

دائـــرة البلـــديـــات والـــنـــقـــل
DEPARTMENT OF MUNICIPALITIES AND TRANSPORT

Abu Dhabi Mosque Development Regulations

Appendix 1

Estidama

Version 3.0 - 2025

About the Department of Municipalities and Transport (DMT)

The Department of Municipalities and Transport was established by Law No. 30 of 2019, and its main priorities are to realize the vision of the leadership which draws on the vision of the UAE's Founding Father, the late Sheikh Zayed bin Sultan Al Nahyan to embrace progress by placing great value on the importance of pursuing development in line with both the needs of present and future generations and the community in general.

The authority embodies the values of good governance, driven by the needs of the community it serves and working with a passion to accomplish its aims. The Department focuses on finding the most effective means of providing essential, modern, responsive and comprehensive municipal services across three regional municipalities, and supports Abu Dhabi's global position as a leader in innovation-led urban planning and transportation, as part of the Abu Dhabi government's commitment to maintaining the highest standards to the benefit of all citizens and residents of the emirate.

The DMT is responsible for continually investing in the development of better infrastructure, facilities and transportation sectors within the emirate, guiding, regulating and monitoring urban development to enhance Abu Dhabi's reputation as a world-class destination to live, work and visit.

The DMT also ensures the highest standards of safety, security, sustainability and technological development of the Emirate of Abu Dhabi's land, air and maritime transport networks, in accordance with the highest international standards and the UAE's legislation with the objective of being the region's connection to the world.

The Department's aspirations are driven by the simple proposition of innovating and building sustainable smart cities, fostering a capacity to change and adapt in order to maintain excellence in services and sustaining prosperity for future generations, allowing the entire Abu Dhabi community to reach their full potential.

For more information about DMT's recent updates, follow us on:
Twitter @AbudhabiDMT
Instagram instagram.com/@AbudhabiDMT
Facebook facebook.com/@AbudhabiDMT

Table of Contents

I. Introduction to Estidama 1
II. Mosque PBRS Scorecard 5
III. How to Use the Guidelines 6
1.0 Team and Process Organisation 9
1.1 Integrated Development Team 10
1.2 Initial Vision and Targets 11
1.3 Design Workshops 12
1.4 Implementation Strategy 13
2.0 Site Context 17
2.1 Natural and Urban Systems Assessment 18
2.2 Natural Systems Protection 20
3.0 Design of Outdoor Spaces 25
3.1 Plot Layout 26
3.2 Outdoor Thermal Comfort 27
3.3 Accessibility and Provision of Community Facilities 28
3.4 Safe, Secure and Healthy Environments 29
3.5 External Waste and Recycling Storage 30
3.6 Natural Systems Management 31
3.7 Landscaping and Irrigation 33
3.8 Stormwater Management 35
3.9 External Building Materials 36
4.0 Design of Indoor Spaces 45
4.1 Ventilation Strategy 46
4.2 Thermal Zoning 51
4.3 Acoustic Design 52
5.0 Material Selection 55
5.1 Modular Flooring Systems 56
5.2 Design for Durability 57
5.3 Regional Materials 58
5.4 Recycled Materials 59
5.5 Reused or Certified Timber 64
5.6 Hazardous Materials 65
6.0 Design of Building Systems 71
6.1 Energy Systems 74
6.2 Energy Metering 73
6.3 Energy Efficient Appliances 76
6.4 Lighting Fixtures 77
6.5 Refrigerants and Fire Suppression 78
6.6 Water Fixtures and Appliances 79
6.7 Water Metering 83
6.8 Design for Legionella Prevention 84
7.0 Mosque Construction 87
7.1 Construction Environmental Management 88
7.2 Construction Waste Management 89
7.3 Procurement During Construction 90
8.0 Performance Verification 95
8.1 Commissioning 96
8.2 Acoustic Verification 96
9.0 Mosque Operation 101
9.1 Sustainability Communication 102
9.2 Indoor Waste and Recycling Storage 103
9.3 Legionella Management 104
Attachment A: Energy Modelling Parameters 109

I. Introduction to Estidama

'Estidama', which means sustainability in Arabic, is the initiative which will transform Abu Dhabi into a model of sustainable urbanisation. Its aim is to create more sustainable communities, cities and global enterprises by balancing the 4 pillars of Estidama: environmental, economic, social and cultural.

The aspirations of Estidama are incorporated into several urban planning initiatives and other Department of Municipalities and Transport (DMT) policies such as the Development Code. Estidama began in 2008 and is the first programme of its kind that is tailored to the Middle East region.

In the immediate term, Estidama is focused on the rapidly changing built environment. It is in this area that the DMT is making significant strides to influence projects under design, development and construction within the Emirate of Abu Dhabi.

The Estidama Pearl Rating System (PRS) is 1 of the key tools for driving and determining sustainable development. The Pearl Rating System for Communities, Buildings and Villas provide a suite of tools that form the basis for sustainable development from master plan to finished building.



The Estidama Pearl Rating System

The PRS aims to address the sustainability of a given development throughout its life cycle from design and construction through to operation. The PRS provides detailed requirements for rating a building's potential performance in relation to the four pillars of Estidama.

The PRS is organised into seven categories that are fundamental to more sustainable development.

- Integrated Development Process: Encouraging cross-disciplinary teamwork to deliver environmental and quality management.
- Natural Systems: Conserving, preserving and restoring critical natural environments and habitats.
- Liveable Spaces: Ensuring the quality of outdoor and indoor spaces.
- Precious Water: Reducing water demand and encouraging alternative water sources.
- Resourceful Energy: Targeting energy conservation through passive design measures, energy efficiency and renewable sources.
- Stewarding Materials: Ensuring consideration of the 'whole-of-life' cycle when specifying and disposing of materials.
- Innovating Practice: Encouraging innovation and cultural expression in building design and construction to facilitate market and industry transformation.

Estidama for Mosques

All new mosques in Abu Dhabi Emirate are required to comply with the minimum Estidama Pearl Rating System Level requirements based on funding source/donor type, as per Information Bulletin #15 (refer to Figure 1) and Information Bulletin #17 (refer to Figure 2). This means that development teams will have to meet all 'required Credits' in the PBRS and, where applicable, a range of 'optional Credits' to earn a minimum of 60 Credit Points.

Mosque development teams are offered a wide range of optional Credits that may be targeted for their projects to earn a minimum of 60 Credit Points. An extensive consultation has been undertaken between many stakeholders to identify a list of recommended optional Credits for mosques which takes into consideration religious requirements and local market capabilities. Mosque development teams are recommended to target these Credits before exploring other alternatives. The recommended optional Credits are highlighted in the Mosque PBRS Scorecard presented on the following page.

Although a minimum 2 Pearl Rating is mandated for applicable mosque projects as per Information Bulletin #15 and #17, mosque development teams may also voluntarily seek a higher rating of 3 to 5 Pearls. The Credit Points required for each level are listed in Table 1.

Requirement	Pearl Rating Achieved
All mandatory Credits	1 Pearl
All mandatory Credits + 60 Credit Points	2 Pearls
All mandatory Credits + 85 Credit Points	3 Pearls
All mandatory Credits + 115 Credit Points	4 Pearls
All mandatory Credits + 140 Credit Points	5 Pearls

Table 1: Pearl Building Rating Levels

The purpose of this document is to provide guidance for the mosque development teams by presenting the most suitable pathway of 'recommended optional Credits', in order to achieve a minimum 2 Pearl Rating, as per Information Bulletin #15 and Information Bulletin #17 (as shown in the following pages).

The detailed requirements of both the required and optional Credits are available from the Pearl Building Rating System (PBRS), available for download at https://dmt.gov.ae/Media-Centre/E-Library.

The project team must consul PBRS manual that contains detailed calculation and documentation requirements to demonstrate compliance with the required Credit Points.

Emirati Vernacular Mosques

The Abu Dhabi Mosque Development Regulations promote the use of Emirati vernacular for the design of mosques. This approach is also in line with Estidama objectives, as there are several elements of vernacular style, as outlined below, which help a designer to achieve the recommended PBRS Credits.

- Riwaq: By providing a shaded external space for prayer, this will help to achieve Credit LBo-R3: Outdoor Thermal Comfort Strategy/LBo-1: Improved Outdoor Thermal Comfort.
- Wind cooling: The cooling effect of the wind has been used throughout Emirati mosque vernacular design to cool both the internal and external areas of a mosque (e.g. sahan).
- Prayer hall proportions: The simple prayer hall proportions used within Emirati vernacular design allow the creation of thermal zoning within mosques, which helps to achieve Credit LBi-5.1: Thermal Comfort & Controls: Thermal Zoning.
- Simple and modest building design: Through the use of Emirati vernacular design elements, the mosque achieves a reduced energy loading, helping to achieve Credit RE-R1: Minimum Energy Performance.
- Use of simple regional materials: Traditional Emirati architecture may use simple regional materials. If followed, this may help to achieve Credit SM-9: Regional Materials.

مجلس أبوظبي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

Estidama Pearl Rating System: Information Bulletin #15

Subject : **Minimum Pearl Rating Level Requirements for New Mosque Projects**
Date : **17 January 2016**

The UPC formally announces changes to the minimum Estidama Pearl Rating System Level requirements for all new mosques, as previously indicated within the Abu Dhabi Mosque Development Regulations (MDR).

All mosques are required to comply[A] with the minimum Estidama Pearl Rating System Level requirements listed below based on the following funding source/donor types:

1. **Individual Donor(s)** (i.e. one or more persons) must achieve a minimum 1 Pearl Rating[B] under the Pearl Building Rating System (PBRS).
2. **Company Donor(s)** (e.g. government, private companies, developers, conglomerates and business group donors) must achieve a minimum 2 Pearl Rating under the Pearl Building Rating System (PBRS).

In order to confirm the funding source/donor type all **appointed** Pearl Qualified Professionals (PQPs) must provide a Donor Name letter signed by the General Authority of Islamic Affairs and Endowments (Awqaf) that includes the following information:

- **Name(s) of Mosque Donor(s)**: Must list the names of all persons and/or companies involved
- **Mosque Donor Type[C]:** Must be identified as either Individual Person(s) or Company
- **Plot Details:** Municipal Affection Plan & Building Site Plan must be attached

In order to obtain an official Donor's Name Letter the appointed PQP must contact the AWQAF Masajed Department Manager of the relevant region/location. The official Donor Name letter must be included within the Liveable Buildings Outdoor credit folder (LBo-R1) as part of the supporting documents.

This change is applicable to new mosque PBRS submissions made **on or after 1st January 2016.**

For further information regarding the Pearl Rating Systems, please visit the Estidama website on http://estidama.upc.gov.ae

Yasmeen Al Rashedi Senior Manager Estidama Department	**Mohamed Al Khadar** Executive Director Urban Development & Estidama

[A] All mosques projects must be submitted to the UPC Estidama Department for review and approval using the correspondence protocol outlined within http://estidama.upc.gov.ae/submit-project/submitting-a-pearl-rating-application.aspx

[B] Prior to 1st January 2016, all mosques (funded by individual donor(s)) that were awarded a 2 Pearl **Design** Rating Notification of Pearl Compliance (NOPC) approval **AND** have **NOT** appointed a **contractor** will be subject to demonstrating a minimum 1 Pearl **Construction** Rating. All mosques (funded by individual donors) that have already commenced construction must demonstrate construction rating compliance with the Pearl Rating awarded at the Design stage.

[C] If multiple donors are present and one of the donors is identified as a company, then the donor type will be classified as 'Company' and subject to a minimum 2 Pearl Rating under the Pearl Building Rating System (PBRS).

Figure 1: Information Bulletin #15
Downlodable at: https://dmt.gov.ae/-/media/Project/DMT/DMT/E-Library/information-bulletin-15.pdf

دائرة التخطيط العمراني والبلديات
DEPARTMENT OF URBAN PLANNING AND MUNICIPALITIES

Estidama Pearl Rating System: Information Bulletin #17 Version 1.0

Subject : **Applicability of the Pearl Rating System to New Stand-Alone Mosque Projects**
Date : **5 September 2018**
Version : **1.0**

This bulletin defines the applicability of the Pearl Building Rating System (PBRS) in relation to **New Stand-Alone** building(s) located on a plot where the defined land use category is Religious/Mosque. This bulletin also supersedes Information Bulletin 3.0 Version 2.0 requirements related to the applicability of the PBRS on building(s) located on a plot where the defined land use category is Religious/Mosque.

The flow chart (**Attachment 1**) explains the criteria for determining which of the following compliance paths applies to a **New Stand-Alone** mosque building and/or addition(s) of **New Stand-Alone** ancillary buildings:

Compliance Paths

A. Comply with the Estidama Temporary Program Requirements
B. Comply with the Estidama Pearl Building Rating System (PBRS) in accordance with Information Bulletin #15 Version 1.0

This change is applicable to new building permit applications submitted on or after **Monday, 9th July 2018**[I].

For further information regarding the Pearl Rating Systems, please visit the Estidama website on https://www.upc.gov.ae/estidama

Yasmeen Al Rashedi Senior Manager Estidama Division	**Mohamed Al Khadar** Executive Director Urban Development Sector

[I] All New Building Permit applications submitted **on or after 9th July 2018**, for New Stand-Alone building(s) located on a plot where the defined land use category is Religious/Mosque must apply Information Bulletin #17 v1.0.

All PBRS Design Rating Mosque and/or Ancillary Building(s) applications approved on or before **9th July 2018** apply the following to the future Construction Rating applications:
- ✓ Information Bulletin #15 v1.0 where the main works contractor has been appointed before **9th July 2018**
- ✓ Information Bulletin #17 v1.0 where the main works contractor has been appointed on or after **9th July 2018**. Note developers/Owners may still choose to demonstrate compliance with the Construction Rating requirements on a voluntary basis by following the current applicable processes and procedures for the Pearl Construction Rating Stage

Figure 2: Information Bulletin #17
Downlodable at: https://dmt.gov.ae/-/media/Project/DMT/DMT/E-Library/Information-Bulletin-17-Version-10.pdf

دائـرة التـخطيط العـمراني والبلـديات
DEPARTMENT OF URBAN PLANNING
AND MUNICIPALITIES

Estidama Pearl Rating System: Information Bulletin #17 Version 1.0

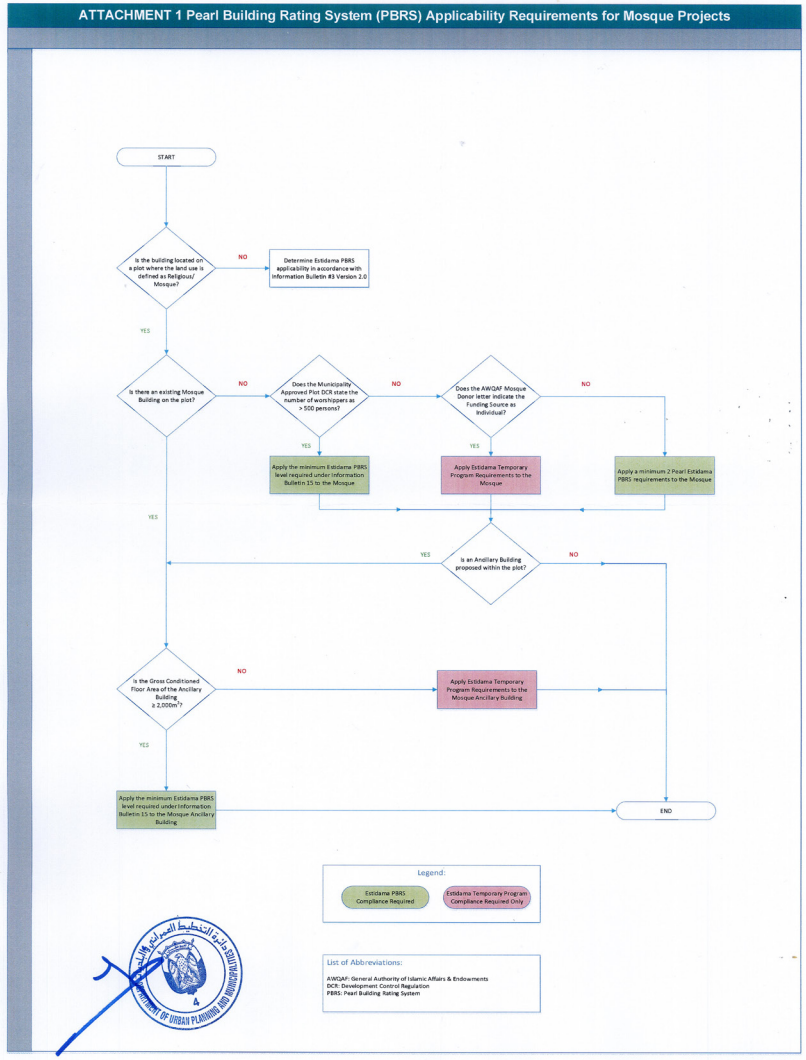
DEFINITIONS

- ✓ **Ancillary building:** A New Stand-Alone building that does not contain any prayer halls but includes one or more of the remaining Functional Components listed within the Abu Dhabi Mosque Development Regulations (Section 2.3, Volume 2 - Design) that support the mosque building.
- ✓ **Gross Conditioned Floor Area:** The gross floor area of conditioned spaces; where the conditioned space is defined as per the ANSI/ASHRAE/IESNA Standard 90.1-2007 definition.
- ✓ **Gross Floor Area (GFA):** The sum of the floor areas of the spaces within a building, including basements, mezzanines and intermediate floors, and penthouses with an internal height of 2.3m or greater. It is measured from the exterior faces of the exterior walls or from the centreline of walls separating buildings. It excludes covered walkways, porches, pipe trenches, exterior terraces or steps, chimneys, roof overhangs and similar features.
- ✓ **New Stand-Alone:** A new enclosed structure that has no physical connection to other buildings (i.e. detached) and will be built on a plot where there may be the presence of existing building(s). Extensions or modifications to existing buildings could be required to meet Pearl Rating System (PRS) requirements in the future.
- ✓ **Religious:** Buildings located on plots where the land use has been categorized as Religious as defined by the applicable Plan 2030, and/or Development Code, and/or Area Plan type(s).
- ✓ **Individual Donor(s)** (i.e. one or more persons) Funded by individual donor(s). In order to obtain an official Donor's Name Letter the appointed PQP must contact the AWQAF Masajed Department Manager of the relevant region/location. The official Donor Name letter must be included within the Livable Buildings Outdoor credit folder (LBo-R1) as part of the supporting documents for projects required to follow compliance path B.
- ✓ **Company Donor(s)** Company donors include those funded by government entities, private companies, developers, conglomerates and business group donors. If multiple donors are present and one of the donors is identified as a company, then the donor type will be classified as 'Company' and subject to a minimum 2 Pearl Rating under the Pearl Building Rating System (PBRS).

