads on MWFRS (Direction Method)

				REFERENCE	
				ASCE 7-16	Chapter 27.
Eave Height (z)	=	10	ft	Existing Conditions	
Roof Depth	=	3	ft	Existing Conditions	
Roof Slope (θ)	=	10	°	Existing Conditions	
Mean Height (h)	=	11.5	ft	Existing Conditions	
Bulding Length (W_L)	=	160	ft	Existing Conditions	
Building Width (W_s)	=	41	ft	Existing Conditions	
Risk Category	=	III		ASCE 7-16	Table 1.5-1
Basic Wind Speed (V)	=	157	mph	Terms of Reference	
Wind Directionality Factor (K_d)	=	0.85		ASCE 7-16	Table 26.6-1
Surface Roughness Cat.	=	B		ASCE 7-16	26.7.2
Exposure Category	=	B		ASCE 7-16	26.7.3
Topographic Factor (K_{zt})	=	1		ASCE 7-16	26.8
Ground Elevation Factor (K_e)	=	1		ASCE 7-16	Table 26.9-1
Gust Effect Factor (G)	=	0.85		ASCE 7-16	26.11
Enclosure Classification	=	Partially Enclosed		ASCE 7-16	26.12
Internal Pressure Coefficient (GC_{pi})	=	0.55	+/-	ASCE 7-16	Table 26.13-1
Velocity Pressure Co-Efficient (K_z)	=	0.57		ASCE 7-16	Table 26.10-1
Velocity Pressure (q_z)	=	$0.00256\ K_z\ K_{zt}\ K_d\ K_e\ V^2$		ASCE 7-16	Eq 26.10-1
	=	30.57	lb/ft^2		
h/L (Wind normal to Ridge)	=	0.07		ASCE 7-16	Fig. 27.3-1
h/L (Wind parallel to Ridge)	=	0.28		ASCE 7-16	Fig. 27.3-1
Roof Pressure Coefficient (C_p) -> Normal to Ridge	=	-0.7		ASCE 7-16	Fig. 27.3-1
Roof Pressure Coefficient (C_p) -> Parallel to Ridge	=	-0.9		ASCE 7-16	Fig. 27.3-1
Design Wind Pressure (p)	=	$q_z\,(GC_p) - q_i\,(GC_{pi})$		ASCE 7-16	Eq 27.3-1

N.B. Due to the dynmaic nature of the internal pressure, the internal presure compenent of this formula is ommitted.

p (Normal to ridge)	=	-18.19	lb/ft^2
p (Parallel to ridge)		-23.39	lb/ft^2

CLIENT:	Ministry of Science Energy and Technology (MSET)	PUBLISHED DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	1
STRUCTURE:	UHWI Hospital - X-RAY		
DONE BY		CHECKED BY:	

Analysis of Simply Supported Timber Rafter

REFERENCE

Codes of Reference

American Wood Council National Design Specification for Wood Construction (AWC 2015)
American Society of Civil Engineers (ASCE 7-16)
Centennial Edition Wood Handbook (WH)
American Wood Council NDS Supplement 2018 (AWC Supp)

Design Material Properties

Maximum Fibre Stress (F_B)	=	2,350	lb/in^2	=	165	kg/cm^2	AWC Supp Table 5-7
Timber Unit Weight Unit Weight (Y_t)	=	60	lb/ft^3	=	4	kg/cm^2	
Modulus of Elasticity (E)	=	1,800,000	lb/in^2	=	111,600	kg/m^3	AWC Supp Table 4B
Shear Stress ($\delta_{allowable}$)	=	175	lb/in^2	=	12	kg/cm^2	

Loading

Tributary Width (T_w)	=	1.50	ft	=	0.46	m	
Roof Self Weight	=	10.00	lb/ft^2	=	48.80	kg/m^2	
Solar Panel System Weight	=	4.00	lb/ft^2	=	19.52	kg/m^2	
Total Dead Load (D)	=	14.00	lb/ft^2	=	68.32	kg/m^2	
Live Load (L)	=	20.00	lb/ft^2	=	97.60	kg/m^2	
Wind Load (W)	=	-23.39	lb/ft^2	=	-114.14	kg/m^2	
Dead Load (D)	=	21	lb/ft	=	102.71	kg/m	
Live Load (L)	=	30	lb/ft	=	146.73	kg/m	
Wind Load (W)	=	-35	lb/ft	=	-171.60	kg/m	
Span (l)	=	24	ft	=	7.16	m	AWC 2015 3.2.1
Design Load (W_u) = $1.2D + 1.6\,Lr + 0.5W$	=	55.78	lb/ft	=	272.21	kg/m	
$1.2D + 1.0W + L + 0.5\,Lr$	=	5.13	lb/ft	=	25.02	kg/m	

Flexural Analysis

Design Moment (M_u) = $W_u l^2/8$	=	3,850.64	lb-ft	=	532.37072	kg-m	
	=	46,207.74	lb-in				
Design tension stress (F'$_t$)	=	$\varphi K_F \lambda F_t C_M C_t C_r$ (glulam)					
	=	$\varphi K_F \lambda F_t C_M C_t C_f C_i C_r$ (sawn lumber)					

CLIENT:	Ministry of Science Energy and Technology (MSET)	PUBLISHED DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	2
STRUCTURE:	UHWI Hospital - X-RAY		
DONE BY:		CHECKED BY:	

						REFERENCE	
Load duration factor (C_D) =	0.90			(ASD Only)		AWC 2015	Table 2.3.2
Wet service or moisture factor (C_M) =	1.00					AWC Supp	Table 4D
Size factor (C_F) =	1.00					AWC Supp	Table 4D
C_{fu} = Flat-use factor	N/A					AWC 2015	
C_t = Temperature factor	1.00					AWC 2015	Table 2.3.3
C_r = Repetitive member factor	1.15					AWC Supp	Table 4A
C_i = Incising factor	0.80					AWC 2015	Table 4.3.8
C_P = Column stability factor	N/A					AWC 2015	
C_L = Beam stability factor	1.00					AWC 2015	3.3.3.3
C_V = Volume factor (applies only to glulam)	N/A					AWC 2015	
C_b = Bearing area factor						AWC 2015	Table 3.10.4
C_c = Curvature factor						AWC 2015	
Time Effect Factor (λ)	0.70					AWC 2015	App.4 N.3.3
Resistance Factor (ϕ)	0.85					AWC 2015	Table 2.3.6
Format Conversion Factor (K_F)	2.54					AWC 2015	Table 2.3.5
Member Type	Sawn Lumber						

Adjusted Maximum Fibre Stress (F'_b) = 2841.24 lb/in^2

Required Section Modulus (Z_{req}) = M_u / F'_t

= 16.26 in^3

Section Geometry

Width (b)	=	2	in	=	5.08	cm
Depth (d)	=	8	in	=	20.32	cm

Actual Section Modulus (Z_{actual}) = $bd^2/6$

= 21.33 in^3 349.59 kg^3

AWC Supp Table 1B

AWC 2015 Eqn 3.3-4

Section Modulus Pass

Shear Check

Max shear (V_{max}) = $wl/2$

= 655.43 lb 297.29731 kg

Shear Stress (δ) = $3V/2A$

= 61.45 lb 27.871623 kg

Shear Capacity Passed

CLIENT:	Ministry of Science Energy and Technology (MSET)	PUBLISHED DATE:	10/28/2021
PROJECT:	SIA at 27 Gov't Facilities	SHEET NO:	3
STRUCTURE:	UHWI Hospital - X-RAY		
DONE BY:		CHECKED BY:	

Deflection Check	REFERENCE

Max allowable deflection for the combined application of dead and live loads is l/240

$$\delta_{alllowable} = {}^{l}/_{240}$$

= 0.10 ft

= 1.18 in = 2.98 cm

$$\delta\ max = -\frac{5}{384} \times \frac{WL^4}{EI}$$

where; $I = bd^3/12$

= 85.33 in^4 = 3551.8415 cm^4

$\delta\ max =$ 5.69 in = 14.45 cm

Deflection Exceeds Limits (Please Check)

Appendix D – Drawings

University Hospital of the West Indies Inquiry Graphic

This graphic was prepared as a reference document to be used to seek confirmations from the salient facility personnel on important factors that as it relates to the site's selection under the Ministry of Science Energy and Technology (MSET) Energy Management and Efficiancy Program (EMEP)

Legend

- Ambulatory Care, Minor Operation, A&E & Pharmacy
- Assesments, Administration & Registration
- Medical Library
- Mona Primary School
- Operating Theatres 1-5, Central Sterilising Dept & ICU
- Orthapeadic Clinic, Outpatients & ENT
- Pathology
- Psychiatry Ward
- Theatres 6&7 & ICU
- Tony Thwaite's Wing
- Tropical Metabolism Unit
- UHWI Hospital
- Ward
- Wards 17-20
- Wards 1-8
- Wards 9-1 & Family Planning Unit

Site Plan
N.T.S.

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE
-	- - - - -	- - - - -

SHEET TITLE

NINTH GRADE BLOCK - ROOF LAYOUT

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

-LCX BERNARD PE, PMP

PROJECT NAME

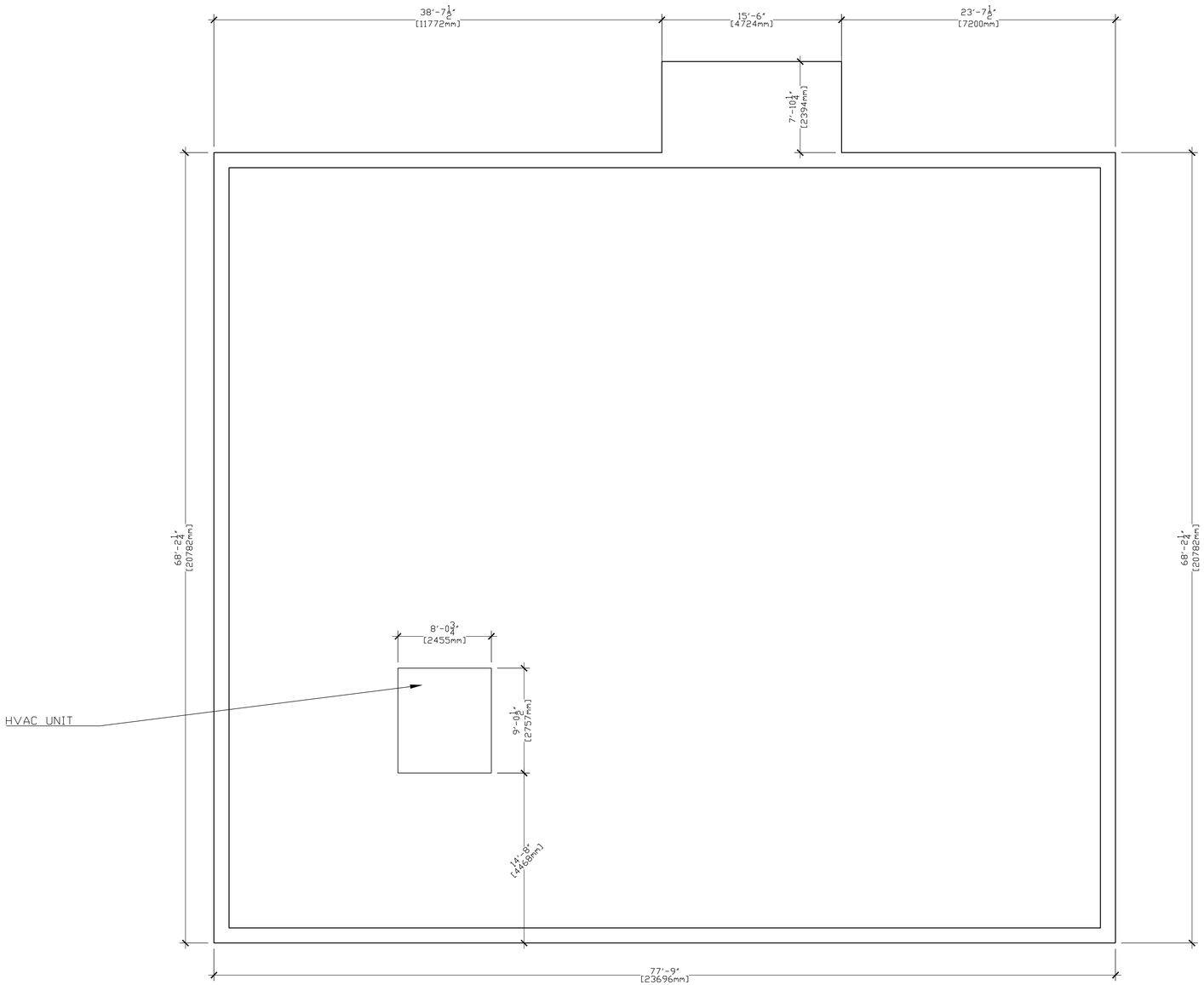
SIA @ 27 GOV'T FACILITIES

UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
2018-02	PLANNING
SCALE	DATE
AS NOTED	Aug 2021

SHEET NUMBER

02



ICU A
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE
ICU A - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

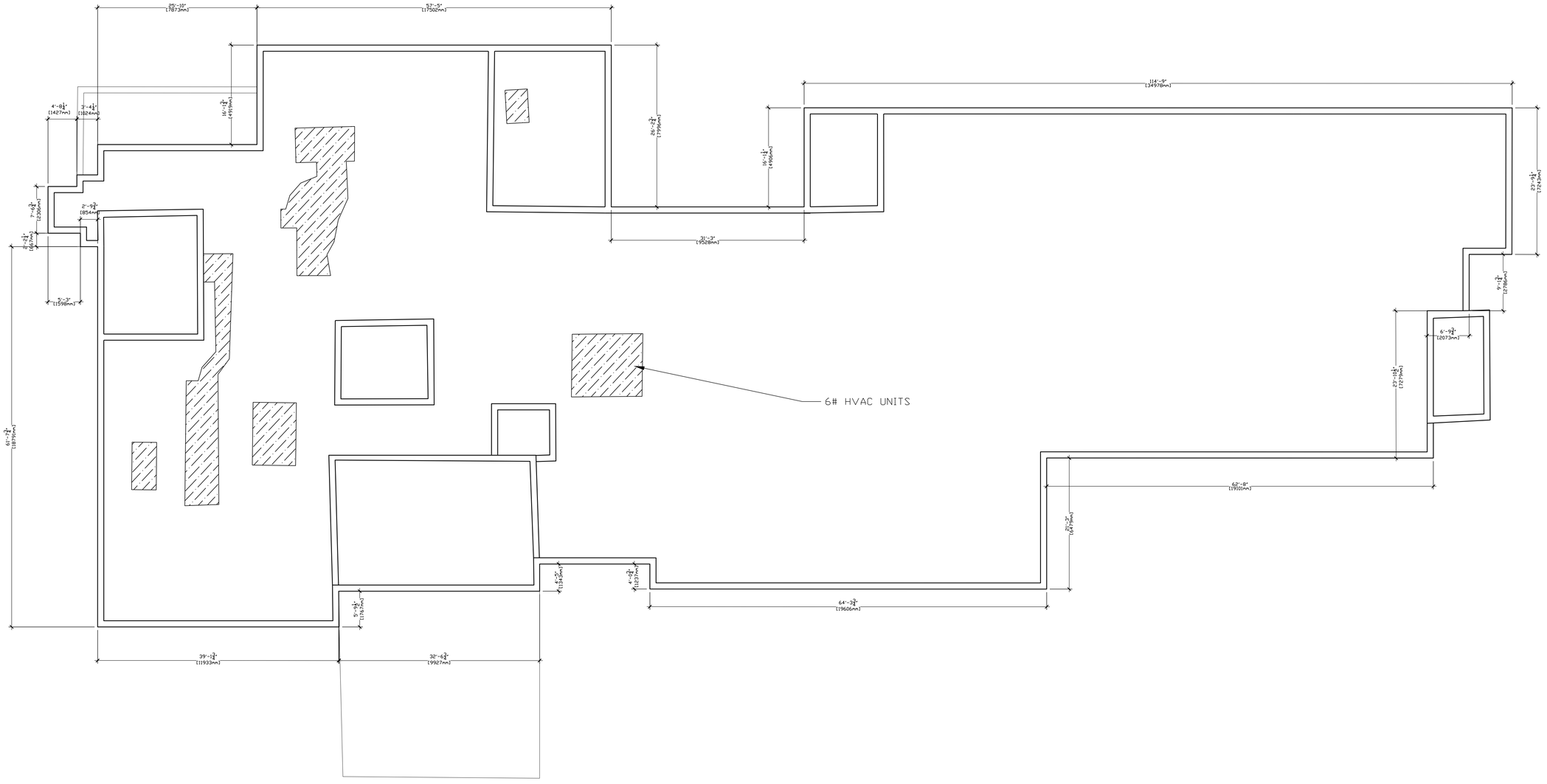
ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
21-02	PLANNING
SCALE	DATE
AS NOTED	Oct 2021