Estidama Pearl Rating System: Information Bulletin #17 Version 1.0

دائـرة التـخطيط العـمراني والبلـديات
DEPARTMENT OF URBAN PLANNING
AND MUNICIPALITIES

ATTACHMENT 1 Pearl Building Rating System (PBRS) Applicability Requirements for Mosque Projects



II. Mosque PBRS Scorecard

Credit Reference	Credit Title	Credit Points Available	
		Total	Recommended Path
IDP	**Integrated Development Process**		
IDP-R1	Integrated Development Strategy	Required	Required
IDP-R3	Basic Commissioning	Required	Required
IDP-3	Construction Environmental Management	2	1
IDP-6	Sustainability Communication	2	2
	TOTAL	**13**	3
NS	**Natural Systems**		
NS-R1	Natural Systems Assessment	Required	Required
NS-R2	Natural Systems Protection	Required	Required
NS-R3	Natural Systems Design & Management Strategy	Required	Required
NS-3	Ecological Enhancement	2	2
	TOTAL	**12**	2
LBo	**Livable Buildings : Outdoors**		
LBo-R1	Plan 2030	Required	Required
LBo-R2	Urban Systems Assessment	Required	Required
LBo-R3	Outdoor Thermal Comfort Strategy	Required	Required
LBo-1	Improved Outdoor Thermal Comfort	2	2
LBo-7	Bicycle Facilities	2	1
	TOTAL	**13**	3
LBi	**Livable Buildings : Indoors**		
LBi-R1	Healthy Ventilation Delivery	Required	Required
LBi-R2	Smoking Control	Required	Required
LBi-R3	Legionella Prevention	Required	Required
LBi-2.1	Materials Emissions : Adhesives & Sealants	1	1
LBi-2.2	Materials Emissions : Paints & Coatings	1	1
LBi-2.3	Materials Emissions: Carpet & Hard Flooring	1	1
LBi-2.4	Materials Emissions : Ceiling Systems	1	1
LBi-2.5	Materials Emissions : Formaldehyde Reduction	2	2
LBi-3	Construction Indoor Air Quality Management	2	2
LBi-5.1	Thermal Comfort & Controls: Thermal Zoning	1	1
LBi-6	High Frequency Lighting	1	1
LBi-9	Indoor Noise Pollution	1	1
Lbi-10	Safe & Secure Environment	1	1
	TOTAL	**23**	12

Credit Reference	Credit Title	Credit Points Available	
		Total	Recommended Path
PW	**Precious Water**		
PW-R1	Minimum Interior Water Use Reduction	Required	Required
PW-R2	Exterior Water Monitoring	Required	Required
PW-1	Improved Interior Water Use Reduction	15	5
PW-2.1	Exterior Water Use Reduction: Landscaping	8	6
PW-2.2	Exterior Water Use Reduction: Heat Rejection	8	8
PW-2.3	Exterior Water Use Reduction: Water Features	4	4
PW-3	Water Monitoring & Leak Detection	4	4
PW-4	Stormwater Management	4	2
	TOTAL	**43**	29
RE	**Resourceful Energy**		
RE-R1	Minimum Energy Performance	Required	Required
RE-R2	Energy Monitoring & Reporting	Required	Required
RE-R3	Ozone Impacts of Refrigerants & Fire Suppression	Required	Required
RE-3	Energy Efficient Appliances	3	3
RE-7	Global Warming Impacts of Refrigerants & Fire	4	2
	TOTAL	**44**	5
SM	**Stewarding Materials**		
SM-R1	Hazardous Materials Elimination	Required	Required
SM-R2	Basic Construction Waste Management	Required	Required
SM-R3	Basic Operational Waste Management	Required	Required
SM-5	Modular Flooring Systems	1	1
SM-6	Design for Durability	1	1
SM-9	Regional Materials	2	2
SM-10	Recycled Materials	6	3
SM-12	Reused or Certified Timber	2	2
SM-13	Improved Construction Waste Management	2	2
SM-14	Improved Operational Waste Management	2	2
	TOTAL	**28**	13

Required Credits

Recommended Credit Points for mosque projects

Figure 3: Mosque PBRS Scorecard

III. How to Use the Guidelines

These Guidelines are intended to complement the PBRS, which is the primary reference document for Estidama compliance. This document provides design and development teams with guidance for achieving the required and recommended Credits. Where relevant, these guidelines provide a pathway to achieving the required mandatory requirements and Credits. Key features of the document organisation are highlighted below.

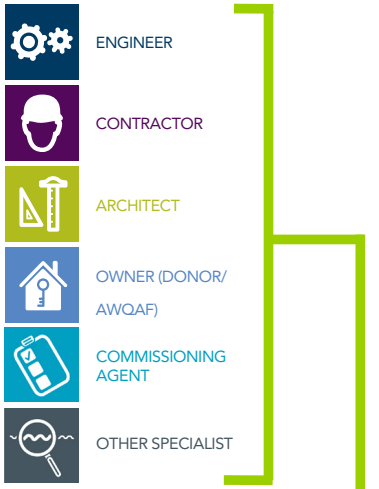
This guideline forms part of the Abu Dhabi Mosque Development Regulations (ADMDR). The ADMDR comprises 3 volumes and 3 appendices that regulate specific aspects of the planning and design of a mosque building, its surroundings and life cycle. The full list of documents is as follows:

- User Guide
- Volume 1 – Planning
- Volume 2 – Design
- Volume 3 – Operations
- Appendix 1 – Estidama
- Appendix 2 – Architectural Prototypes
- Appendix 3 – Vernacular Study

The ADMDR documents have been written to complement each other. The mosque developer, designer and contractor must utilise these guidelines in conjunction with the entire suite of ADMDR volumes and appendices.

The members of the design and development team responsible for requirements discussed on the page are highlighted on the upper corner of the page (refer to Figure 3).

E – Engineer
C – Contractor
A – Architect
O – Owner (Donor/Awqaf)
CA – Commissioning Agent
OS – Other Specialist



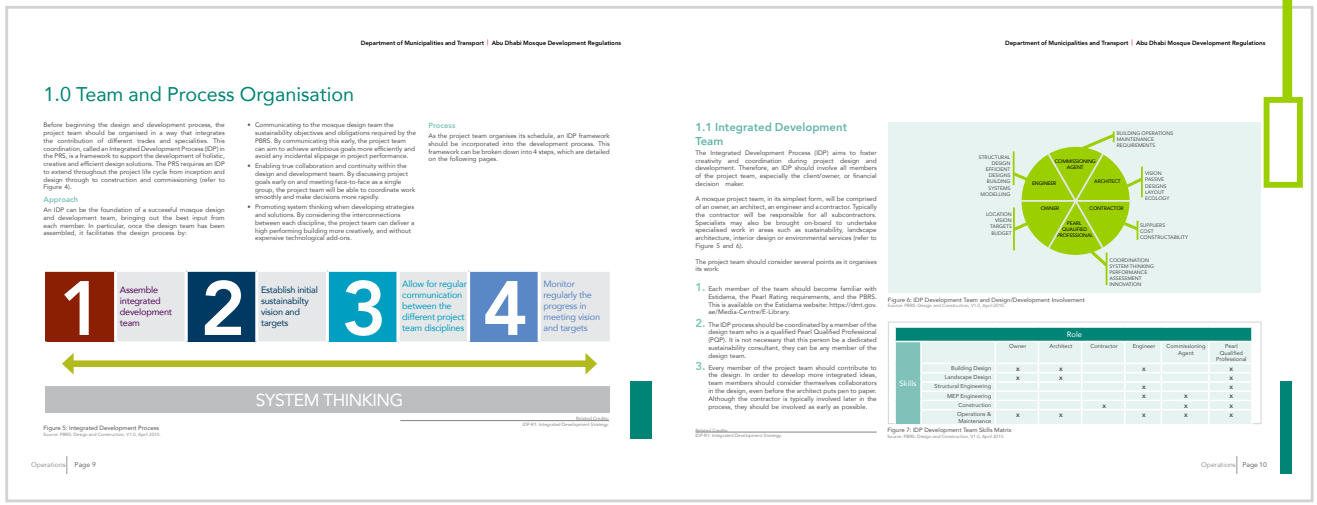


Figure 4: Extract from Appendix 1 – Estidama.

1.0
Team and Process Organisation

1.0 Team and Process Organisation

Before beginning the design and development process, the project team should be organised in a way that integrates the contribution of different trades and specialities. This coordination, called an Integrated Development Process (IDP) in the PRS, is a framework to support the development of holistic, creative and efficient design solutions. The PRS requires an IDP to extend throughout the project life cycle from inception and design through to construction and commissioning (refer to Figure 4).

Approach

An IDP can be the foundation of a successful mosque design and development team, bringing out the best input from each member. In particular, once the design team has been assembled, it facilitates the design process by:

- Communicating to the mosque design team the sustainability objectives and obligations required by the PBRS. By communicating this early, the project team can aim to achieve ambitious goals more efficiently and avoid any incidental slippage in project performance.
- Enabling true collaboration and continuity within the design and development team. By discussing project goals early on and meeting face-to-face as a single group, the project team will be able to coordinate work smoothly and make decisions more rapidly.
- Promoting system thinking when developing strategies and solutions. By considering the interconnections between each discipline, the project team can deliver a high performing building more creatively, and without expensive technological add-ons.

Process

As the project team organises its schedule, an IDP framework should be incorporated into the development process. This framework can be broken down into 4 steps, which are detailed on the following pages.



Figure 5: Integrated Development Process
Source: PBRS: Design and Construction, V1.0, April 2010.

Related Credits:
IDP-R1: Integrated Development Strategy.

1.1 Integrated Development Team

The Integrated Development Process (IDP) aims to foster creativity and coordination during project design and development. Therefore, an IDP should involve all members of the project team, especially the client/owner, or financial decision maker.

A mosque project team, in its simplest form, will be comprised of an owner, an architect, an engineer and a contractor. Typically the contractor will be responsible for all subcontractors. Specialists may also be brought on-board to undertake specialised work in areas such as sustainability, landscape architecture, interior design or environmental services (refer to Figure 5 and 6).

The project team should consider several points as it organises its work:

1. Each member of the team should become familiar with Estidama, the Pearl Rating requirements, and the PBRS. This is available on the Estidama website: https://dmt.gov.ae/Media-Centre/E-Library.
2. The IDP process should be coordinated by a member of the design team who is a qualified Pearl Qualified Professional (PQP). It is not necessary that this person be a dedicated sustainability consultant, they can be any member of the design team.
3. Every member of the project team should contribute to the design. In order to develop more integrated ideas, team members should consider themselves collaborators in the design, even before the architect puts pen to paper. Although the contractor is typically involved later in the process, they should be involved as early as possible.

Related Credits:
IDP-R1: Integrated Development Strategy.



Figure 6: IDP Development Team and Design/Development Involvement
Source: PBRS: Design and Construction, V1.0, April 2010.

		Role					
		Owner	Architect	Contractor	Engineer	Commissioning Agent	Pearl Qualified Professional
Skills	Building Design	x	x		x		x
	Landscape Design	x	x				x
	Structural Engineering				x		x
	MEP Engineering				x	x	x
	Construction			x		x	x
	Operations & Maintenance	x	x		x	x	x

Figure 7: IDP Development Team Skills Matrix
Source: PBRS: Design and Construction, V1.0, April 2010.

1.2 Initial Vision and Targets

The most important aspect of the IDP is a shared vision and a series of targets established to achieve it (refer to Figure 7). These should be developed early in the design process and be aligned with the minimum Pearl Rating requirements for mosque design.

1. Develop a vision for the mosque project. This should be a general aspirational target that will give coherence to the design process.
2. Establish objectives for achieving the vision. These should be more specific goals.
3. Establish specific and measurable targets for achieving the objectives and vision. These will form a framework for the design process.
4. Develop solutions for reaching the targets. Identifying practical, cost effective, integrated solutions will be the outcome of the design and development process.

Vision	"Provide a comfortable environment for worship that will avoid wasteful resource use."
Objectives	"Adopt a climate-responsive design that minimises the need for artificial lighting and air-conditioning, and uses efficient technologies that reduce energy and water consumption."
Targets (Credits)	"Reduce potable water use to 20% below the usage of a typical mosque" (Credit PW-1 Improved Interior Water Use Reduction); "Design the mosque to achieve a minimum energy performance as per Credit RE-R1: Minimum Energy Performance."
Solutions	"Architect: Strategic window placement and shading. Engineer: Specify low-flow water ablution fixtures. Engineer: Specify high energy performance AC, fans and lighting fixtures."

Figure 8: Narrative Summarising Vision, Objectives, Targets and Solutions

Related Credits:
IDP-R1: Integrated Development Strategy.

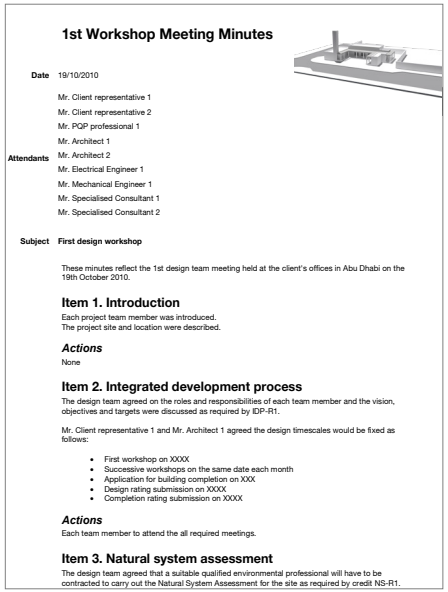
1.3 Design Workshops

After a kick-off workshop and establishment of the vision, objectives and targets, it is important to continue holding multidisciplinary design workshops to foster creativity and collaboration and to ensure everyone is aware of important decisions made throughout the development process (refer to Figure 8).

Schedule regular multidisciplinary workshops at the outset of project planning. These should include the following topics, at a minimum:

- Site and ecology;
- Orientation and climatic response;
- Energy and water consumption;
- Waste management;
- Indoor comfort; and
- Sustainable materials specifications.

Additional workshops can also be scheduled on an 'as needed' basis. Each meeting should be documented in an appropriate manner. This could take the form of photographs or signatures of design members present at workshops (refer to Figure 9).



1st Workshop Meeting Minutes

Date 19/10/2010

Attendants
Mr. Client representative 1
Mr. Client representative 2
Mr. PQP professional 1
Mr. Architect 1
Mr. Architect 2
Mr. Electrical Engineer 1
Mr. Mechanical Engineer 1
Mr. Specialised Consultant 1
Mr. Specialised Consultant 2

Subject First design workshop

These minutes reflect the 1st design team meeting held at the client's offices in Abu Dhabi on the 19th October 2010.

Item 1. Introduction
Each project team member was introduced.
The project site and location were described.

Actions
None

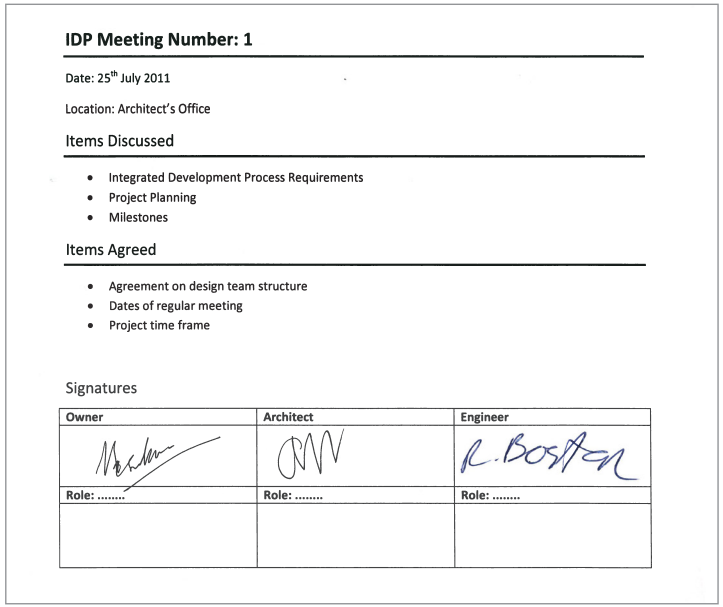
Item 2. Integrated development process
The design team agreed on the roles and responsibilities of each team member and the vision, objectives and targets were discussed as required by IDP-R1.

Mr. Client representative 1 and Mr. Architect 1 agreed the design timescales would be fixed as follows:

- First workshop on XXXX
- Successive workshops on the same date each month
- Application for building completion on XXX
- Design rating submission on XXXX
- Completion rating submission on XXXX

Actions
Each team member to attend the all required meetings.

Item 3. Natural system assessment
The design team agreed that a suitable qualified environmental professional will have to be contracted to carry out the Natural System Assessment for the site as required by credit NS-R1.



IDP Meeting Number: 1

Date: 25th July 2011

Location: Architect's Office

Items Discussed

- Integrated Development Process Requirements
- Project Planning
- Milestones

Items Agreed

- Agreement on design team structure
- Dates of regular meeting
- Project time frame

Signatures

Owner	Architect	Engineer
Role:	Role:	Role: .....

Figure 10: Workshop documentation

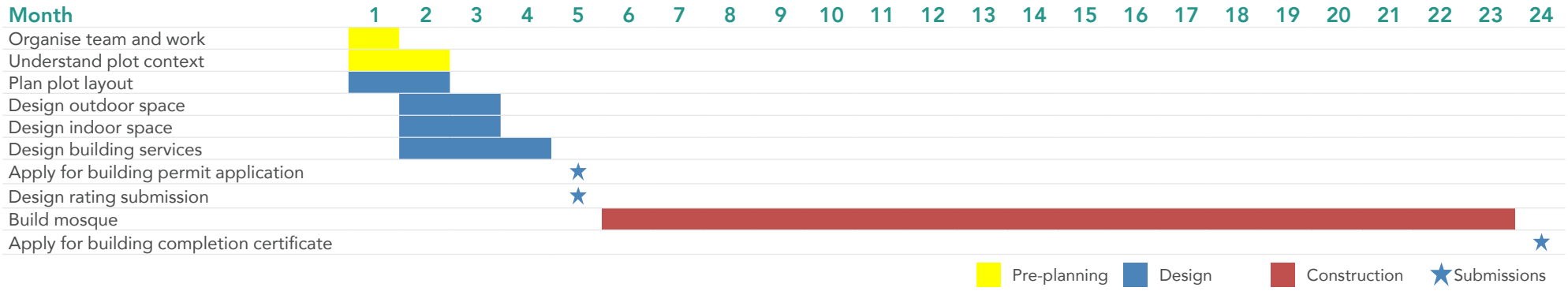


Figure 9: Mosque Integrated Development Process chart

Related Credits:
IDP-R1: Integrated Development Strategy.

1.4 Implementation Strategy

A strategy for implementing the sustainability goals of a mosque and eligible ancillary building(s) under Information Bulletin 17 should be developed to ensure that sustainability targets established during design are met during construction and occupancy. This can be facilitated as the team is organised.

All members of the development team should be engaged early in the process, including the contractor and commissioning agent (who will verify the performance of building systems). If possible, these members should be involved in the whole IDP process.

The specification documents must contain the sustainability targets and solutions established during the IDP workshops. There should be language ensuring compliance with all mandatory PBRS Credits and targeted optional Credits that lead to the targeted Pearl Rating, where applicable.

The mosque Imam must receive an Operations Manual and a Maintenance Manual. These will provide instructions on efficient operation and proper maintenance of building systems, as well as behaviours that reduce the waste of resources. (Refer to Section 9.0, as well as Volume 3 – Operations).

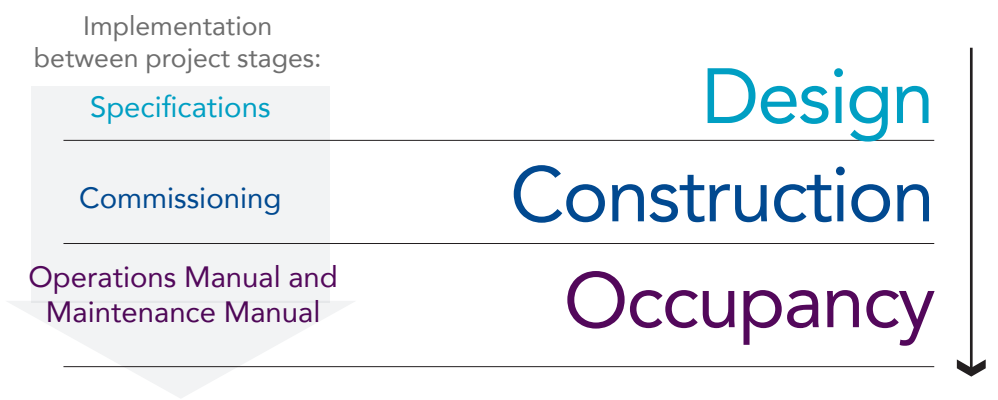


Figure 11: Implementation Strategy Development

Related Credits:
IDP-R1: Integrated Development Strategy.

2.0
Site Context

2.0 Site Context

At the start of the design process, the design team should seek ways to understand and optimise the relationship between the mosque plot and its surroundings.

A thorough understanding of the site's natural and urban context will help inform an optimal plot layout and mosque design. This will support many design objectives, including:

- Improved outdoor thermal comfort;
- Energy use reduction;
- Water conservation; and
- Ecological enhancement.

There are many resources that can support an analysis of both natural and urban systems, including the master planning documents for the neighbourhood in which the mosque is located. Others are listed in 'Useful Resources' below.

Natural systems, such as the existing habitat and topography, and urban systems, such as nearby community facilities, could be examined in separate assessments or together. Ultimately, all site information should be integrated in order to identify opportunities and constraints associated with building on a particular plot.

Identifying important contextual opportunities and constraints allows the mosque development to take advantage of special site features and address site challenges effectively. Information obtained in the Natural and Urban Systems Assessment informs the formation of a complete opportunities and constraints analysis. An example study is shown on page 12, illustrating how opportunities and constraints can be used to inform the design of a plot.

The design team should then move onto the next step in the process; planning the plot layout.

Useful Resources:

- DMT Plant Information is available in Abu Dhabi Public Realm Design Manual (PRDM), Version 3, 2022, Appendix-3
- Geographical Information Database for UAE **http://geoportal.abudhabi.ae**
- Google Map/Earth
- EnergyPlus Weather Data **http:// apps1.eere.energy.gov**
- Interpretation Manual of Major Terrestrial Natural and Seminatural Habitat Types of Abu Dhabi Emirate, Gary Brown and Benno Boer, Environmental Research and Wildlife Development Agency, September 2004.
- Terrestrial Environment of Abu Dhabi Emirate, Environment Agency Abu Dhabi, 2008 **www.ead.ae**
- Handbook for Phase 1 Habitat Survey – a technique for environmental audit, JNCC, 2007 **www.jncc.gov.uk**
- Environment Agency **http://www.ead.ae**
- Union for Conservation of Nature, IUCN, **www.iucn.org**
- Wild Flowering Plants of UAE, Environmental Research and Wildlife Development Agency, 2002
- Birds of Abu Dhabi – Checklist, Environmental Research and Wildlife Development Agency, July 2001
- Vascular Plants of Abu Dhabi Emirate, Gary Brown and Sabitha Sakkir, August 2004
  Regulation and Supervision Bureau (RSB) **www.rsb.gov.ae**
- Abu Dhabi Water and Electricity Authority (ADWEA) www.adwea.com/en/index.html
- Abu Dhabi Water and Electricity Company (ADWEC) **www.adwec.ae**
- Abu Dhabi Distribution Company (ADDC) **www.addc.ae**
- Al Ain Distribution Company (AADC) **www.aadc.ae**
- Abu Dhabi National Energy Company (TAQA) **www.taqa.ae/en/uae.html**
- Abu Dhabi Transmission and Dispatch Company (TRANSCO) **www.transco.ae**



Related Credits:
NS-R1: Natural Systems Assessment.
LBo-R2: Urban Systems Assessment.

2.1 Natural and Urban Systems Assessment

At the beginning of the design process and before plot clearance takes place, an assessment of the natural and urban systems in the context of the plot and its immediate surroundings needs to be undertaken.

The assessments, which can be documented in a narrative, maps and plot photos, can be a combination of desktop studies and field surveys and should cover the following elements where applicable (refer to Figure 12).

Natural Systems

Topography, Geology and Soil Conditions

Topography, geology and soil conditions are important for understanding key viewpoints, how building foundations should be constructed, how different areas will accommodate landscaping and how the plot will drain both rainwater and irrigation water.

Hydrology and Groundwater

Groundwater is a precious environmental resource. Groundwater hydrological conditions and any groundwater abstraction currently taking place on the plot should be identified to determine the drainage strategy and susceptibility of groundwater to pollution/contamination.

Waste and Contamination

Any contamination on the plot by petrol, refuse or other chemicals and materials that could be harmful to human health or the environment should be identified to determine the need for remediation. If previously unreported contamination is found or suspected, the plot developers should contact the relevant environmental agency to determine further testing and remediation requirements.

Archaeological Features

Appropriate desk studies and consultations with relevant Government bodies, such as the Abu Dhabi Tourism & Culture Authority (TCA), should be carried out to determine the potential for archaeological features to be found on the plot. During the field survey, any notable features should be recorded.

Microclimate

The local plot microclimate, including winds and shaded areas, should be evaluated to identify passive design features that can be incorporated into the design to improve thermal comfort. Abu Dhabi's characteristic sun angles, daily temperature swings and relative humidity should be considered.

Flora and Fauna, Priority Species, Habitats and Ecosystems

Though most proposed plots in Abu Dhabi will contain limited habitat, areas that contain priority habitats, such as mangroves, sea grasses, etc, are particularly important to protect and preserve.

Attention should be paid to identify 'Significant Assets' and 'Valuable Assets'. Significant Assets in Abu Dhabi include intertidal mudflats, mangroves, vegetated sandy beaches, marine (seagrass, coral, etc.), wadis, sand sheets and low dunes, interdunal plains and high dunes, alluvial plains and jebels, or any other sensitive habitats identified. Significant Assets also include protected species determined to be critically endangered, vulnerable, threatened, near threatened or sensitive.

Valuable Assets are features of ecological value, including healthy native trees or shrubs.

Urban Systems

Land Use Context and Connectivity

Proximity to residential zones, centres of employment and community facilities must inform the mosque plot planning in terms of connectivity and accessibility, but also the mosque programming in relation to provision of community facilities within the mosque itself.

Mobility

The design and development team must investigate surrounding street patterns, access to existing and planned transportation networks, nearby transit stops and parking availability to inform plot planning and provision of functional sidewalks and pathways, parking and bicycle storage.

Utilities

An early understanding of existing and planned utility networks, including electricity, gas, potable water and wastewater, is required in order to inform utilities design for the mosque plot and ensure cost-effective connections to existing networks.

Air Quality

An observational survey of the mosque and its immediate surroundings must be conducted to determine air quality conditions and local contaminants from the surrounding environment. The outdoor air quality investigation shall be documented as required in Credit LBi-R1 Healthy Ventilation Delivery.

Related Credits:
NS-R1 Natural Systems Assessment.
LBo-R1 Plan 2030.
LBo-R2 Urban Systems Assessment.
LBo-3 Accessible Community Facilities.
LBo-2 Pearl Rated Communities.
LBi-R1 Healthy Ventilation Delivery.

Example – Natural and Urban Systems Assessment

- Although sparsely vegetated, the proposed plot includes 2 notable ecological assets, depicted in photos (a spiny-tailed lizard burrow and several ghaf trees). The existing ghaf trees, as a native species, are valuable for both habitat and landscaping.
- The plot is mostly flat with soil being found to be sandy up to a depth of 35cm with a more rocky substrate underneath. In the north western portion of the plot area, soil contains more sandy load, which is in part related to the presence of trees.
- As a previously unutilised location, no contamination has been identified or suspected on this plot.
- Within a 350m walking distance, there are mostly residential zones with 2 community facilities: a school and a community centre.
- The area is only served by 1 bus route connecting the neighbourhood to Abu Dhabi City. Parking is available running parallel to the E11 Highway.
- The main line utilities run along the major E11 Highway with the authorities providing utilities access from the neighbouring community.
- The existing streets throughout the community are dual single lane streets which also include a pedestrian corridor on both sides.
- The microclimate generally corresponds to Abu Dhabi averages with some particularities as follows:
  - High midday sun with marginal overshadowing from adjacent developments to the south;
  - Exposed on north and south sides;
  - Warmer southern winds prevailing during the day;
  - Existing trees on the plot provide shaded zones; and
  - Adjacent properties can break-up wind patterns and introduce turbulence.



Spiny-tailed lizard burrow.



Ghaf trees.



Figure 12: Natural and Urban Systems Assessment Plan

2.2 Natural Systems Protection

After evaluating the natural assets of the plot, the design teams must build around or responsibly relocate existing natural assets and offset any disruption caused by development.

Where Significant and Valuable Assets are present, a Natural Systems Protection, Mitigation or Compensation Plan needs to be produced. This, along with supporting studies, must be prepared by a suitably qualified ecological specialist.

The ecological features of the plot can either be protected or disturbance can be mitigated. 3 strategies to do this are identified in the PBRS. These are summarised in Table 2.

If the Natural Systems Assessment clearly documents that the plot has no significant or valuable natural assets, the plot does not need protection or mitigation. A further Credit can be achieved if the requirements of Credit PW-2.1: Exterior Water Use Reduction: Landscaping are followed and the project provides landscaping that consists of native species and uses minimal water.

All Significant Assets associated with a protected area, national park, a coastal park, ecological hotspot, or a coastal conservation zone, must be protected, and 80% of Valuable Assets protected.

If part of the Natural Systems Design and Management Strategy includes mitigation or compensation, at least 70% of Significant Assets and 50% of Valuable Assets must be protected. If mitigation occurs on-site, new habitat areas must equal the area of the lost assets. If on-site mitigation is impractical and off-site compensation must be pursued, the new habitat area must be twice the area of assets lost.

During the design of outdoor areas, project teams should lay out buildings, streets and public spaces on-site to protect and celebrate the presence of on-site ecological features. These features could form a theme for site-wide landscaping strategies.

The Natural Systems Design and Management Strategy should outline any activities that may cause damage to sensitive areas during the construction and operation phases of the development. It should identify measures that have been designed into the scheme and those that will be implemented during operation to protect these areas/species, for example; limiting access to mangrove areas and providing boardwalks for pedestrians to minimise damage to mangrove roots. The Strategy should include measures such as:

- Design protection measures;
- Ensuring that work compounds, access tracks and so on are not located in or adjacent to sensitive habitats;
- Establishing temporary fencing around protected areas to restrict access;
- Undertaking any works near protected areas in a manner so as to safeguard their integrity; and
- Undertaking works considering any critical seasons for protected species.

Strategy	Significant assets to be protected on-site (% of significant assets)	Valuable assets to be protected on-site (% of valuable assets)	Maximum reclaimed land (% of land area)	Maximum impact affecting the coastal edge (% of coastal edge)	Mitigate/ compensate lost habitat at an area replacement ratio of:	Other Requirement/Comment
1. Protection	100%	80%	25%	20%	N/A	Retain and protect from damage and destruction sufficient to maintain the feature's existing structure and function.
2. On-site Mitigation (DMT approval required)	70%	50%	25%	20%	2:1	Provide an ecological corridor between plot and mitigated area. Confirmation of the appointment of a management and maintenance contractor (minimum 5-year contract).
3. Off-site Compensation (DMT approval required)	70%	50%	25%	20%	2:1	Compensation site in the Emirate of Abu Dhabi, a degraded area and located outside Plan 2030 area. Confirmation of the appointment of a management and maintenance contractor (minimum 5-year contract).

Table 2: Natural Systems Protection, Mitigation or Compensation Plan

Some of these measures could be included in the Construction Environmental Management Plan (CEMP) when prepared as part of the requirements of Credit IDP-3: Construction Environmental Management.