SHEET NUMBER
02



Tony Thwaites Wing
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

TONY THWAITE'S WING - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

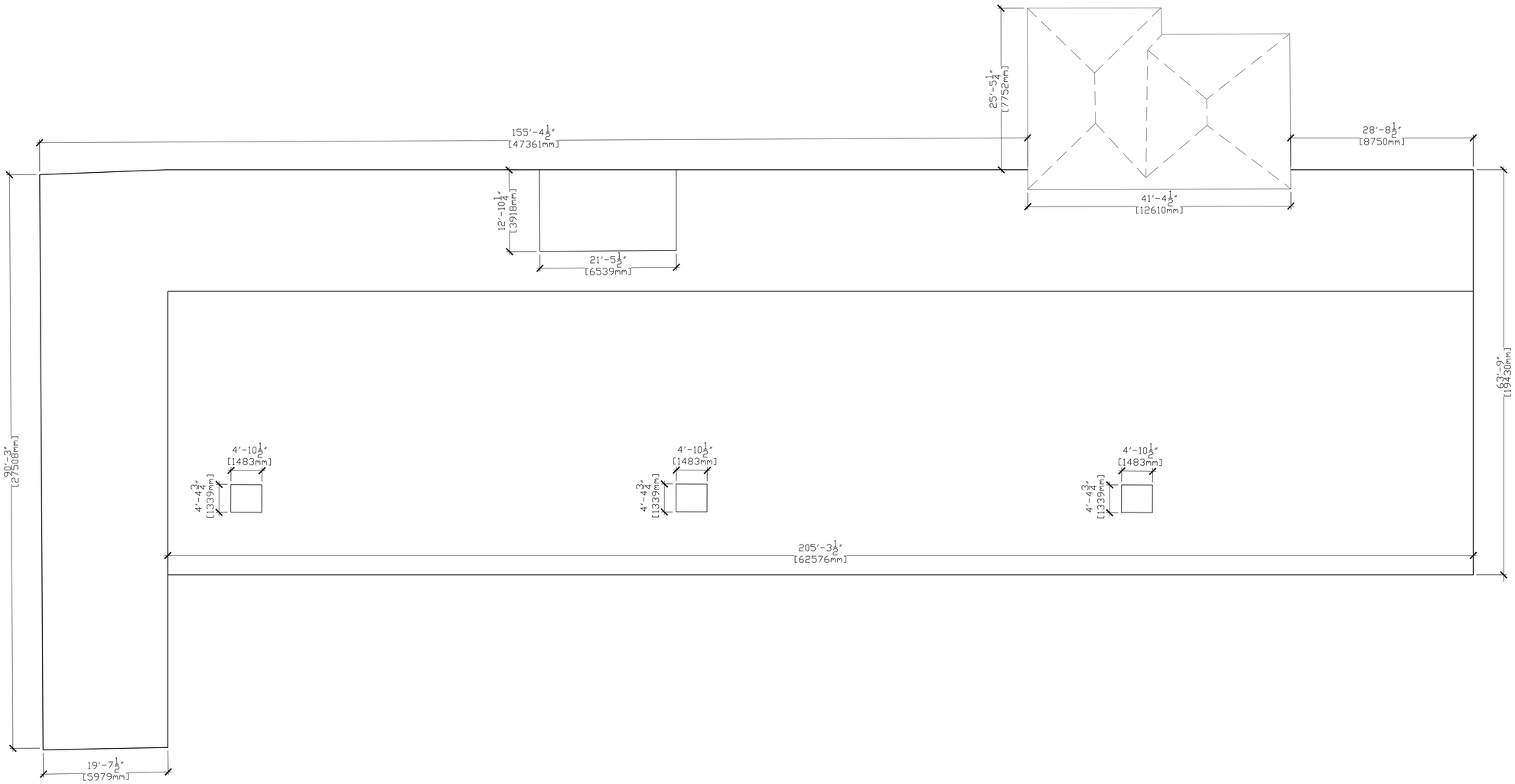
PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
21-02	PLANNING
SCALE	**DATE**
AS NOTED	Oct 2021

SHEET NUMBER

03



OPERATING THEATRES 1-5
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE
-	- - - -	- - - -

SHEET TITLE
OPERATING THEATRES 1-5 - ROOF LAYOUTS

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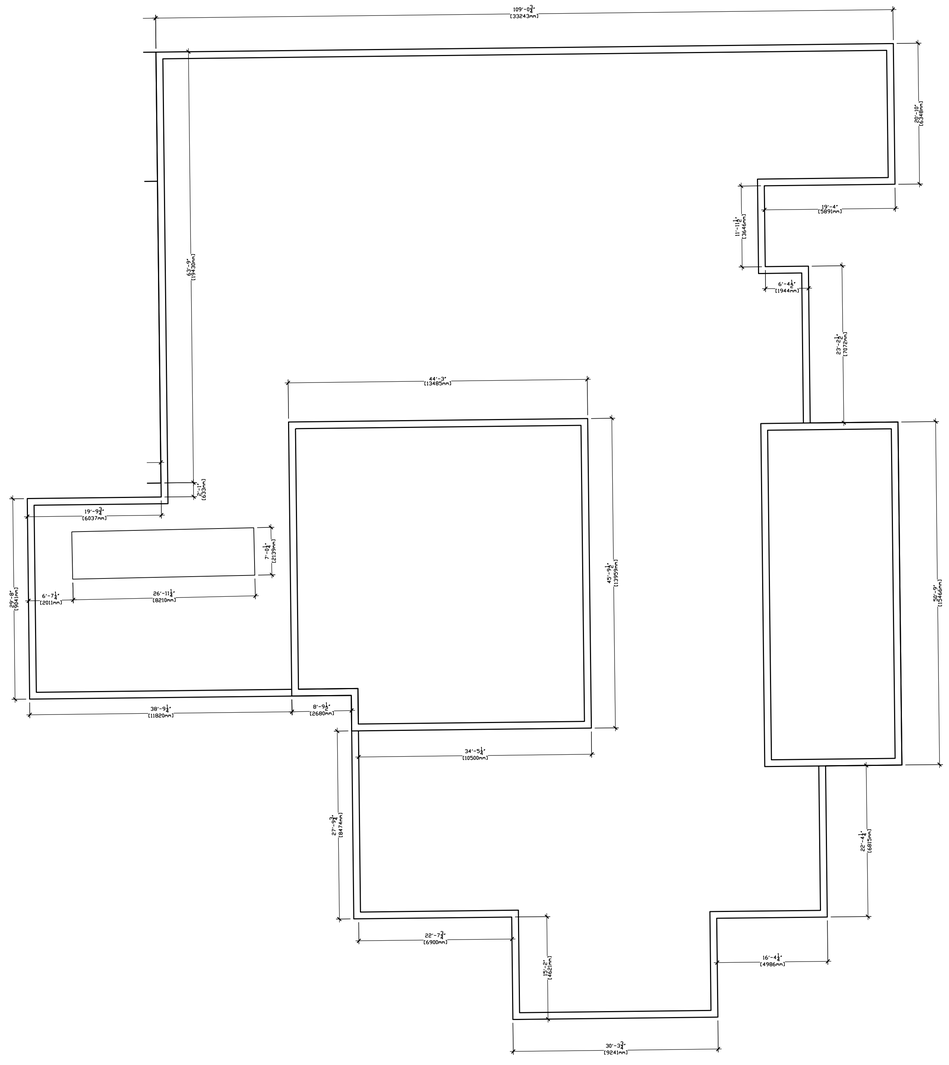
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS
ALEX BERNARD PE, PMP

PROJECT NAME
SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
21-02	PLANNING
SCALE	**DATE**
AS NOTED	Oct 2021