As well as the Natural Systems Assessment Report, the Mitigation Strategy Report should identify the areas to be protected and measures adopted to ensure their protection, as outlined in the Protection Strategy Report. It should identify the mitigation areas and justification for the appropriateness for mitigation including:

- Area calculations;
- Identification of appropriate plant nurseries;
- Continuous monitoring of success or failure of young plants; and
- Management techniques to encourage establishment, which should be adapted following any failures (if any).

The Compensation Strategy Report should demonstrate options considered for off-site compensation and the selection criteria for the proposed compensation site. The Report should include measures to ensure flora establishment as outlined in the Mitigation Strategy Report and protection measures as outlined in the Protection Strategy Report. Consideration should be given to the habitat lost on the proposed plot and the potential to provide enhanced habitat of a similar type to the habitat lost.

The author of this chapter of the Natural Systems Assessment Report should be a qualified ecologist who has experience in habitat establishment for those particular habitats, e.g. a mangrove specialist.

Related Credits:
NS-R2: Natural Systems Protection.
IDP-3: Construction Environmental Management.
PW-2.1: Exterior Water Use Reduction: Landscaping.

3.0
Design of Outdoor Spaces

3.0 Design of Outdoor Spaces

Following on from the natural and urban systems assessment and analysis work to determine the broader natural and urban context of the mosque project (refer to Section 2.0), the design and development team must address the following design factors when planning the layout of outdoor spaces within the mosque plot in order to develop an integrated approach to plot planning and design:

- Accessibility and connectivity;
- Ecological enhancement;
- Outdoor thermal comfort;
- Water efficiency;
- Energy efficiency;
- Waste management;
- Hazardous materials; and
- Smoking control.

Careful consideration must be given when locating buildings within the plot, pathways and plot access points to optimise accessibility and connectivity with the surrounding community amenities and facilities in accordance with Credit LBo-3: Accessible Community Facilities and Volume 1 – Planning (refer to Sub-section 3.3). The mosque should also be linked to adjacent streets to facilitate pedestrian, bicycle and vehicular movements and provide adequate bicycle storage to meet the requirements of Credit LBo-7: Bicycle Facilities.

The mosque plot landscape should be designed to respect and link to existing natural habitats, where present, and should have a clear and coherent Natural Systems Design and Management Strategy as required by Credits NS-R2: Natural Systems Protection and NS-R3: Natural Systems Design and Management Strategy.

The extent, selection, location and irrigation strategy of the mosque's plant palette should result in reduced irrigation demand as required by Credit PW-2.1: Exterior Water Use Reduction: Landscaping, while providing sufficient planting to meet design objectives.

Appropriate building massing, the integration of well-placed and well-chosen landscaping, both soft and hardscapes and sufficient and appropriate shading elements, such as trees and/or structural shading, will contribute to improving outdoor thermal comfort to address the minimum requirements of Credits LBo-R3: Outdoor Thermal Comfort Strategy and LBo-1: Improved Outdoor Thermal Comfort.

Although the orientation of the mosque is fixed towards qibla, the placement of mosque buildings within the plot and in relation to each other, coupled with a climate-responsive envelope design, provide good opportunities for reducing energy demand in relation to Credit RE-R1: Minimum Energy Performance. Design and development teams should explore opportunities to reduce internal heat gains while harnessing sufficient daylight in key spaces such as prayer halls.

While the amount of glazing should be limited to what is necessary, achievement of this is demonstrated by:

- Careful placement of glazing within the building envelope;
- Integration of shading, such as mashrabiya panels or overhangs, to limit or eliminate direct solar radiation; and
- Use of envelope components (such as windows, walls and roofs) that meet the maximum performance criteria specified in Credit RE-R1: Minimum Energy Performance.

The mosque must include appropriately sized external waste storage spaces with appropriate and adequate access for waste collection vehicles to meet the requirements of Credit SM-R3: Basic Operational Waste Management.

Hazardous materials in outdoor spaces, such as treated timber containing Chromated Copper Arsenate (CCA), must be avoided as per the requirements of Credit SM-R1: Hazardous Materials Elimination.

Outdoor items, such as shading structures and outdoor furniture, must be evaluated where they are proposed. It is unlikely that playground furniture will be present, but if it is intended, then this must also be considered.

Finally, a mosque plot-wide smoking ban must be introduced to meet the requirements of Credit LBi-R2: Smoking Control. In particular, signage should be provided at key locations to indicate that visitors are entering a non-smoking environment.

Related Credits:
NS-R2: Natural Systems Protection.
NS-R3: Natural Systems Design and Management Strategy.
LBo-R3: Outdoor Thermal Comfort Strategy.
LBo-1: Improved Thermal Comfort.
LBo-3: Accessible Community Facilities.
LBo-7: Bicycle Facilities.
LBi-R2: Smoking Control.
PW-2.1: Exterior Water Use Reduction: Landscaping.
RE-R1: Minimum Energy Performance.
SM-R1 Hazardous Materials Elimination.
SM-R3: Basic Operational Waste Management.

3.1 Plot Layout

The layout of the mosque within the designated plot has many implications later in the design process, especially with regards to energy performance and outdoor thermal comfort. In addition to the guidance provided in Volume 2 – Design, the design team should carefully consider the following:

Optimise Natural Light but Minimise Solar Gains

1. Utilise external shading devices to reduce solar gain, while maintaining external views (e.g. provision of horizontal shading on south orientation and vertical shading on east and west orientations).
2. Use shadows cast by surrounding buildings to provide shade and reduce solar gain.
3. Locate windows in shaded areas, recessed into the wall, or facing north to provide light to indoor spaces.
4. Use roof-lights sparingly as these significantly increase solar heat gains. Consider using sunpipes or solar-tubes instead.

Harmonious Integration with Surroundings and Pedestrian Environments

1. Cool breezes can reduce heat build-up in external areas as well as freshen the air in externally accessible areas. Hot winds cause unpleasant and uncomfortable conditions resulting in the build up of heat in external areas, which increases the heat load of the building and pedestrian thermal discomfort.
2. Consider position, form and orientation of nearby buildings to understand wind movement and how the external environment is affected.
3. Use mosque form and position to best use cool breezes. This will help to reduce the build-up of heat and/or stagnant air at pedestrian level.
4. Use the mosque form to shelter pedestrian areas from hot or high-speed winds. Consider the use of external mosque features, as well as mosque form and massing, to minimise adverse impacts of the wind on the public realm. Features to be considered include, but are not limited to:
   - Shading devices, e.g. brise-soleil, mashrabiya panels, etc;
   - Overhangs;
   - Breaks in façade continuity;
   - Podiums;
   - Openings; and
   - Permeable features.
5. Consider potential adverse impacts of downwash, corner accelerations and local wind direction changes amongst other effects.
6. Consider the need for mitigation of adverse wind conditions within the public realm. Potential mitigation strategies include, but are not limited to:
   - Canopies;
   - Wind screens;
   - Shelter belts; and
   - Deployable structures.

Related Credits:
LBo-R3: Outdoor Thermal Comfort Strategy.
RE-R1: Minimum Energy Performance.

3.2 Outdoor Thermal Comfort

Outdoor thermal comfort is especially important for a mosque given the potential for worshipper overflow during Friday, Ramadan or Eid prayers, therefore provision of shading to provide outdoor thermal comfort is required for specific outdoor areas of the mosque (refer to Figure 13).

To achieve worshipper comfort, the shading percentage required in Credit LBo-R3: Outdoor Thermal Comfort Strategy should be achieved on the summer solstice (June 21st at 1.00pm) within the following mosque areas:

- Overflow prayer areas; and
- Pedestrian walkways.

Mosque building orientation can maximise opportunities for solar heat gain avoidance during summer months and self-shading throughout the year. The basic consideration for optimising self-shading opportunities includes the directional orientation of the supporting mosque building (excluding the predefined prayer hall orientation), which would facilitate achieving the shading requirements of Credit LBo-R3: Outdoor Thermal Comfort Strategy.

Additional shading can be provided by mature trees or by structures such as canopies. If structural elements are used, their outer surfaces must have a minimum Solar Reflectance Index (SRI) of 29. The SRI is a measure of a surface's ability to reflect solar heat on a scale of 0 to 100. The higher the SRI value is, the better the surface is at reflecting solar heat.

High SRI values can be achieved through the use of light reflective materials or finishes. Despite the importance of shading outdoor areas, careful consideration is required in the design of shading features so as not to detract from the aesthetics of the mosque and to avoid obstruction of major walkways leading worshippers to and from the mosque.

The following requirements in Table 3 illustrate potential strategies for acquiring the necessary shading percentages using optimised mosque layouts, natural elements or selective construction elements.

By complying with these requirements, the mosque is eligible for 1 Credit Point under Credit LBo-1: Improved Outdoor Thermal Comfort.

Location	Shading Requirement	Time of Shading
Riwaq	100%	Summer Solstice (June 21st) at 1.00pm
Sahan	No PBRS requirement (but shading must be provided if overflow is expected within the project).	Summer Solstice (June 21st) at 1.00pm
Public Circulation Areas	85% (this should include, at a minimum, a link between a plot entry portal and the riwaq and other high pedestrian traffic use areas).	Summer Solstice (June 21st) at 1.00pm

Table 3: Required Shading Levels

Note: All prayer areas, including overflow prayer areas shall provide 100% shading. During high capacity events, temporary shading may be considered for these areas but these must fit in with the overall architectural intent of the mosque.



Figure 13: Illustration of a Mosque with Outdoor Shading

Related Credits:
LBo-R3: Outdoor Thermal Comfort Strategy.
LBo-1: Improved Outdoor Thermal Comfort.

3.3 Accessibility and Provision of Community Facilities

A mosque provides a location where the community comes together on a regular basis. Therefore, it is beneficial that a mosque be accessible and located in an area with safe and easy access to other community facilities. This will allow worshippers to combine daily prayers with day-to-day tasks and will promote the use of individual mosques.

Designing a mosque adjacent to community facilities (e.g. adjacent to a kindergarten or grocery store) is highly encouraged as it will provide worshippers with additional points of activity and social interaction, helping to integrate the mosque within the community.

Locating mosques adjacent to existing or planned women's centres will encourage female worshippers to attend daily prayers in the designated prayer area at the mosque. Moreover, incorporating crèches into the mosque design provides the opportunity for families with dependent infants to attend daily prayers at the mosques within their community.

The provision of community centres and recreation areas adjacent to the mosque will encourage local youth to attend daily prayers at the mosque as they will be able to combine daily prayer with recreational activities.

Related Credits:
LBo-R2: Urban Systems Assessment.
LBo-3: Accessible Community Facilities.
LB0-4: Active Urban Environments.
LBo-7: Bicycle Facilities.

A full list of eligible community facilities can be found within Credit LBo-3: Accessible Community Facilities and are summarised as follows:

- Women's centre or youth centre;
- Kindergarten, daycare or school;
- Library;
- Post office;
- Police station;
- Healthcare facilities/pharmacy;
- Public open space that contains shaded playgrounds, public squares and family parks; and
- Retail comprising any of the following:
  - Bank and ATM;
  - Grocery store or supermarket;
  - Restaurant and café; and
  - General retail.

The mosque will be eligible for 1 Credit Point under Credit LBo-3: Accessible Community Facilities where it can be demonstrated that 5 of the above listed community facilities are within a 350 m safe walking distance from the mosque plot boundary.

The developer will need to submit a site plan indicating a 350 metre radius around the mosque building and indicate on the plan where the community facilities are located within this radius.

Bicycle Facilities

All mosques should provide bicycle storage facilities so that worshippers who wish to ride a bicycle to the mosque can do so. The provision of bicycle storage facilities will promote alternative transport and a healthier lifestyle.

The requirements of Credit LBo-7: Bicycle Facilities are summarised as follows:

- Provide solid bicycle parking stands that allow both bicycle wheel and frame to be securely locked;
- Ensure each bicycle stand is at least 2 m x 0.75 m;
- Ensure that an aisle of at least 1.5 m wide is provided alongside the bicycle parking to allow for manoeuvring;
- Provide shading for all bicycle parking stands; and
- To avoid congestion, bicycle storage facilities should be located within the plot boundary at a suitable distance from the mosque entrance, but still within a suitable walking distance from the mosque entrance.

The mosque designer should provide a minimum of 2 bicycle parking stands per 10 parking spaces, but not less than that required by Volume 1 – Planning (refer to Section 2.0), highlighted below:

- A minimum of 5 bicycle parking stands for mosques designed to accommodate less than 500 worshippers; or
- A minimum of 10 bicycle parking stands for mosques designed to accommodate 500 worshippers or more.

By complying with these requirements, the mosque is eligible to achieve 1 Credit Point under Credit LBo-7: Bicycle Facilities.

3.4 Safe, Secure and Healthy Environments

Safety and Security

Providing a safe and secure environment for worshippers to pray in is of high importance (refer to Volume 2 – Design). The key drivers behind safety and security for mosques are as follows:

- Fire and life safety: Ensure that worshippers are protected in the unlikely case of a fire within the mosque.
- Crime protection: Ensure the risk and threat of crime in and around a mosque is eliminated through smart environmental design.
- Physical security: Ensure a safe, secure and accessible environment is provided to worshippers.
- Community support: Ensure the mosque design allows it to play a central role within the community.

The objectives and design guidelines of safety and security for mosques are detailed within Volume 2 – Design. The mosque designer should utilise this guidance within the design of the mosque.

By complying with these requirements and the requirements of Credit LBi-10: Safe & Secure Environment, the mosque is eligible to achieve 1 Credit Point.

Examples of Physical Security and Community Access

Mosque users require movement not only along the street in the pedestrian realm but also in areas where pedestrian crossings are located. As pedestrians, mosque users are the most vulnerable of all street users. Special care and consideration is needed to identify potential issues and to design facilities accordingly.

Care should be taken when considering how the mosque will be linked to the rest of the community. To provide a high-quality pedestrian environment and ensure pedestrian safety, pedestrian crossings shall be provided on all streets to accommodate primary pedestrian desire lines and should meet the spacing standards outlined in the Abu Dhabi Urban Street Design Manual (refer to Figure 14).

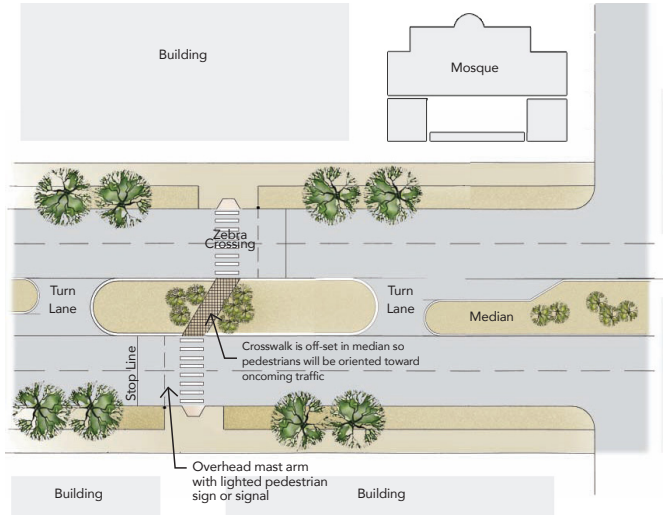


Figure 14: Safe Access to the Mosque

Healthy Environment

Credit LBi-R2 Smoking Control has the following requirements for mosque projects:

- Establish smoke-free environments in all internal and external areas within the mosque plot boundary;
- Train security staff to enforce a non-smoking policy; and
- Provide signage which indicates that all internal and external areas of the mosque are designated smoke-free.

Related Credits:
LBi-R2: Smoking Control.
LBi-10: Safe & Secure Environment.

3.5 External Waste and Recycling Storage

The mosque design and development team must develop an Operational Waste Strategy as per the requirements of Credit SM-R3: Basic Operational Waste Management. The strategy should address:

- All sources of waste generated within the mosque plot and throughout its operation;
- The provision of adequately sized on-site storage;
- Accessibility of storage areas by waste collection vehicles; and
- Final handling in terms of recycling or disposal.

The strategy must result in the provision of an appropriately sized external waste storage area and any relevant indoor storage containers where waste can be segregated into the following streams – at a minimum:

- Recyclable plastics, glass and metals;
- Recyclable paper and cardboard; and
- Non-recyclable waste.

In addition, a special container must be provided for the collection of Islamic documents which require a specific handling procedure by Awqaf and Tadweer (The Center of Waste Management – Abu Dhabi).

Related Credits:
SM-R3: Basic Operational Waste Management.
SM-14: Improved Operational Waste Management.

Waste Storage Sizing

The sources of waste within a mosque will vary depending on the mosque size, the extent of landscaping, specific operations (e.g. paper towels provided in ablution areas/plastic cups provided at drinking points), the time of week or year (i.e. regular prayer time vs. Ramadan, where Iftar meals may be offered), and the mosque's relation to the community where it is located (i.e. whether the mosque waste recycling points will be used by worshippers to dispose of collected recyclable household waste).

The design and development team must identify all possible waste streams throughout the mosque operation in order to provide adequate external waste and recyclables storage. Further guidance may be obtained from Tadweer (The Center of Waste Management – Abu Dhabi).

Waste Storage Location and Design

The mosque designer should consult with Tadweer (The Center of Waste Management – Abu Dhabi) to identify the best location of the external waste storage area. The discussion should also address the following:

- Accessibility requirements for waste collection vehicles (e.g. provision of a ramp);
- Labelling requirements;
- Security (e.g. locked waste room);
- Lighting provisions; and
- Cleaning requirements (e.g. use of ceramic finishes and provision of water and wastewater points).

3.6 Natural Systems management

The landscaped area of a mosque should provide an area of both high ecological value and high social value to the community, and the worshippers of the mosque. Increasing the ecological value of the landscaped areas can promote species diversity and enhance the overall aesthetics of the outside areas. This also increases the social value of the mosque and attracts worshippers from the surrounding community.

When designing the landscaped areas surrounding the mosque, the mosque designer should consider using a variety of native and adaptive drought tolerant plants, in accordance with the DMT's Abu Dhabi Public Realm Design Manual and the requirements of Credit NS-3 Ecological Enhancement (refer to Figure 15). The aim is to reduce water demand for irrigation and enhance the ecological value of the plot.

A Natural Systems Design and Management Strategy is also required to be prepared by the mosque designer, to ensure the long-term survival and prosperity of the landscape areas within the mosque plot. The Strategy must include the management of any on or off-site protected, mitigated or compensated natural asset areas and should promote soil protection and enhancement, low maintenance requirements and low demand for resources within the mosque plot. Moreover, the Strategy should identify the seasons during which each management activity will be carried out.

Suitable Planting for District Jame'e Mosques

 Atriplex glauca	 Pennisetum villosum	 Sesuvium portulacastrum
 Setcreasea purpurea	 Tecoma stans	

Suitable Planting for Jame'e Mosques

 Agave 'Blue Agave'	 Aloe striata	 Bougainvillea glabra
 Bougainvillea hybrids	 Crassula argentea	 Tradescantia spathacea

Suitable Planting for Masjid Mosques

 Aerva javanica	 Leptadenia pyrotechnica	 Atriplex glauca
 Bougainvillea glabra	 Bougainvillea hybrids	

Figure 15: Recommended Planting for Mosques

Soil Protection and Enhancement

Plant selection should suit existing soils on-site. Where soil enhancement is required, this should be tailored to the existing soil type. Design and development teams should consider enhancing soils with water and nutrient retaining supplements. Soils should be protected from erosion, pollution and increases in salinity. Paths should be provided to avoid pedestrian compaction of soil. Irrigation should consider the topography of the site and soil erosion.

Low Maintenance Requirements

Landscaping should be a combination of hard and soft landscaping, and should minimise the application of fertilisers, pesticides and herbicides. Landscaping should promote low maintenance requirements.

Low Demand for Resources

Plant selection should reflect the microclimate conditions of the area. Water efficient irrigation systems, such as monitored drip irrigation, should be adopted to minimise water consumption (refer to Section 12.0 and Attachment B in Volume 2 – Design).

Ecological Enhancement

The mosque design and development team should consider the use of a variety of native and adaptive plant species within the plot boundary. 2 Credit Points are available under Credit NS-3: Ecological Enhancement when 70% of the plants used as part of the landscape comprise native, drought and/or saline tolerant species and a minimum of 10 plant species.

Related Credits:
NS-R3: Natural Systems Design and Management Strategy.
NS-3: Ecological Enhancement.

3.7 Landscaping and Irrigation

The landscaping and irrigation of the external mosque areas will have a wide range of impacts on the sustainability of the mosque. These impacts range from irrigation water demand and material selection through to plant selection and open space provision. It is important that the mosque designer understands the landscape and irrigation requirements and should take into consideration any information taken from the Natural Systems Design and Management Strategy.

The mosque designer should also work in close communication with the Awqaf-appointed maintenance contractor who will be undertaking the operation and maintenance of the landscaped areas.

Hardscape Material Selection

The mosque designer must implement the following design measures when selecting hardscape materials for external landscape design:

- Meet the requirements of Volume 2 – Design;
- All hardscape materials must be standard pavers to allow for easy replacement of hardscape; and
- All hardscape materials must consist of permeable systems or open pavers. Where appropriate, the designer must consider subsurface conditions to ensure that it is capable of appropriate infiltration.

Irrigation Rates

The average irrigation rate to be utilised for landscaped areas should be a maximum of 2 l/m^2/day. This irrigation rate is to be applied to the whole of the landscaped area. This means that the ratio of hardscape to softscape areas will determine the amount of irrigation water available for softscape areas.

For example, should a landscaped area consist of 50% hardscape and 50% softscape then applying an irrigation demand rate of 2 l/m^2/day across the entire landscape will essentially allow 4 l/m^2/day of irrigation demand to the softscaped areas (there is no need to irrigate hardscape areas).

By complying with the requirements of Credit PW-2.1: Exterior Water Use Reduction: Landscaping and providing the Estidama Assessor with the relevant calculations, the mosque is eligible to achieve 4 Credit Points for the plant selection section of the credit.

Irrigation Systems

All mosques within the Emirate of Abu Dhabi should incorporate water efficient irrigation systems. This means implementing strategies and technologies which will minimise the amount of potable water lost through system losses (i.e. leakage) or operational losses (i.e. wind spray).

The mosque designer can implement the following design measures into the mosque irrigation system:

- Sub-surface drip irrigation system with appropriate filtering to avoid clogging or an appropriate surface drip irrigation;
- Moisture sensors to minimise excessive irrigation levels;
- Grouping all planting into irrigation zones with the required demand rate dependent on plant demand rates; and/or
- Soil amendment techniques to promote healthy soils and reduce evapotranspiration.

The mosque designer must submit a narrative explaining the irrigation system design and include relevant schematic diagrams and specification.

By complying with the requirements of Credit PW-2.1: Exterior Water Use Reduction: Landscaping, the mosque is eligible to achieve 1 Credit Point.

Related Credits:
PW-2.1: Exterior Water Use Reduction: Landscaping.
PW-2.2: Exterior Water Use Reduction: Heat Rejection.
SM-9: Regional Materials.
SM-10: Recycled Materials.

Irrigation Operation and Maintenance

The Awqaf-appointed maintenance contractor will be responsible for the operation and maintenance of the irrigation systems for all mosques. The mosque designer must communicate the irrigation system requirements to the Awqaf-appointed maintenance contractor and develop an appropriate Irrigation Operation and Maintenance Plan for inclusion in the Operations and Maintenance Manuals (refer to Volume 3 – Operations).

The Irrigation Operation and Maintenance Plan must include, as a minimum, the following:

- Regular monitoring requirements of the water usage and efficiency of the irrigation system, including locating and fixing any leaks present;
- The procedure to shut system down when a failure or leak occurs in the system to prevent wastage of water;
- The control philosophy for irrigation zoning, and the ability to shut individual irrigation zones down in the event of a malfunction; and
- Details on the irrigation system metering and sub-metering arrangements.

Recycled Condensate Water

In order to further minimise potable water use in the mosque irrigation system, the mosque designer may allow for the provision of an exterior water allowance from the condensate recovery from Air Handling Units (AHUs) and Fan Coil Units (FCU), where feasible.

The mosque may be designed to allow for the capture, storage and reuse of condensate recovery water into the irrigation system. The mosque developer will need to determine the amount of water obtained through condensate recovery. Where the condensate recovery is equal to the irrigation requirements, the mosque will be eligible for 2 Credit Points under Credit PW-2.2: Exterior Water Use Reduction: Heat Rejection.

Note that if the mosque does not use water for heat rejection (i.e. it only uses FCU), then the mosque will, by default, achieve 8 Credit Points under PW-2.2: Exterior Water Use Reduction: Heat Rejection.

3.8 Stormwater Management

Despite the low frequency of rainfall in Abu Dhabi, when storm events occur they often result in flash floods, which results in traffic congestion and the pollution, and contamination of land, urban stormwater drainage systems and receiving water bodies in the Emirate.

Credit PW-4: Stormwater Management encourages mosque design and development teams to develop stormwater management solutions that address both stormwater quantity and quality control.

Quantity Control

When designing roofs and ground landscaping of the mosque, the designer must consider ways in which to control stormwater run-off and quantities. This is possible through the use of:

- Pervious hardscaping products that promote infiltration such as open-grid paving;
- Sustainable Urban Drainage Systems (SUDS) such as ponds, vegetated swales and wetland; and
- Structural stormwater management solutions such as tanks, pipes and concrete channels.

The mosque designer must demonstrate through calculations that the post-development stormwater run-off and quantities as a result of the 2-year (24-hour) design storm, does not exceed the pre-development run-off and quantities.

By complying with these requirements, the mosque is eligible to achieve 1 Credit Point under Credit PW-4: Stormwater Management, when a combination of structural and non-structural control solutions are used. Further guidance on stormwater calculation is provided.

Stormwater Calculations

Generally stormwater run-off will be estimated based on the following formula:
$Q = 240 \times C \times I \times A$

Where:
Q = The peak run-off rate (m^3/day).
240 = conversion factor required to calculate Q in m^3/day.
C = the run-off coefficient.
I = the average rainfall intensity for the selected frequency and for a duration equal to the time of concentration (mm/hr).
A = the size of drainage area.

The rainfall intensity must be calculated based on Abu Dhabi Intensity Duration Flow (IDF) curves. The coefficient of run-off is the percentage of water which will run off the ground surface during a storm. The remaining amount of precipitation is lost to infiltration, transpiration, evaporation and depression storage. The values of run-off coefficients for developed areas used by Abu Dhabi Municipality are presented in Table 4.

Types of Drainage Area	Run-off Coefficient
Business	
Downtown business areas	0.70-0.95
Business and residential mixed areas	0.50-0.70
Residential	
Walled plots	0.20-0.40
Single – family and villa areas	0.30-0.50
Multi – units, detached	0.40-0.60
Multi – units, attached	0.60-0.75
Apartments (residential building)	0.50-0.70
Industrial	
Light areas	0.50-0.80
Heavy areas	0.60-0.90
Parks/cemeteries	0.10-0.25
Playgrounds	0.20-0.40
Unimproved areas	0.10-0.30
Grassed Areas	
Sandy soil, flat, 2%	0.05-0.10
Sandy soil, average, 2-7%	0.10-0.15
Sandy soil, steep, 7%	0.15-0.20
Heavy soil, flat, 2%	0.13-0.17
Heavy soil, average, 2-7%	0.18-0.25
Heavy soil, steep, 7%	0.25-0.35
Pavements	
Asphalt	0.70-0.95
Concrete	0.80-0.95
Interlocking pavers	0.70-0.85
Roofs	0.75-0.95

Table 4: Run-off Coefficients for Developed Areas

Related Credits:
PW-4: Stormwater Management.

3.9 External Building Materials

As the design of the mosque building and plot take shape, the design team must consider appropriate materials for external structures and building façades. Aesthetic aspirations must be able to accommodate PBRS thermal performance requirements in terms of construction practicalities.

Project teams may elect to follow 1 of 2 options to demonstrate compliance:

- Prescriptive route: details of the building material requirements that must be met are listed in Attachment A (Prescriptive Method Requirements); or
- Performance route: requires an energy model to demonstrate compliance.

There are several additional requirements that must be considered when specifying these materials (refer to Volume 2 – Design).

Achieving the Wall, Roof and Floor U-Value Requirements

With the extreme desert climates that exist in the region, significant importance is placed on the use of high performance building materials. The U-value is a common measure of the 'thermal transmittance' of a construction and in simple terms represents a measure of the rate of heat transfer so that a lower U-value represents increased thermal resistance.

Related Credits:
LBo-R3: Outdoor Thermal Comfort Strategy.
LBo-1: Improved Outdoor Thermal Comfort.
RE-R1: Minimum Energy Performance.

Several important considerations must be addressed to successfully implement the U-value requirements listed in Attachment A. The following list is focused on walls to demonstrate key concepts that the design team must address:

- Windows and doors must be excluded from the calculation of the overall wall U-value;
- The wall U-value must be the area-weighted average of all wall constructions and thermal bridges in the building (for example, a mosque built using insulated concrete blocks must also consider the structural areas, such as columns and thermal bridges through mortar, when calculating the overall wall U-value);
- Internal walls (those with consistently identical conditions on either side) need not meet U-value requirements;
- Care must be taken to ensure continuity of insulation where walls meet roofs (e.g. insulation should be suitably designed around parapets);
- Insulation must be provided to soffits over external colonnades/walkways where present;
- Depending on location and associated climate, the need for suitable vapour barriers must be addressed to eliminate the possibility of interstitial condensation in the summer months; and
- The use of high reflective surface coatings to reflect solar heat away (requirements for SRI) coatings are provided in Attachment A).

Achieving Window U-value and Solar Heat Gain Coefficient Requirements

Window selection is important in relation to overall building energy usage because windows generally will not perform as well as wall constructions in terms of U-value, however they also introduce useful light into occupied spaces.

While the U-value deals primarily with conductive gains through the window, radiative heat gains are also present through the glass. To address the radiative heat gains, another parameter known as the Solar Heat Gain Coefficient (SHGC) is used. The requirements that must be met for windows are listed in Attachment A.

Several important considerations must be addressed to achieve the project's U-value and SHGC targets. The following list demonstrates the key concepts that the design team must address:

- The U-value considers both the glass and frame components of windows. To simplify window selection, a U-value limit for glass has been prescribed which may be used when the frame is thermally broken;
- Window ratios for mosques must also be limited, as detailed in Attachment A.
- The designer should try to limit or eliminate direct solar radiation where possible so that daylight is introduced through the brightness of the sky rather than the sun (diffuse radiation). This can be achieved by the use of solar shading projections and mashrabiya panels (especially to east and west façades which are the hardest to shade); and
- The use of after-market solar films on glass to achieve SHGC requirements must be avoided. Instead, factory applied tints or reflective or sputtered coatings must be used.

Achieving External Shading SRI Requirements

When providing external shading, the design team must consider the type of shading that best suits the mosque. Shade can be created using trees, structural or temporary shades. Where the project is to use structural or temporary shades, the design team must ensure that the fabric has an outer surface (sky facing) SRI greater than 78 to reflect solar heat away.

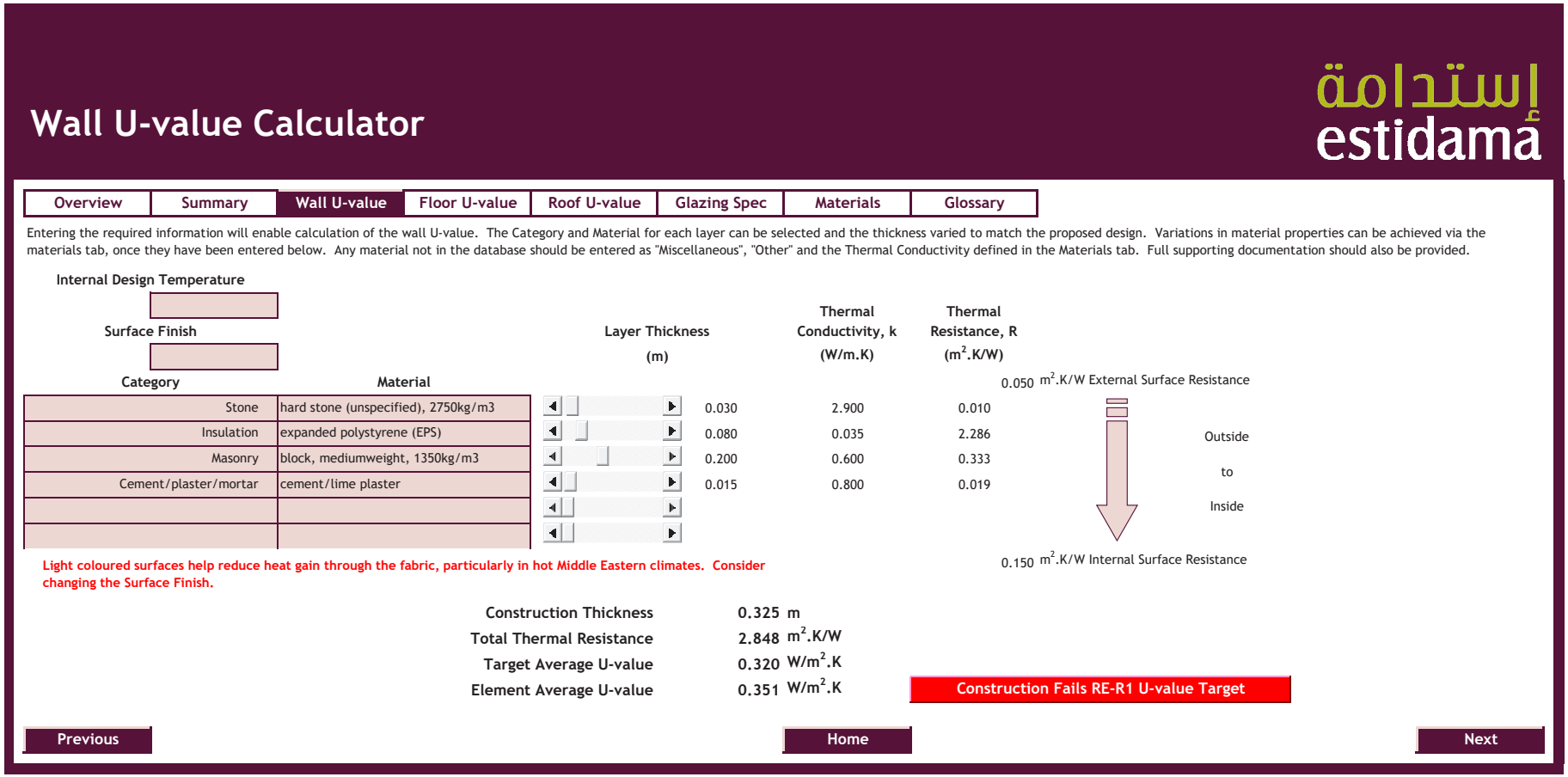


Figure 15: Sample U-Value Calculations for Wall

Roof U-value Calculator

إستدامة estidama

Overview | Summary | Wall U-value | Floor U-value | **Roof U-value** | Glazing Spec | Materials | Glossary