SHEET NUMBER
04



SURGICAL ICU (ICU B)
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

ICU B - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

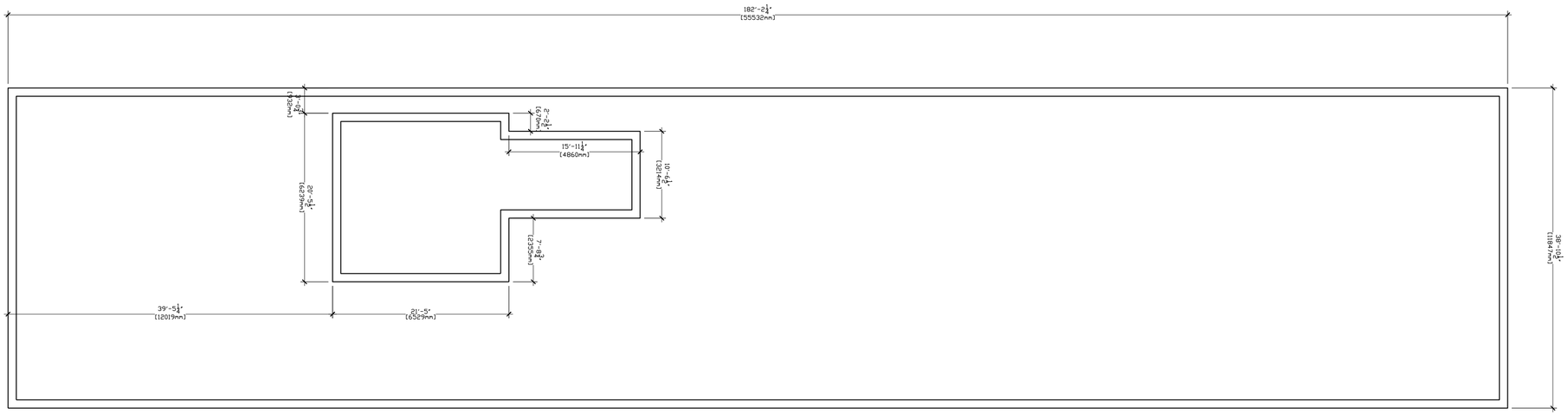
PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
21-02	PLANNING
SCALE	**DATE**
AS NOTED	Oct 2021

SHEET NUMBER

05



SPECIALTY WARDS
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

SPECIALTY WARDS - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

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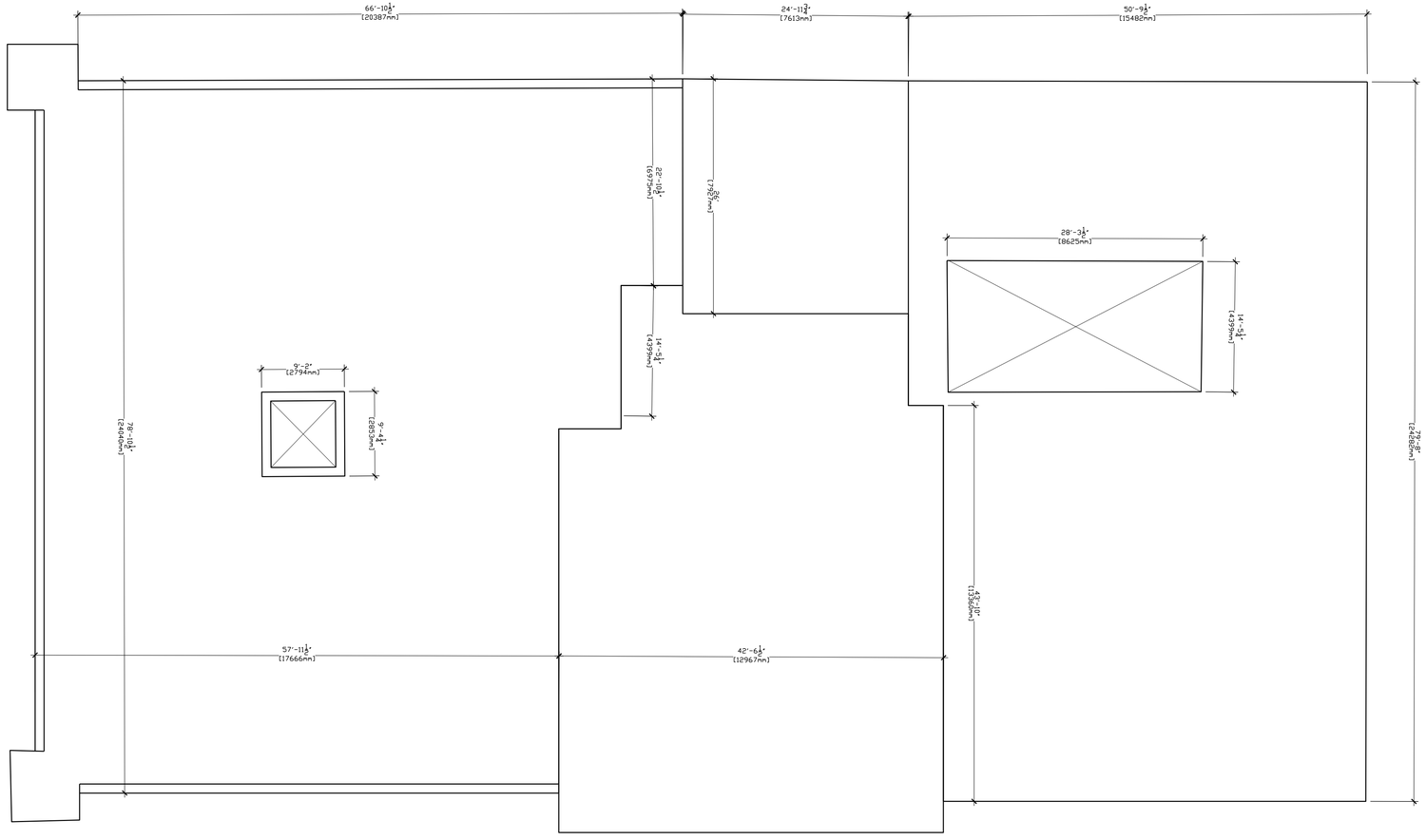
SHEET NUMBER

06



PSYCHIATRY WARD (WARD 21)
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

PSYCHIATRY WARD - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

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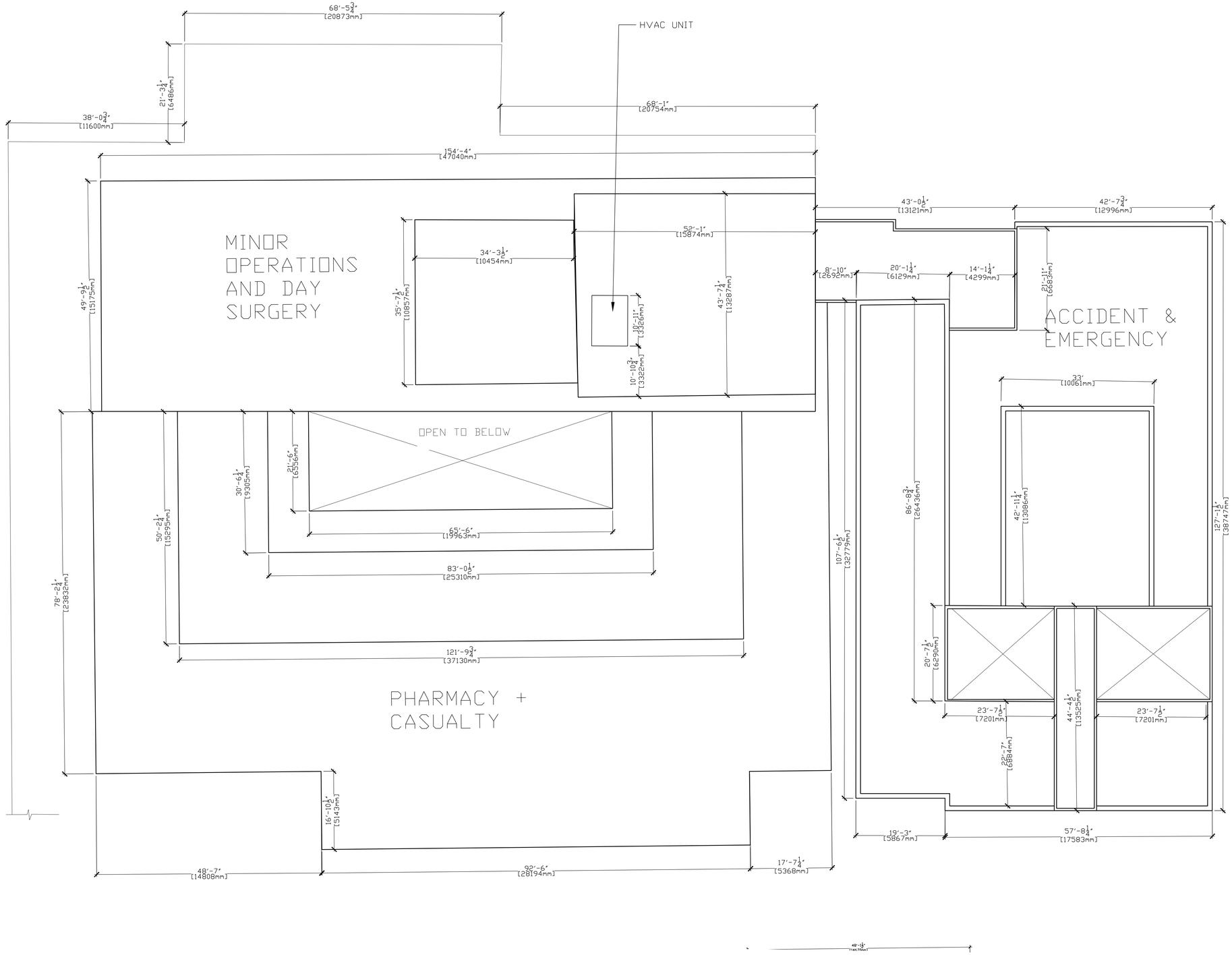
SHEET NUMBER