Entering the required information will enable calculation of the roof U-value. The Category and Material for each layer can be selected and the thickness varied to match the proposed design. Variations in material properties can be achieved via the mate

Internal Design Temperature

0

Surface Finish	Site Exposure
White	Exposed

Category	Material	Layer Thickness (m)	Thermal Conductivity, k (W/m.K)	Thermal Resistance, R (m^2.K/W)
				0.039 m^2.K/W External Surface Resistance
Concrete, cast	glass reinforced	0.030	0.900	0.033
Insulation	expanded polystyrene (EPS)	0.100	0.030	3.344
Concrete, cast	dense, reinforced	0.200	1.900	0.105
Cement/plaster/mortar	cement plaster, 1760kg/m3	0.015	0.720	0.021
				Outside
				to
				Inside
				0.206 m^2.K/W Internal Surface Resistance

Building Total Roof Area	75	m^2
Construction Thickness	0.345	m
Total Thermal Resistance	3.748	m^2.K/W
Target Average U-value	0.140	W/m^2.K
Element Average U-value	0.267	W/m^2.K

Construction Fails RE-R1 U-value Target

Previous | Home | Next

Figure 16: Sample U-Value Calculations for Dome

Roof U-value Calculator

إستدامة estidama

Overview | Summary | Wall U-value | Floor U-value | **Roof U-value** | Glazing Spec | Materials | Glossary

Entering the required information will enable calculation of the roof U-value. The Category and Material for each layer can be selected and the thickness varied to match the proposed design. Variations in material properties can be achieved via the materials tab, once they have been entered below. Any material not in the database should be entered as "Miscellaneous", "Other" and the Thermal Conductivity defined in the Materials tab. Full supporting documentation should also be provided.

Internal Design Temperature

0

Surface Finish	Site Exposure
	Partial

Category	Material	Layer Thickness (m)	Thermal Conductivity, k (W/m.K)	Thermal Resistance, R (m^2.K/W)
Concrete blocks/tiles	tiles	0.028	1.100	0.025
Cement/plaster/mortar	cement mortar, dry, 1900kg/m3	0.020	0.930	0.022
Loose fill/powders	sand	0.050	1.740	0.029
Insulation	extruded polystyrene	0.120	0.035	3.429
Concrete, cast	dense, reinforced	0.250	1.900	0.132
Cement/plaster/mortar	cement plaster, 1760kg/m3	0.020	0.720	0.028

0.038 m^2.K/W External Surface Resistance

Outside

to

Inside

0.206 m^2.K/W Internal Surface Resistance

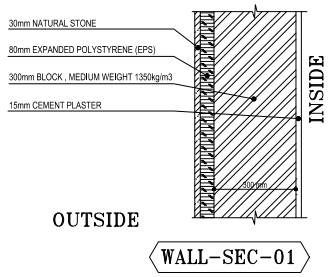
Light coloured surfaces help reduce heat gain through the fabric, particularly in hot Middle Eastern climates. Consider changing the Surface Finish.

Building Total Roof Area	526	m^2
Construction Thickness	0.488	m
Total Thermal Resistance	3.907	m^2.K/W
Target Average U-value	0.140	W/m^2.K
Element Average U-value	0.256	W/m^2.K

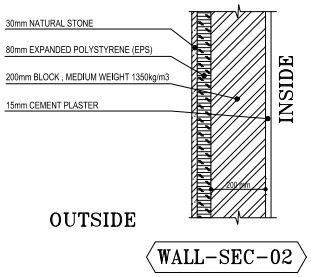
Construction Fails RE-R1 U-value Target

Previous | Home | Next

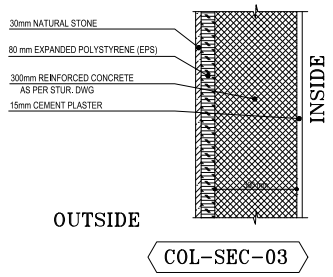
Figure 17: Sample U-Value Calculations for Roof



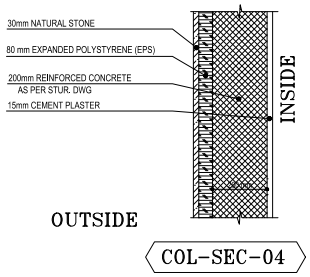
U- Value = 0.332 w/m²k



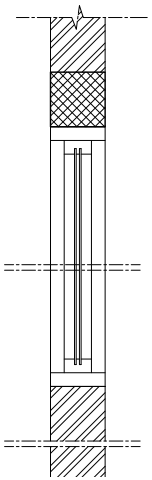
U- Value = 0.351 w/m²k

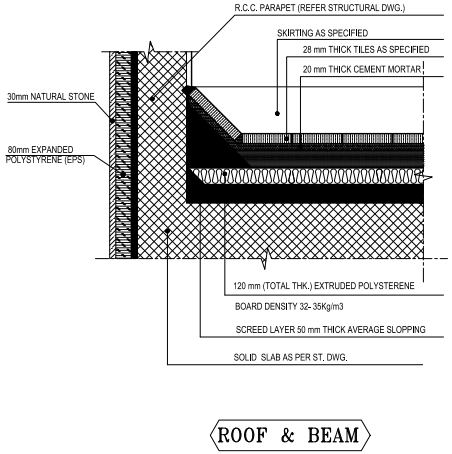


U- Value = 0.374 w/m²k

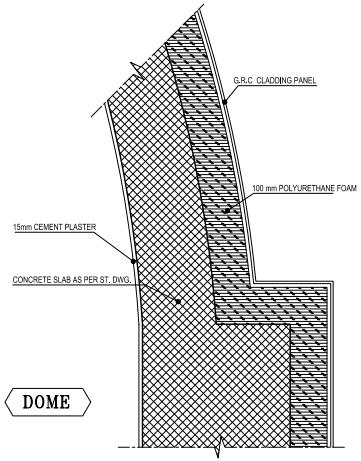


U- Value = 0.382 w/m²k

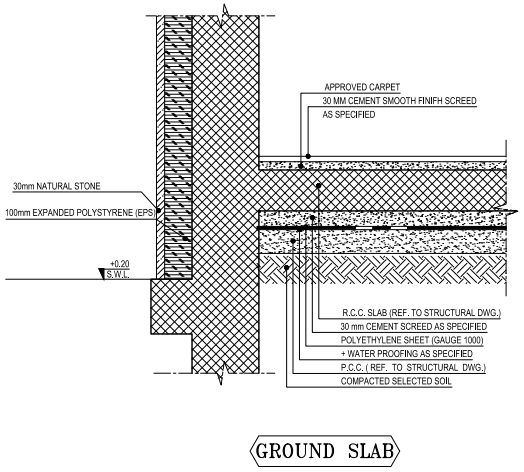




U- Value = 0.256 w/m²k

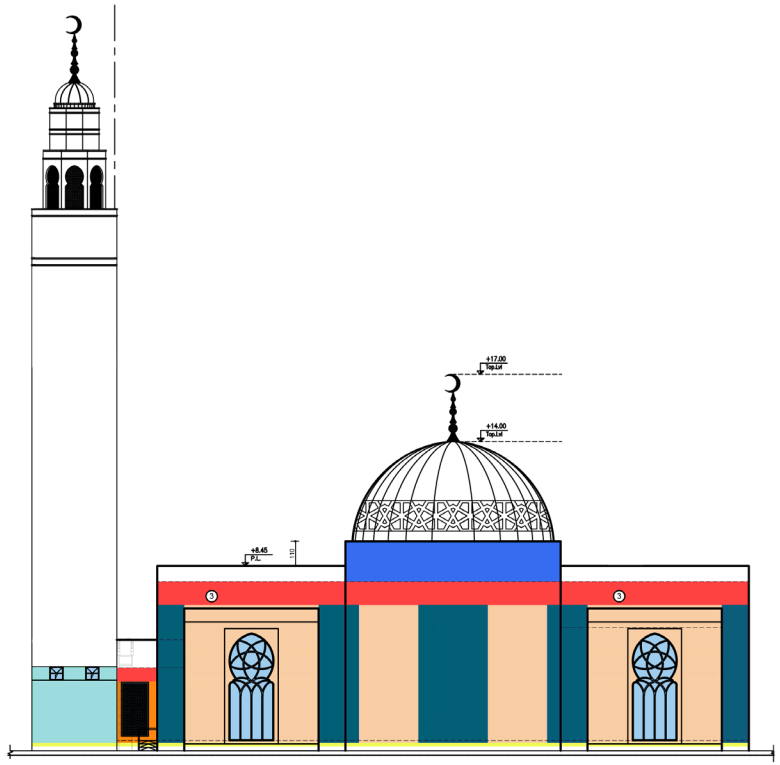


U- Value = 0.267 w/m²k



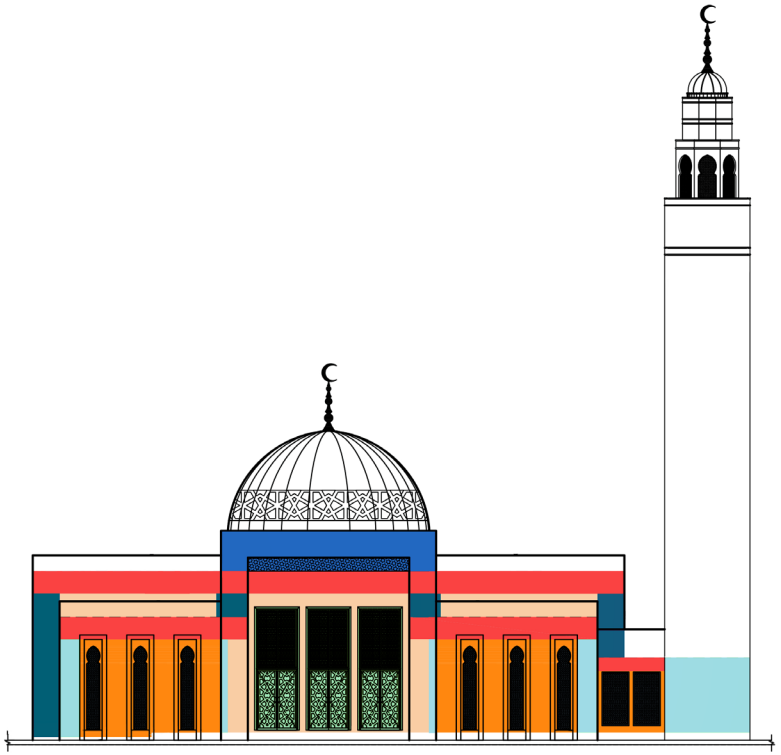
U- Value = 0.108 w/m²k

Figure 18: Sample Sections



1 ELEVATION (3)
A-203 (MOSQUE) Scale 1:100

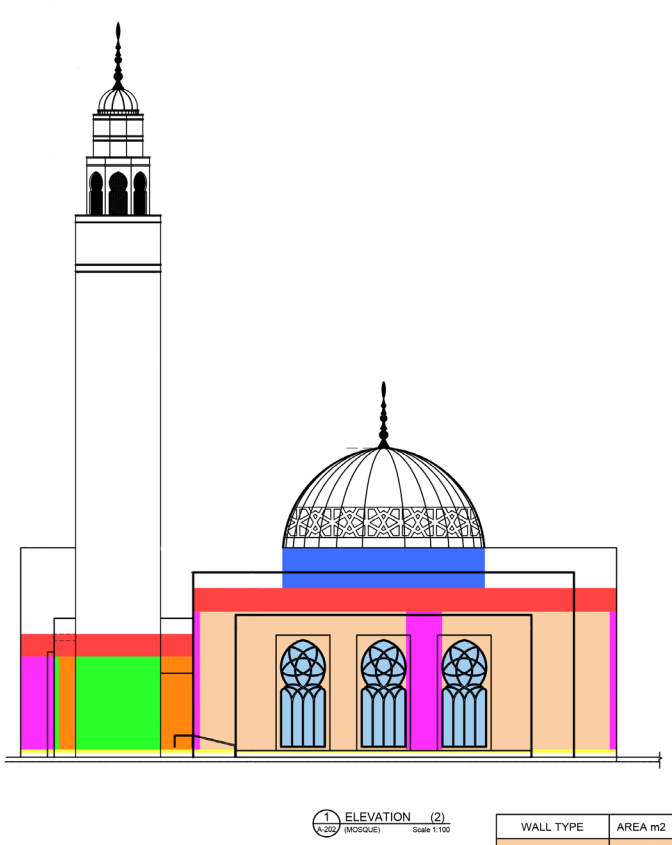
WALL TYPE	AREA m2	U-VALUE
WALL 01	88.85	0.332
WALL 02	2.07	0.351
COLM/BEAM 01	55.96	0.374
COLM/BEAM 02	12.20	0.382
GROUND SLAB	4.80	0.108
ROOF 01 & BEAM	28.79	0.382
ROOF 02 & BEAM	17.28	0.267
VISION PANEL	21.13	2.2
DOOR	00	2.2
TOTAL	260.75	



1 ELEVATION (1)
A-201 (MOSQUE) Scale 1:100

WALL TYPE	AREA m2	U-VALUE
WALL 01	33.82	0.332
WALL 02	42.46	0.351
COLM/BEAM 01	14.04	0.374
COLM/BEAM 02	22.86	0.382
GROUND SLAB	4.83	0.108
ROOF 01 & BEAM	45.00	0.382
ROOF 02 & BEAM	17.28	0.267
VISION PANEL	18.70	2.2
DOOR	33.00	2.2
TOTAL	261.66	

Figure 18: Front, Back and Side Elevation Sample U-Value Calculations



1 ELEVATION (2) (MOSQUE) Scale 1:100

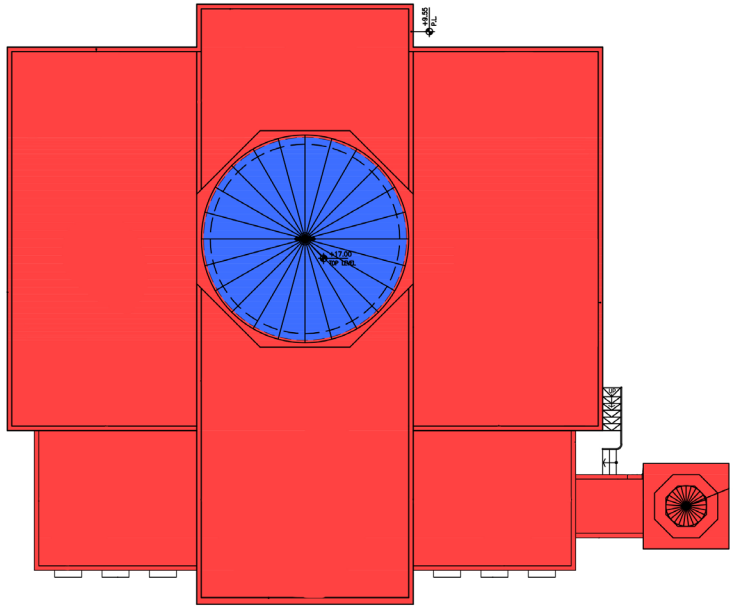
WALL TYPE	AREA m2	U-VALUE
WALL 01	76.40	0.332
WALL 02	9.13	0.351
COLM/BEAM 01	19.75	0.374
COLM/BEAM 02	16.60	0.382
GROUND SLAB	4.00	0.108
ROOF 01 & BEAM	27.54	0.382
ROOF 02 & BEAM	17.28	0.267
VISION PANEL	26.30	2.2
DOOR	00	2.2
TOTAL	226.67	

Figure 18 (contd.): Front, Back and Side Elevation Sample U-Value Calculations

$U_{avg} = \sum (Wall\ Area * U) / \sum Wall\ Area$

No.	WALL TYPE	ROOF	TOTAL AREA	RATIO	TOTAL WALL AREA	U-VALUE	Total U-VALUE	Average U-VALUE
6	Roof-01	589.46	**589.46**	84.2%	700.46	0.256	150.902	0.258
7	Roof-02 (Dome)	111.00	**111.00**	15.8%		0.267	29.637	
	TOTAL	**700.46**	**700.46**	**100%**				

ROOF TYPE	AREA m2	U-VALUE
ROOF 01 & BEAM	589.46	0.256
DOME	111.00	0.267
TOTAL	700.46	



1 ROOF FLOOR PLAN (MOSQUE) Scale 1:100

Figure 19: Dome Sample U-Value Calculation

4.0
Design of Indoor Spaces

4.0 Design of Indoor Spaces

There are many factors to consider when planning the internal layout of a mosque. The primary consideration is functionality, as the mosque exists to serve the religious needs of the community and, therefore, must meet certain requirements (refer to Sections 2.0 and 3.0 in Volume 2 – Design).