07



MINOR OPERATIONS, ACCIDENT & EMERGENCY AND PHARMACY
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE
MINOR OPS./A&E/PHARMACY -ROOF LAYOUT

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS
ALEX BERNARD PE, PMP

PROJECT NAME
SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
21-02	PLANNING
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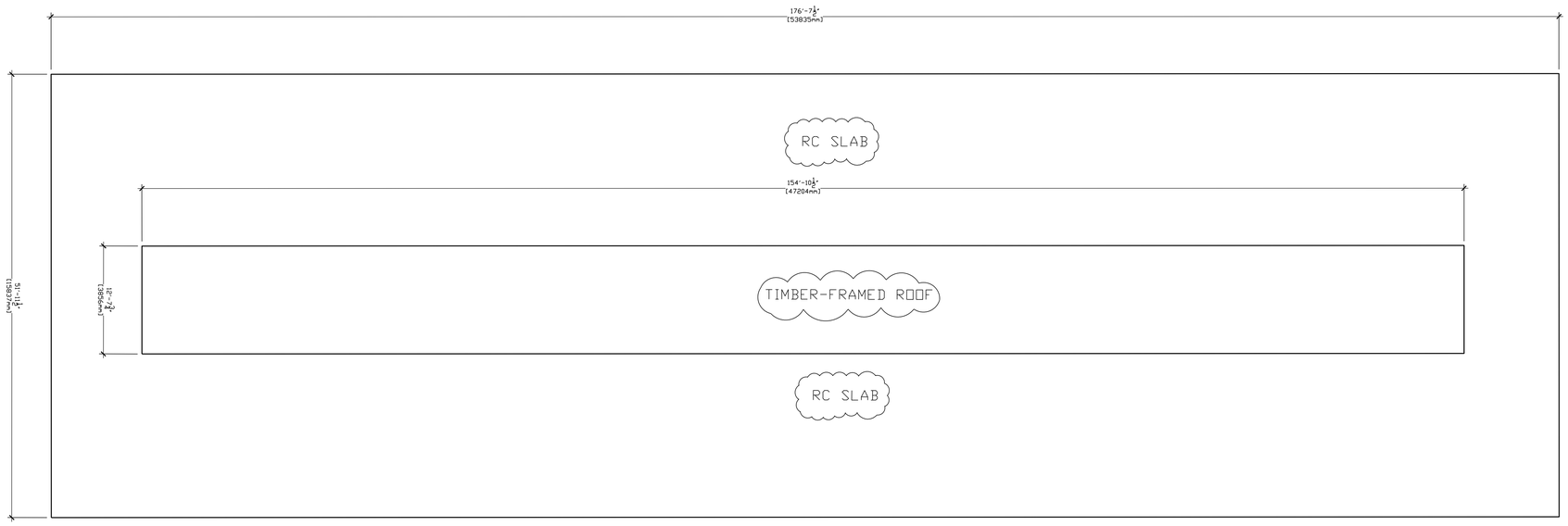
SHEET NUMBER
08



ENT & ORTHOPEDICS
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

E.N.T. & ORTHOPEDICS
- ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
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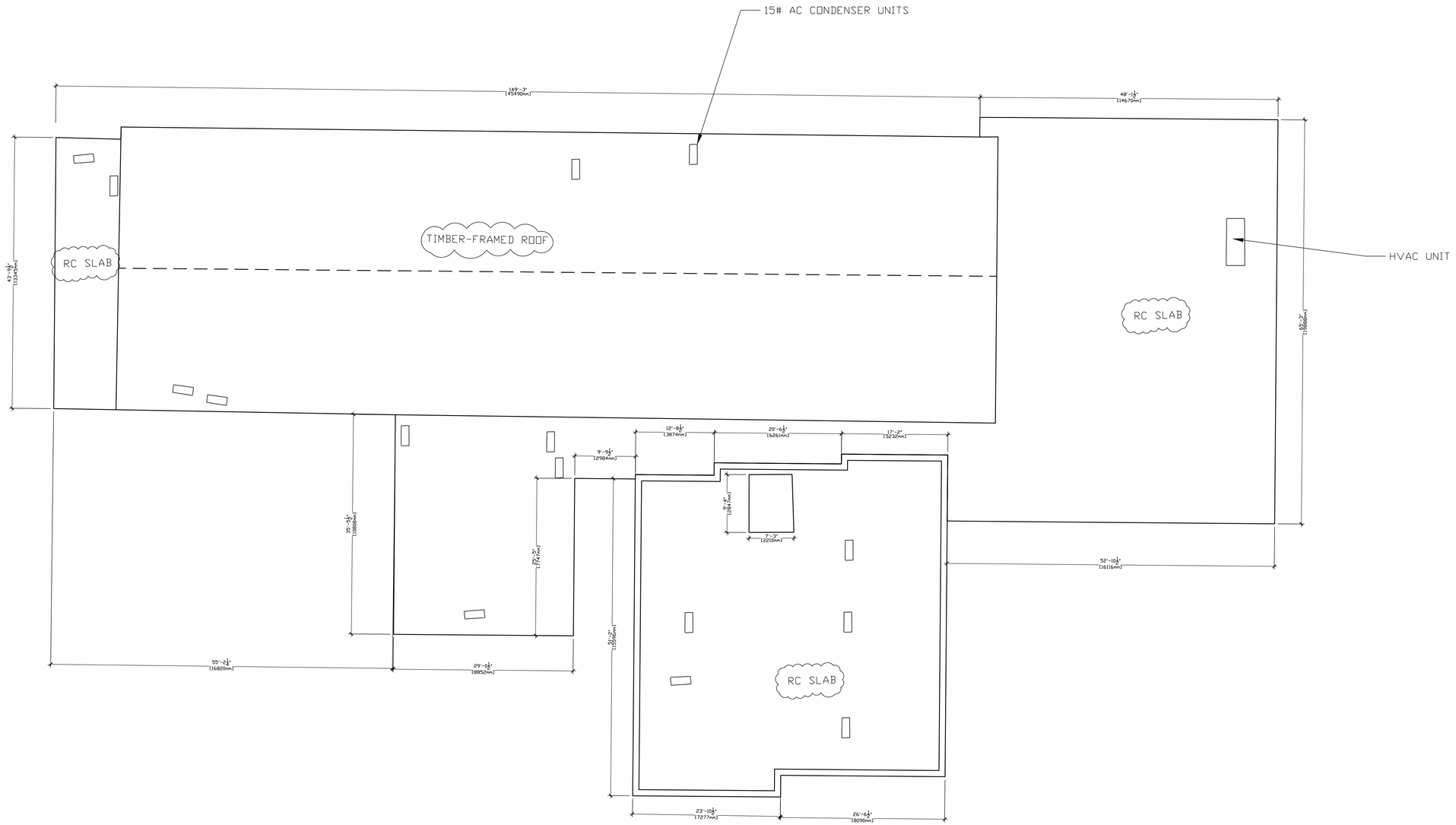
SHEET NUMBER

09



X-RAY CAUTERIZATION & ULTRASOUND
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