In order to develop a sustainable mosque, the design team must consider other critical factors such as ventilation, controls, thermal comfort, natural lighting and material emissions. This section focuses on ventilation strategies and thermal zoning.

Ventilation

The provision and quantity of clean ventilation air must be considered at the design stage in order to meet the requirements of Credit LBi-R1: Healthy Ventilation Delivery. The design team must address:

- Sources of pollution to be avoided (both within the mosque plot and beyond);
- Exhaust air discharges, including those associated with ablution and toilet facilities;
- Ventilation rates to be achieved according to Estidama requirements;
- Mosque usage patterns in relation to varying ventilation and cooling according to demand;
- Effective thermal zoning to ensure adequate on-floor plant capacity and associated controls; and
- Any proposed physical sub-partitioning within the prayer halls to facilitate the flexible use of space.

The design team must produce appropriate documentation to demonstrate how these considerations have been addressed and embedded within the mosque design drawings, specifications and associated documents.

Thermal Zoning

Thermal zoning is a key concept in assessing the thermal response of the building. Credit LBi-5.1: Thermal Comfort & Controls: Thermal Zoning, requires an understanding of the relationship between the spatial organisation of the building and exposure to environmental factors. Thermal zoning is a method of designing and controlling the Heating, Ventilation and Air Conditioning (HVAC) system so that occupied areas can be maintained at a different temperature to unoccupied areas using independent setback thermostats. Zones vary with orientation and with exposure to environmental conditions.

Buildings are usually divided into 2 major zones:

- Exterior Zone: The area inward from the outside wall (5 metres from the perimeter wall). The Exterior Zone is directly affected by outdoor conditions. Separate zones and controls must be designed for a maximum of 40m^2 of open plan space.
- Interior Zone: The area contained by the External Zone. The Interior Zone is only slightly affected by outdoor conditions and usually has a uniform cooling load requirement. Separate zones and controls must be designed for a maximum of 100m^2 of open plan space.

Each thermal zone must have thermostats that control air speed or temperature, at a minimum.

Acoustic Design

The acoustic design of a building is another important consideration. As such, the requirements for limiting noise pollution should be considered by the designer. Credit LBi-9: Indoor Noise Pollution requires designers to demonstrate they have considered internal ambient noise levels and they have taken into account external noise contributors within their design.

Related Credits:
LBi-R1: Healthy Ventilation Delivery.
LBi-5.1: Thermal Comfort & Controls: Thermal Zoning.
LBi-9: Indoor Noise Pollution.

4.1 Ventilation Strategy

The purpose of building ventilation systems is to provide fresh air inside the mosque and for the suitable removal of air contaminants. To achieve this, the following design measures must be addressed:

- Location of air intakes in relation to sources of pollution;
- Location of exhaust air discharges;
- Ventilation rate requirements;
- Varying demand for fresh air according to space usage and daily occupancy variations; and
- Thermal zoning strategy.

Air Intakes

When considering the location of air intakes (including doors and operable windows), the designer must ensure that the separation distances comply with the minimum thresholds set out in Table 5 (more detail on these requirements is provided in ASHRAE 62.1:2007 Table 5.1).

Related Credits:
LBi-R1: Healthy Ventilation Delivery.
LBi-5.1: Thermal Comfort & Controls: Thermal Zoning.

	Air Intake Minimum Separation Distance (metres)
Significantly contaminated exhaust	5
Noxious or dangerous exhaust	10
Vents, chimneys, and flues from combustion appliances and equipment	5
Garage entry, automobile loading area or drive-in queue	5
Truck loading area or dock, bus parking/idling area	7.5
Driveway, street, or parking area	1.5
Thoroughfare with high traffic volume	7.5
Roof, landscaped grade, or other surface directly below intake	0.3
Garbage storage/pick-up area or dumpsters	5
Cooling tower intake or basin	5
Cooling tower exhaust	7.5

Table 5: Minimum Air Intake Separation Distances

The designer must present their strategy for the location of air intakes. This strategy must include an air intake plan showing all sources of pollution including:

- Waste storage areas;
- Air Handling Unit (AHU) exhausts;
- Toilet and kitchen air extractor units;
- Car parking;
- Driveways and streets;
- Roads and highways;
- Bus and taxi ranks;
- Cooling towers; and
- Any other notable pollution sources.

To fulfil the requirements of this strategy, the designer must visit the plot before commencing design of the ventilation systems to document and photograph the location of pollution sources arising immediately outside the mosque plot. Distances of pollutant sources to the plot boundary must also be included in the air intake plan.

Exhaust Air Discharges

When determining the position of exhaust air discharges, the designer must consider the location of air intakes, operable windows and entrances of the mosque and neighbouring buildings.

Exhaust air discharges must not be located within the defined public realm, such as pedestrian pathways, in addition to the riwaq and sahan.

Ventilation Rates

The mosque designer must design the mechanical ventilation system in accordance with the requirements of ASHRAE 62.1.2007: Table 6.1, relevant extracts of which are shown in Table 6.

Varying Fresh Air Demand

Occupancy will vary substantially in prayer halls, multi-purpose halls and Qur'anic class areas. The ventilation system must have the ability to accommodate varying occupancy. At a minimum, unoccupied spaces, or parts of spaces, must be capable of turning down the provision of fresh air via response from the local thermostat controller.

Larger mosques, i.e. those serving more than 1,000 worshippers, should utilise CO2 sensors to determine the fresh air demand and modulate the fresh air provision.

In all mosques, the ventilation system must be designed to accommodate space subdivision through partitioning to ensure turn down of fresh air to unoccupied spaces.

By complying with these requirements, the mosque is eligible to achieve Credit LBi-R1: Healthy Ventilation Delivery.
A sample of fresh air calculation as per ASHRAE 62.1.2007 and exhaust schedule is included in the following pages.

Thermal Zoning

The mosque designer must design the ventilation system in conjunction with the thermal zoning strategy discussed in Section 4.2, which sets out the requirements of Credit LBi-5.1: Thermal Comfort & Controls: Thermal Zoning, and within Volume 2 – Design.

No.	Building	Space/ Room Type	Occupancy Rate	Ventilation Rate l/s		Extract Rates (l/s)	Indoor Design Conditions	
				People Outdoor Air Rate (l/s/person)	Area Outdoor Air Rate (l/s/m^2)		Temperature (°C)	Relative Humidity (%)
1	Imam's/ Mu'athen's Residence*	Bedroom	First bedroom 2; each additional bedroom 1.	Not less than 2.5	0.3	-	23°C +/- 1°C	50% +/- 10%
		Living areas	Based on number of bedrooms. First bedroom 2; each additional bedroom 1.	Not less than 2.5	0.3	-	23°C +/- 1°C	50% +/- 10%
		Kitchen	-	N/A	-	25 l/s (for continuous operation)/12.5lps (for intermittent operation)	23°C +/- 1°C	50% +/- 10%
		Toilet	-	N/A	-	12.5 l/s (continuous operation)/25lps (intermittent operation)	23°C +/- 1°C	50% +/- 10%
2	Mosque	Office	5 Occs./100 m^2	2.5	0.3		23°C +/- 1°C	50% +/- 10%
		All prayer halls	1 Occs./0.9 m^2	2.5	0.3		23°C +/- 1°C	50% +/- 10%
		Lobby	10 Occs/100 m^2	2.5	0.3		23°C +/- 1°C	50% +/- 10%
		Library	10 Occs/100 m^2	2.5	0.6		23°C +/- 1°C	50% +/- 10%
		Store	-	-	0.6		23°C +/- 1°C	50% +/- 10%
		Ablution	-	-	-	24 l/s per basin (for intermittent operation)	23°C +/- 1°C	50% +/- 10%
		Toilet	-	-	-	35 l/s per WC or urinal (for intermittent operation)	23°C +/- 1°C	50% +/- 10%
		Shower	-	-	-	9lps l/s per showerhead (for continuous operation), 24 l/s per showerhead (for intermittent operation)	23°C +/- 1°C	50% +/- 10%

Table 6: Sample Calculation for Mechanical Ventilation System

Related Credits:
LBi-R1: Healthy Ventilation Delivery.
LBi-5.1: Thermal Comfort & Controls: Thermal Zoning.

* Note:
These regulations are optional, otherwise, Imam/Mu'athen's residence to comply with natural ventilation requirements as per Section 5 of ASHRAE 62.1.

Fresh Air Calculations														
No.	Space Name - Number	Floor	AREA - A (m^2)	Occupants - O	Rp	Ra	F/A Demand (L/S) = (Rp*O)+(Ra*A) (L/s)	ESTIDAMA F/A Supply (L/S) = Sfa	ASHRAE 62.1	EMT Space	Total Area - TA (m^2)	Total Occupancy - TO	Occupancy Density (m^2 /person) = TA / TO	Occupancy Fresh Air (l/s/person) = Total Sfa/ TO
					OA/Person (L/s) .Person	L/s.m^2								
1	Male Prayer Room	Ground Floor	420	445	2.5	0.3	1,238.5	1,240	Place of Religious Workship	Place of Religious Workship	470.4	500	0.9	2.8
2	Female Prayer Room	Ground Floor	50.4	55	2.5	0.3	152.62	155						
	GF Sub-Total	-	470.4	500			1,391	1,395						
	Fresh Air	-	470.4	500			1,391	1,395						

Table 7: Sample Fresh Air Calculations - as per ASHRAE 62.1.2007

Exhaust Schedule												
No.	Space Name - Number	Floor	AREA - A (m^2)	Occupants O	ASHRAE 62.1 Minimum Exhaust Rates	Actual Exhaust Capacity (L/s)	ASHRAE 62.1	Total Exhaust (L/s)	Total Area (m2)	Total Occupancy	Occupancy Density (m^2/ person)	Fresh Air (l/s/person)
1	Male Ablution	Ground Floor	16.34	0	35	378	Rest Rooms	897	39.30	0	0	0
2	Women Ablution	Ground Floor	11.56	0	35	141						
3	Imam Bath	Ground Floor	5.60	0	35	94						
4	Toilets in Imam	Ground Floor	5.80	0	25	472						
5	Imam Kitchen	Ground Floor	8.60	0	25	95	Dining Area	189	9	0	0	0

Table 8: Sample Exhaust Schedule

4.2 Thermal Zoning

Thermal zoning is the principle of sizing on-floor systems according to the varying peak loads within the space (refer to Figure 20). A key outcome of thermal zoning is the ability to control HVAC systems so that occupied spaces can be maintained at a different temperature to unoccupied spaces without compromising occupant thermal comfort. Appropriate thermal zoning of the interior spaces of the mosque is important to minimise the amount of energy used in space cooling.

Mosque spaces that must be considered include the male and female prayer areas, multi-purpose hall and Qur'anic class areas, as all of these will experience widely varying occupancies throughout the year and tend to be large enough to warrant zoning.

When planning for the HVAC system that will serve these spaces, the designer should establish thermal zones, with each zone having a dedicated indoor cooling unit and local thermostat controller.

The size of each thermal zone should be 35m² to 40m² for perimeter spaces and 70m² to 100m² for internal areas. Perimeter thermal zones along the same wall may be combined. For larger mosques, a central Building Management System (BMS) should be installed to link with all cooling units and thermostat controllers.

Accommodating Partitioning Within the Mosque

A mosque will typically cater for 5 daily prayers each day of the year. Depending on the type of mosque, additional prayers may need to be catered for. The expected occupancy density may vary from 100% for jame'e and Eid prayers, to approximately 20% to 25% for Fajr prayers.

Where the use of space subdivision through partitioning is utilised, the thermal zoning strategy must accommodate this physical sub-division of space by providing suitable thermostatic controls, sensors and supply terminals to enable energy savings to be made. The occupied space should be controlled to the design temperature with the unoccupied space allowed to drift to an appropriate design set-back temperature.

Consideration must be given to the need for provision of fresh air to occupied spaces and how the HVAC system will be designed to accommodate these variations.

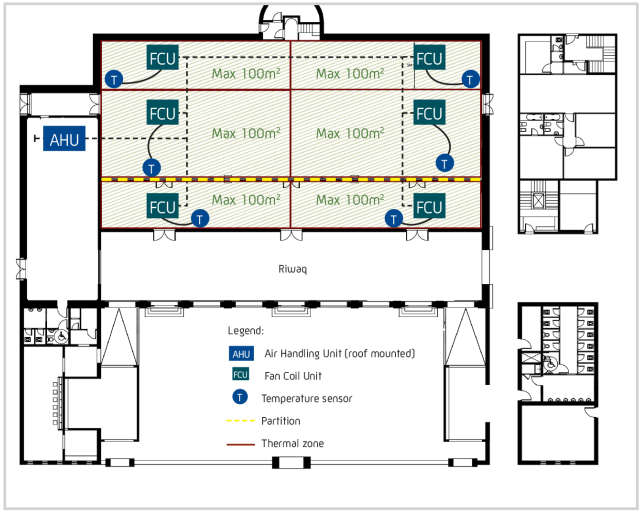


Figure 20: Example of Thermal Zoning in a Prayer Hall

While not part of Credit LBi-5.1: Thermal Comfort & Controls: Thermal Zoning, it is expected that the designer will also provide lighting systems with local controls that reflect the intended space use strategy.

Space subdivision is best achieved through easily movable partitioning. Permanent partitioning can be considered as long as it can be demonstrated that it does not interfere with the primary mosque functions. In either case, the partitioning system must extend from the finished floor to the underside of the ceiling.

Where the mosque demonstrates the requirements of Credit LBi-5.1 Thermal Comfort & Controls: Thermal Zoning have been met, it will be eligible for 1 Credit Point.

Related Credits:
LBi-5.1: Thermal Comfort & Controls: Thermal Zoning.

4.3 Acoustic Design

The mosque designer should demonstrate that internal ambient noise levels are between 40-50 dB(A)Leq in the areas to be occupied within the mosque. For the Imam's residence, the internal ambient noise levels should be less than 35dB(A) Leq(8hour) and 45dB(A)Lmax, fast in bedrooms and less than 40dB(A)Leq in other areas.

From the early stages, the building can be designed to minimise the internal ambient noise levels. This can be achieved by considering several aspects such as:

- Location of noise sensitive areas of the building with respect to external noise sources, such as surrounding streets;
- Consideration of the air-gaps in construction and provision of appropriate sealing measures;
- Location of rooftop AHUs;
- Provision of sound attenuators on air ducts carrying air at high velocities;
- Velocity of air in the ducts;
- Noise generated by MEP equipment;
- Design of internal drainage piping to reduce noise; and
- Use of wall insulation for minimising ambient noise.

Only noise from building services and external noise sources should be included in measurements and calculations. All analyses must represent the noisiest areas of the building, typically near façades on busy streets. All calculations, measurements and acoustic reports must be signed off by a qualified acoustics engineer.

Related Credits:
LBi-9: Indoor Noise Pollution.

5.0
Material Selection

5.0 Material Selection

The construction of a mosque uses many materials, such as concrete, metal, wood, glass, plastics and paints. To generate these products, the raw materials must be extracted, processed into usable form, manufactured into assembled products, packaged and transported before they are used in the construction of the mosque. Repairs, renovations and modifications to the mosque puts additional pressure on the demand for raw materials. Regardless of which products are selected to construct a mosque, hazardous materials, such as asbestos, must not be used due to the potential negative health implications.

During the useful life of the mosque, the permanent residents (Imam and Mu'athen) and worshippers will consume products and discard associated waste such as food, paper, cardboard, bottles and plastic bags. At the end of the useful life of the mosque, significant quantities of demolition waste must be disposed of. According to Tadweer (The Center of Waste Management – Abu Dhabi), almost 6,000,000 tonnes of waste are generated in the Emirate every year but many more tonnes of scarce raw materials are required to manufacture the products.

Most of Abu Dhabi's waste is currently disposed of in dedicated areas called landfills and left to slowly decay. Unfortunately, some waste is illegally dumped in unauthorised locations. Both of these practices have many negative impacts:

- Pollution of the local environment – groundwater and soil contamination;
- Production of methane, a potent greenhouse gas, by waste decay;
- Injuries to local wildlife;
- Harbouring of disease by rats and flies;
- Environmental noise;
- Odour; and
- Dust.