X-RAY - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

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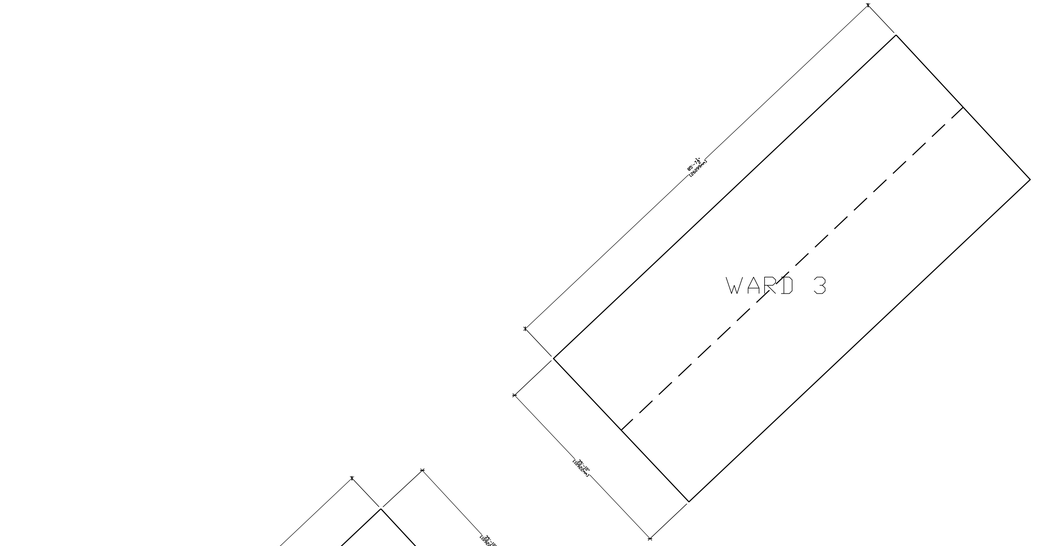
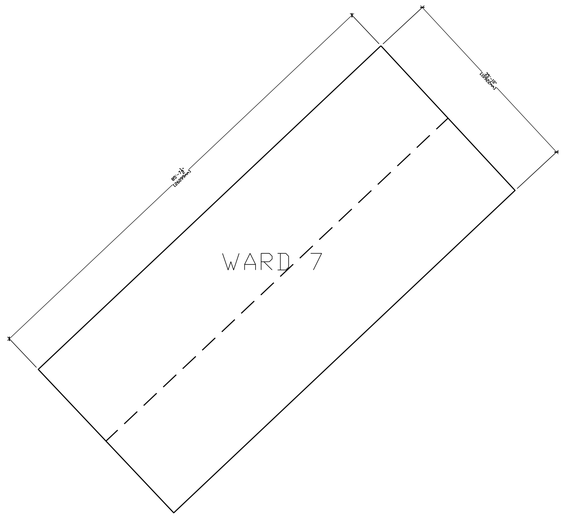
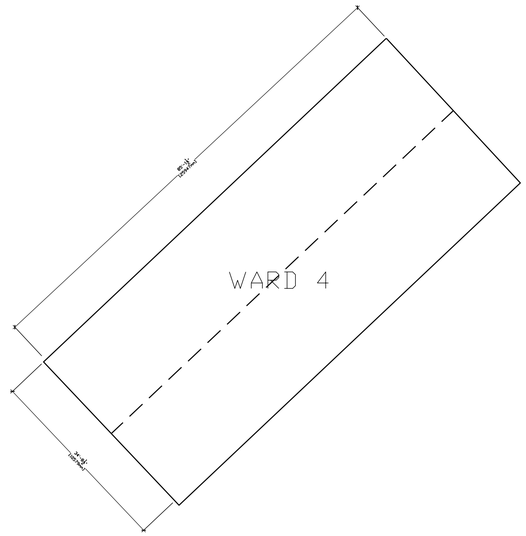
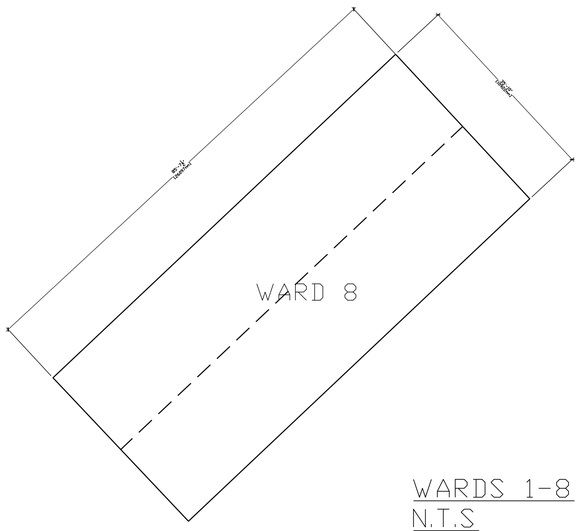
SHEET NUMBER

10









WARDS 1-8
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
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NO.	REVISION	DATE

SHEET TITLE

WARDS 1-8 - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES

UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
21-02	PLANNING
SCALE	**DATE**
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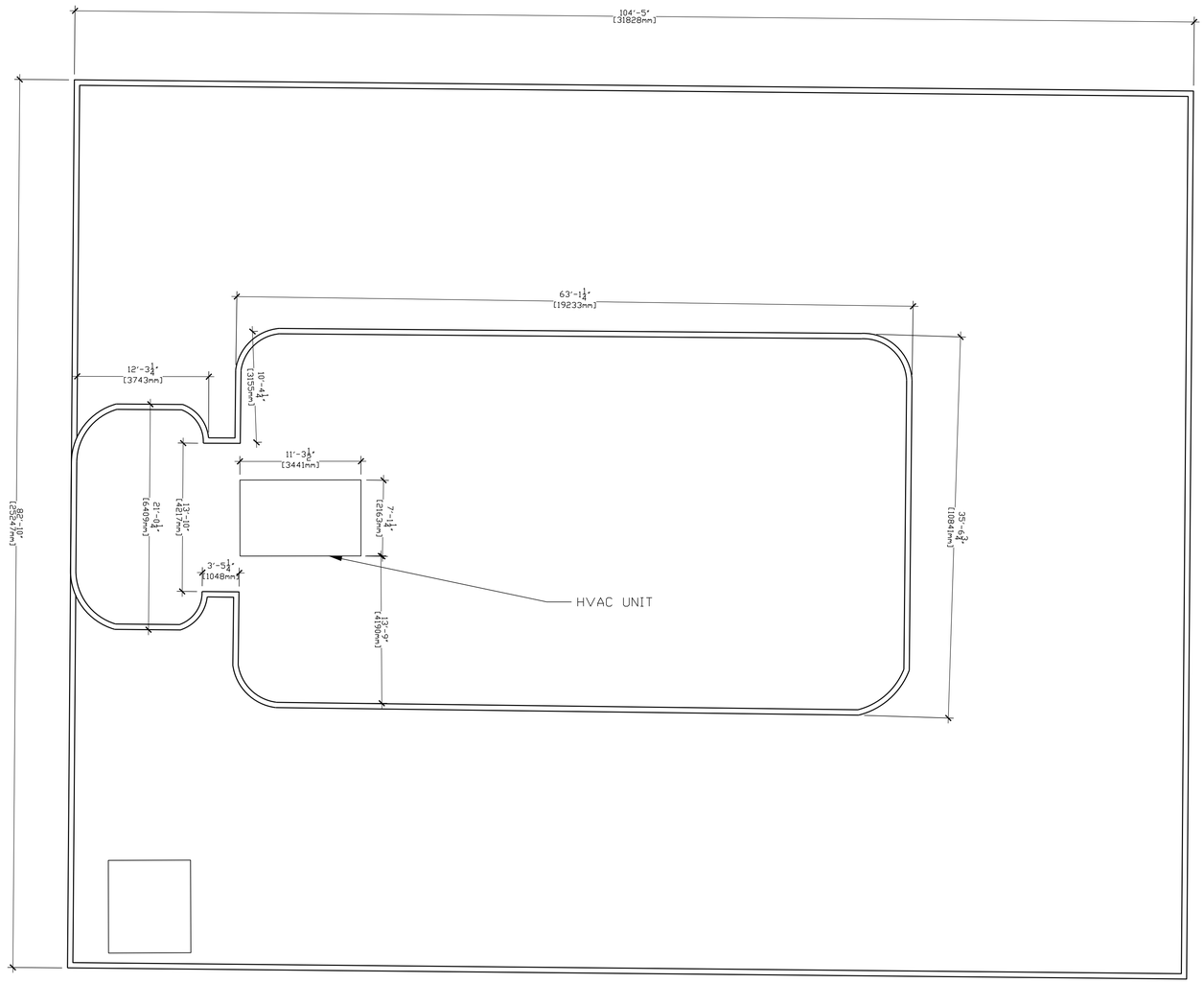
SHEET NUMBER

11



WARDS 1-8
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

ADMINISTRATION - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
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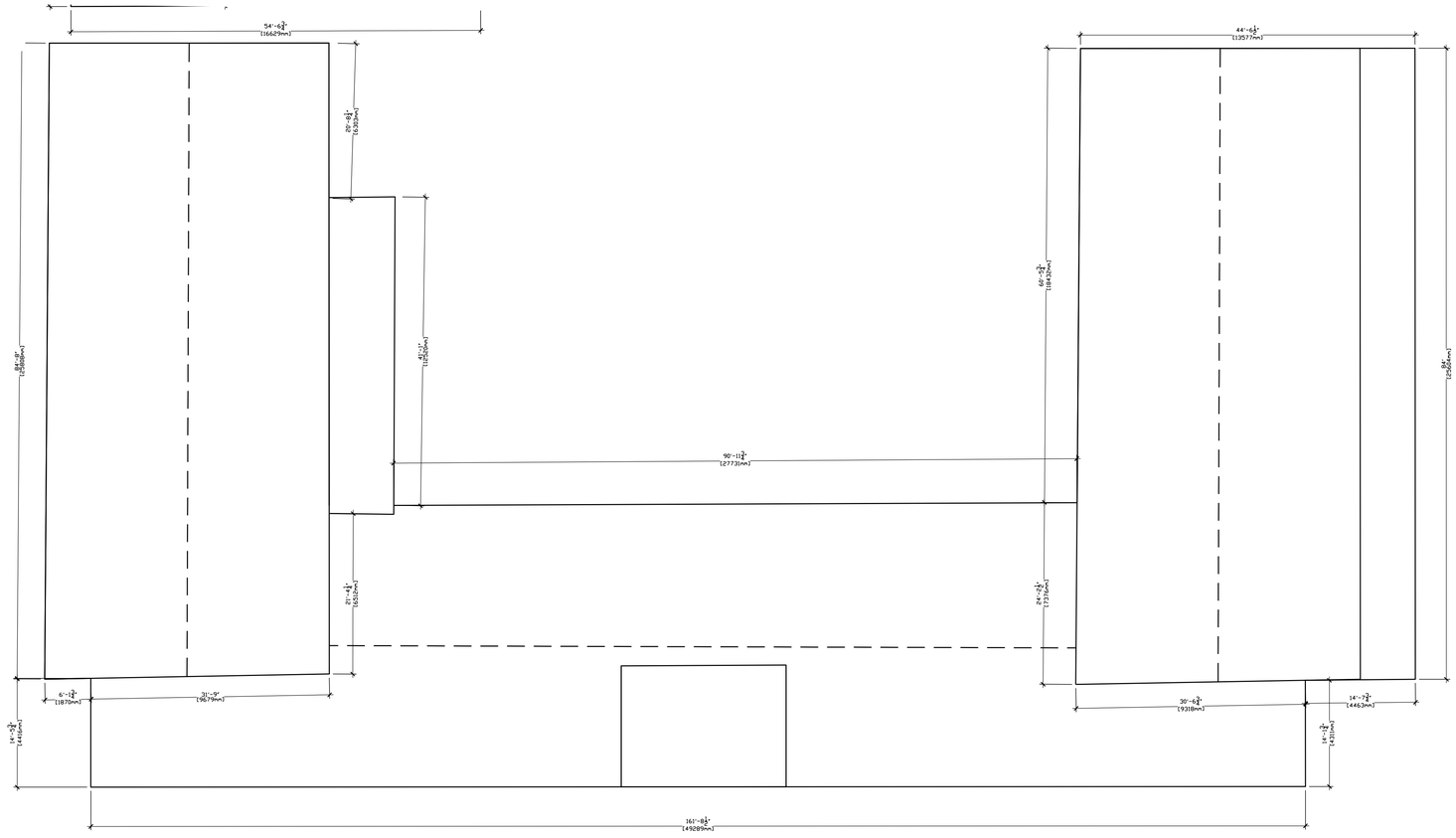
SHEET NUMBER

12



WARDS 11 & 12
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

WARDS 11 & 12 - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

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ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
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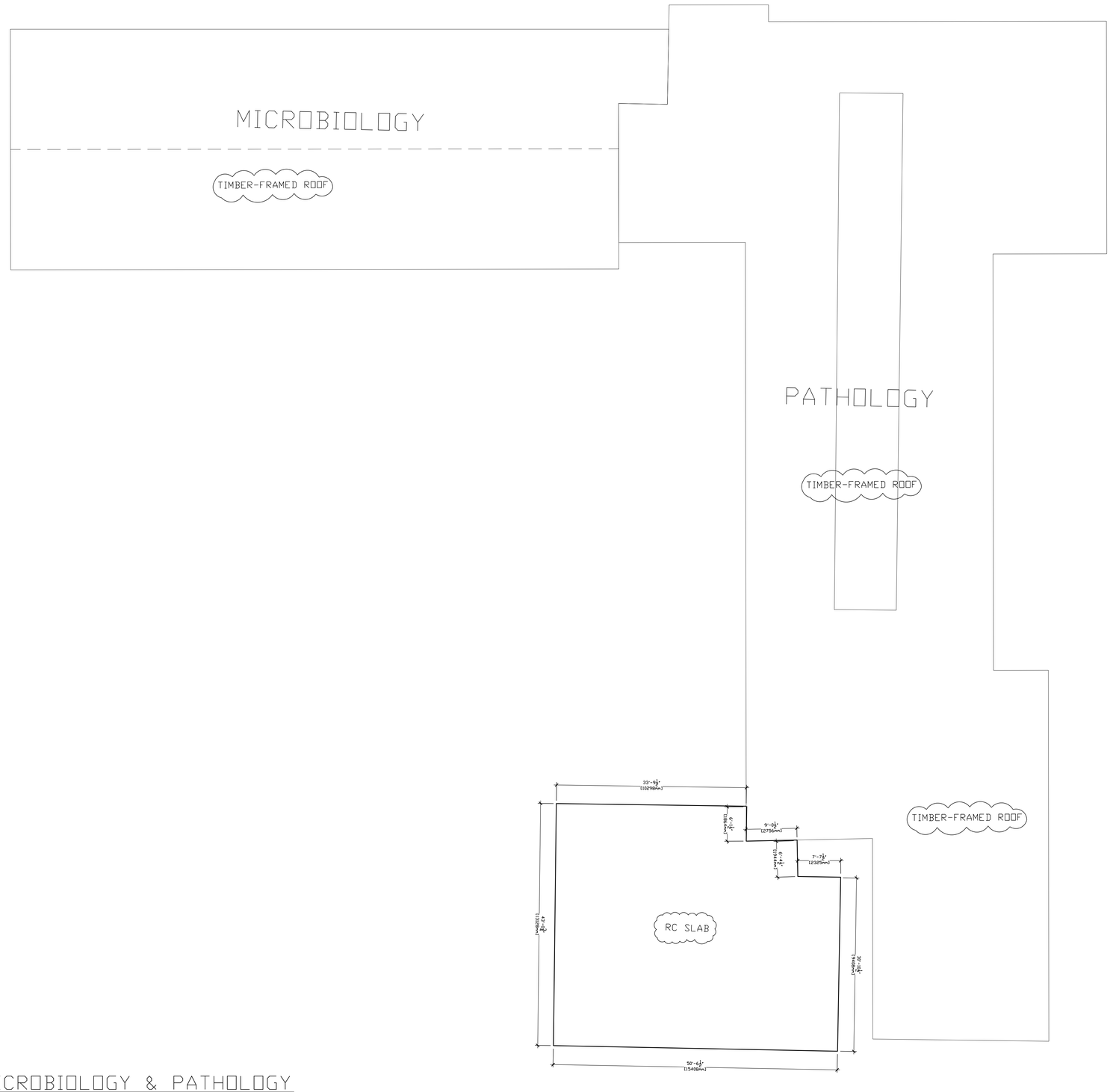
SHEET NUMBER

13



MICROBIOLOGY & PATHOLOGY
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE
-	- - - -	- - - -

SHEET TITLE

MICROBIOLOGY & PATHOLOGY - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES

UNIVERSITY HOSPITAL OF THE WEST INDIES

PROJECT NO.	ISSUE STATUS
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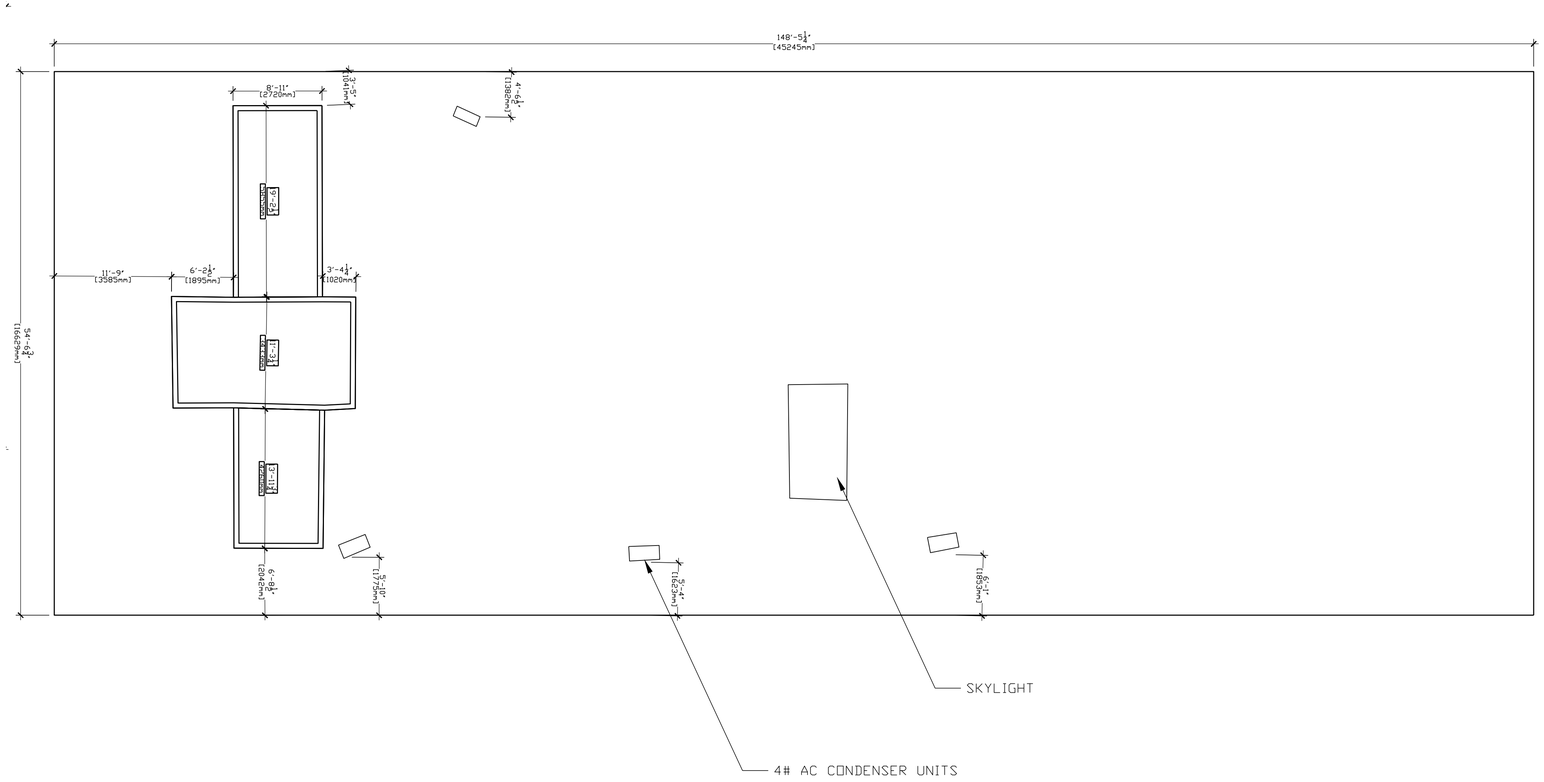
SHEET NUMBER

14



LABOUR WARD
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE

SHEET TITLE

LABOUR WARD - ROOF LAYOUT

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES
UNIVERSITY HOSPITAL OF THE WEST INDIES

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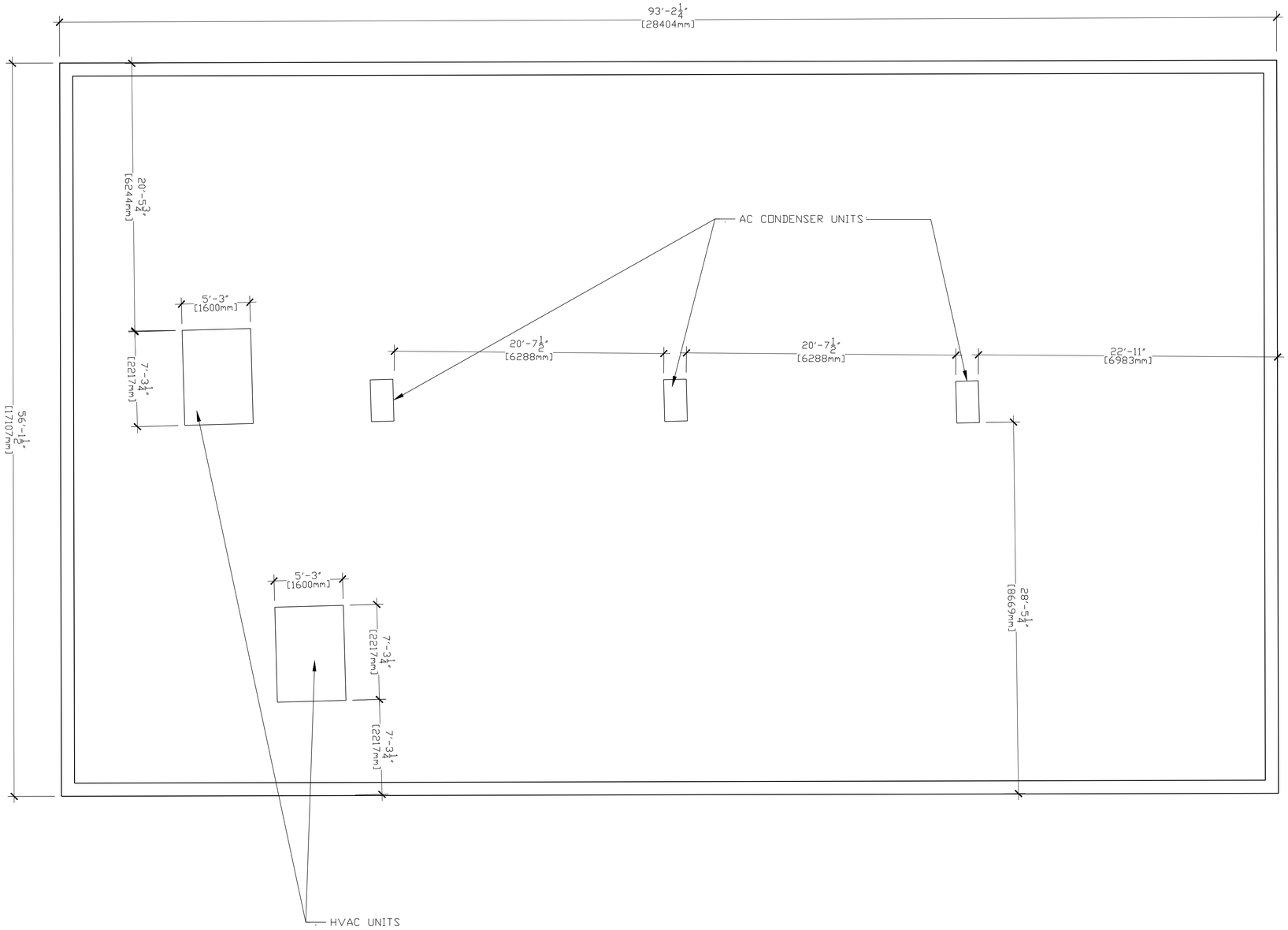
SHEET NUMBER

15



MEDICAL LIBRARY
N.T.S

NOTES

1. DO NOT SCALE DRAWING.
2. DRAWING REPRESENTS IDENTIFIABLE EXISTING CONDITIONS AS OBSERVED AT THE TIME OF VISIT.

NO.	REVISION	DATE
-	- - - -	- - - -

SHEET TITLE

MEDICAL LIBRARY - ROOF LAYOUTS

DRAWN BY:	ALEX BERANARD
DESIGNED BY:	N/A
CHECKED BY:	ALEX BERNARD
AUTHORIZED BY:	ALEX BERNARD

CONSULTANTS

ALEX BERNARD PE, PMP

PROJECT NAME

SIA @ 27 GOV'T FACILITIES

UNIVERSITY HOSPITAL OF THE WEST INDIES

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SHEET NUMBER

16