The following items are the topics covered by the PBRS which should be addressed when designing any mosque. These topics begin to address the challenge of reducing our impact on the world's natural resources, the environmental impacts associated with our actions and providing spaces which do not harm its residents and visitors.

Hazardous Materials

The mosque must eliminate the use of asbestos and Chromated Copper Arsenate (CCA) treated timber.

Low Emission Materials

Adhesives and sealants, paints and coatings, flooring and ceiling systems should be specified to reduce the quantity of odorous and harmful indoor air contaminants. All internal construction materials and installed furniture should not exceed formaldehyde content class E1 levels.

Construction Waste

A Construction and Demolition Waste Management Plan (CDWMP) must be in place in order to identify methods of waste collection, transport and disposal. The CDWMP must identify the materials to be diverted from landfill and indicate whether the materials will be segregated on-site or commingled. If materials are planned for salvage, the CDWMP must indicate their planned use.

Operational Waste

An Operational Waste Strategy (OWS) must be in place in order to identify methods of waste collection, transport and disposal. Adequately sized and accessible facilities and clearly labelled containers must be provided for the storage and collection of source-segregated waste.

Modular Materials

Waste associated with the replacement of flooring systems should be minimised through the use of modular flooring systems.

Durable Materials

A Building Durability Plan (BDP) should be developed and implemented to optimise the integrity of the building envelope. The BDP should address condensation, water ingress, improper drainage and the protection of vulnerable areas of the building envelope.

Recycled Materials

Recycled steel and aggregate, as well as an alternative to Portland cement, should be used in order to reduce the amount of waste going to disposal.

Regional Materials

Air-freighted materials should be avoided and building materials with a reduced transport impact, as well as those which promote regional economies, should be selected.

Related Credits:
SM-R1: Hazardous Materials Elimination.
SM-R2: Basic Construction Waste Management.
SM-R3: Basic Operational Waste Management.
SM-5: Modular Flooring Systems.
SM-6: Design for Durability.
SM-9: Regional Materials.
SM-10: Recycled Materials.
SM-12: Reused or Certified Timber.
LBi-2.1: Material Emissions: Adhesives & Sealants.
LBi-2.2: Material Emissions: Paints & Coatings.
LBi-2.3: Material Emissions: Carpet & Hard Flooring.
LBi-2.4: Material Emissions: Ceiling Systems.
LBi-2.5: Material Emissions: Formaldehyde Reduction.

5.1 Modular Flooring Systems

The use of modular flooring systems (carpets and tiles) reduces the amount of waste associated with replacing large areas of flooring that is damaged due to accident or general use. Modular flooring systems provide a solution to this as only the section of flooring that is damaged requires replacement, hence reducing the amount of waste generated.

In order to provide comfort during prayer, and to assist with the cleanliness of the mosque, the main areas in mosques are covered in carpet. This provides an excellent opportunity to implement a modular flooring system (carpet) (refer to Figure 21) (refer to Sub-section 3.4.1 in Volume 2 – Design).

The mosque designer must specify that a minimum of 95% of all flooring systems in the mosque is laid with a modular flooring system. In addition, the modular flooring system must meet 1 of the following requirements of Credit SM-5: Modular Flooring Systems:

- A minimum of 30% post-consumer recycled content;
- Be fully or partly recyclable;
- Be rapidly renewable; or
- Be extracted, harvested or recovered and manufactured locally as required by Credit SM-9: Regional Materials.

Where the mosque designer and/or contractor can demonstrate the above requirements are met through the submission of drawings, carpet or tile specifications, the mosque is eligible to achieve 1 Credit Point under SM-5: Modular Flooring Systems.



Figure 21: Example of a Modular Flooring System in a Mosque (Carpet)

Related Credits:
SM-5: Modular Flooring Systems.

5.2 Design for Durability

The intention when constructing a mosque is for the building to last as long as possible with minimum maintenance and replacement of building systems. Therefore it is very important that the mosque designer and contractor take the necessary steps to ensure that vulnerable building elements are not exposed to damage.

The type of damage that a mosque could endure ranges from structural damage through to water damage, and must be protected through appropriate design, commissioning, building performance verification and sound construction techniques.

In order to be eligible for 1 Credit Point under Credit SM-6: Design for Durability, the mosque designer must submit a narrative which describes the following measures, which must be undertaken/implemented during the design and construction of a mosque:

- Condensate capture: the mosque designer should specify that all AHUs and FCUs have appropriate condensate capture capabilities. Build-up of condensate can lead to water leakage and cause damage to ceiling systems and flooring/carpets;
- Crash protective system (where applicable): bollards should be designed in order to prevent vehicular crash damage to structural and façade elements of the mosque; and
- Waterproofing of drains and ablution areas: the mosque designer and/or contractor must detail the procedure for waterproofing all drainage and piping within the mosque. This is to protect the building from leaks from the drainage and water pipes of the mosque. The water supply systems in the ablution toilet areas must be included as these are areas with a high likelihood of water leakage.

5.3 Regional Materials

The selection and procurement of regional materials for a mosque project reduces the energy and pollution associated with transport while supporting local and regional economies. Regional materials are defined under Credit SM-9: Regional Materials as those extracted, harvested, processed and manufactured within 500 km of the mosque plot.

2 Credit Points can be achieved under Credit SM-9: Regional Materials when the design and development team can demonstrate that the cost of regional materials represents more than 20% of the total materials cost on the project.

Material costs includes concrete, masonry, metals, wood, plastics and composites, thermal and moisture protection, openings, finishes, earthwork and exterior improvements. Labour and equipment costs, lifts and escalators and MEP equipment should be excluded from the calculations.

The project team must request the materials suppliers or manufacturers to provide formal documentation describing the origin of the material extraction and manufacture.

The PBRS Submission Templates include a Regional Materials Calculation Template under SM-9: Regional Materials tab. This template must be used in order to demonstrate compliance with the threshold requirements of the Credit.

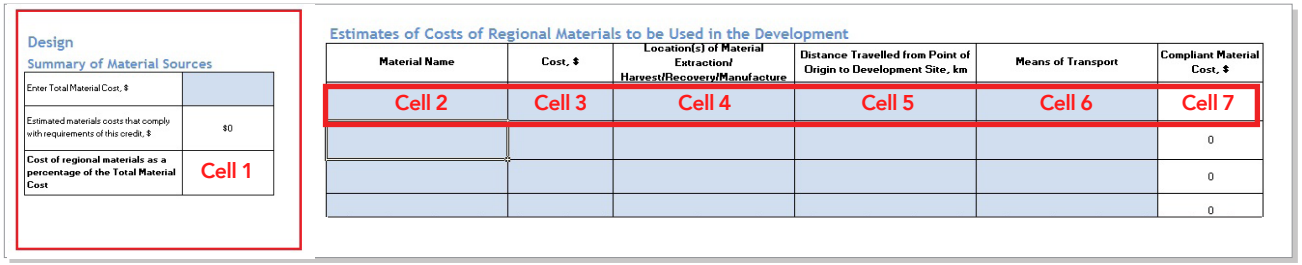
Regional Materials Calculation

Percentage Regional Materials =
(cost of the regional material / total cost of material) x 100

Related Credits:
SM-6: Design for Durability.

Regional Materials Calculation Template

The details of each individual regional item procured for the project must be inserted into this calculation template (refer to Figure 22) (refer to Table 7):



Design

Summary of Material Sources

Enter Total Material Cost, $	
Estimated materials costs that comply with requirements of this credit, $	$0
Cost of regional materials as a percentage of the Total Material Cost	Cell 1

Estimates of Costs of Regional Materials to be Used in the Development

Material Name	Cost, $	Location(s) of Material Extraction/ Harvest/Recovery/Manufacture	Distance Travelled from Point of Origin to Development Site, km	Means of Transport	Compliant Material Cost, $
Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7
					0
					0
					0

Figure 22: Extract from the Regional Materials Worksheet

Cell	Requirement
Cell 1	Insert the total cost of materials for the mosque project (e.g. AED 1 million).
Cell 2	Insert the product name (e.g. carpet).
Cell 3	Insert the estimated product cost (e.g. AED 38,657).
Cell 4	Insert the location of origin for the material, i.e. the furthest point to the project site from the point of extraction, harvest or recovery, or the point of manufacture (e.g. Fujairah).
Cell 5	Insert the distance travelled by the materials to the construction site. This is calculated as the 'distance travelled by road or rail' + (0.1 x distance travelled by sea) (e.g. 207 km).
Cell 6	Insert the means of transport of the material to the construction site, i.e. by road, rail or sea.
Cell 7	This cell will be outputted by the worksheet as the amount that is in compliance with the Credit requirements. That is, if the mosque material (e.g. carpet weaved in Fujairah at a distance of 207 km from the project plot) costing AED 38,657 was confirmed to be sourced within a distance of 500 km from the mosque plot, then the compliant material cost will also be AED 38,657.

Table 7: Worksheet Process

Related Credits:
SM-9: Regional Materials.

Definitions

- The 'furthest point of origin' is the longest distance to the project site from (1) the point of extraction, harvest or recovery or (2) the point of manufacture;
- The distance travelled is calculated as (distance travelled by road or rail) + 0.1 x (distance travelled by sea);
- Calculations to include distance to site but do not include returns;
- Where materials or primary constituent elements are quarried, extracted or harvested, the calculation begins at this point and includes the distance travelled to the manufacturing processing facility;
- For composite materials, a weighted average by weight (mass) must be applied to the distance; and
- Where products are primarily comprised of recycled materials (i.e. 90% by weight or more), the calculation begins at the point of manufacture.

5.4 Recycled Materials

Materials manufactured from recycled content require fewer raw materials to be used as part of their manufacture and indirectly contribute to the reduction of waste going to landfill. Design and development teams are required to consider the use of cement replacement, recycled steel, recycled aggregate or any other recycled material for the mosque project as required by Credit SM-10: Recycled Materials.

Recycled Steel

It is recommended that mosque projects procure and use structural steel with post-consumer recycled content. By meeting the below requirements which are set out within Credit SM-10: Recycled Materials - Recycled Steel, a mosque is eligible for 1 Credit Point:

- For steel-framed mosque buildings, 50% of the steel by weight must have a minimum of 25% post-consumer recycled steel; or
- For concrete-framed mosque buildings using steel as part of the concrete reinforcing, 80% of the steel by weight must have a minimum of 90% post-consumer recycled steel.

Steel with post-consumer recycled content refers to steel that has completed the end of its life cycle after being used by consumers (e.g. scrap metal) and has been diverted back to the manufacturing process.

The project team must request the steel supplier or manufacturer to provide formal documentation describing the post-consumer recycled content of the steel supplied for the project.

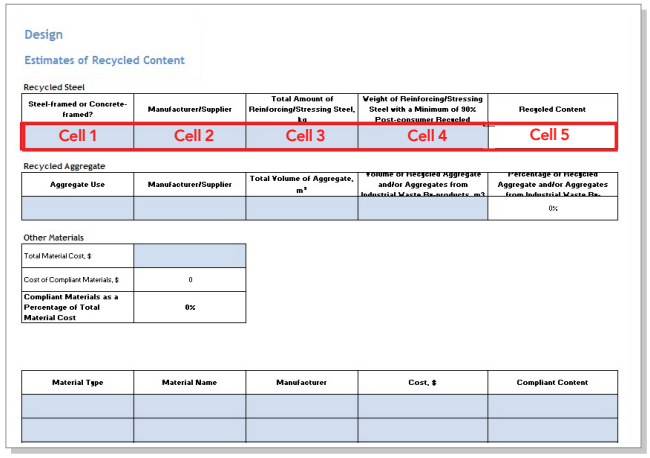
In order to demonstrate compliance with Credit SM-10: Recycled Materials, the project team must calculate the percentage of recycled or reused structural steel used on the project that meets the criteria above. The following equation and calculation template must be used:

Recycled Steel Calculation

Percentage of Recycled Steel = (weight of recycled or reused structural steel / total weight of structural steel) x 100

Recycled Steel Calculation Template

The details of each individual recycled item procured for the project must be inserted into the calculation template (refer to Figure 23).


Design

Estimates of Recycled Content

Recycled Steel

Steel-framed or Concrete-framed?	Manufacturer/Supplier	Total Amount of Reinforcing/Stressing Steel, kg	Weight of Reinforcing/Stressing Steel with a Minimum of 90% Post-consumer Recycled	Recycled Content
Cell 1	Cell 2	Cell 3	Cell 4	Cell 5

Recycled Aggregate

Aggregate Use	Manufacturer/Supplier	Total Volume of Aggregate, m^3	Volume of Recycled Aggregate and/or Aggregates from Industrial Waste By-products, m^3	Percentage of Recycled Aggregate and/or Aggregates from Industrial Waste By-
				0%

Other Materials

Total Material Cost, $	
Cost of Compliant Materials, $	0
Compliant Materials as a Percentage of Total Material Cost	0%

Material Type	Material Name	Manufacturer	Cost, $	Compliant Content

Figure 23: Extract from Recycled Materials Worksheet

Table 8: Worksheet Process

Cell	Requirement
Cell 1	Select from the drop-down list the building framing used in the project: steel framed or concrete framed (e.g. steel framed).
Cell 2	Insert the name of the manufacturer (e.g. Steel Co.). At a later date, proof of engagement of the selected manufacturer supplying the particular recycled product will have to be provided to the Estidama Assessor for review.
Cell 3	Insert the estimated weight (in kg) of reinforced steel to be used on-site (e.g. 1,000 kg).
Cell 4	Insert the estimated weight (in kg) of recycled steel (e.g. 250 kg).
Cell 5	The output will show the percentage of recycled steel used in the mosque project.

Related Credits:
SM-10: Recycled Materials.

Recycled Aggregate

Recycled aggregate is another material which may also be procured and used on-site for the mosque project.

Recycled aggregate constitutes material (of different sizes and sources, usually concrete or asphalt) that is crushed and recycled rather than sent to landfill for disposal.

By meeting the below requirements, which are set out within Credit SM-10: Recycled Materials - Recycled Aggregate, 2 Credit Points can be achieved:

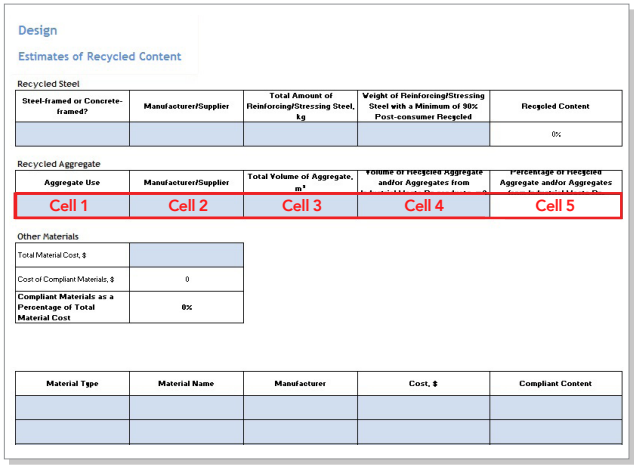
- All aggregate used during mosque construction as base, sub-base or backfill must be 100% recycled.
  The contractor should contact suppliers that can provide 100% recycled aggregate or crush material on-site.
  Proofs or formal documentation describing recycled aggregate supplied for the project must be obtained by the contractor to comply with the requirements of Credit SM-10: Recycled Materials - Recycled Aggregate.
  In order to demonstrate compliance with the requirements of Credit SM-10: Recycled Materials - Recycled Aggregate, the project team must calculate the percentage of recycled aggregate used for the project that meets the criterion above. The following equation and calculation template must be used:

Recycled Aggregate Calculation

Percentage of recycled aggregates = (weight of recycled aggregates / total volume of aggregates) x 100

Recycled Aggregate Calculation Template

The details of each individual recycled aggregate procured for the project must be inserted into the calculation template (refer to Figure 24).


Design

Estimates of Recycled Content

Recycled Steel

Steel-framed or Concrete-framed?	Manufacturer/Supplier	Total Amount of Reinforcing/Stressing Steel, kg	Weight of Reinforcing/Stressing Steel with a Minimum of 90% Post-consumer Recycled	Recycled Content
				0%

Recycled Aggregate

Aggregate Use	Manufacturer/Supplier	Total Volume of Aggregate, m³	Volume of Recycled Aggregate and/or Aggregates from	Percentage of Recycled Aggregate and/or Aggregates
Cell 1	Cell 2	Cell 3	Cell 4	Cell 5

Other Materials

Total Material Cost, $	
Cost of Compliant Materials, $	0
Compliant Materials as a Percentage of Total Material Cost	0%

Material Type	Material Name	Manufacturer	Cost, $	Compliant Content

Figure 24: Extract from Recycled Materials Worksheet

Table 9: Worksheet Process

Cell	Requirement
Cell 1	Select from a drop-down list of 3 options setting out the use of the recycled aggregate to be used in the project: structural and non-structural applications, or base, sub-base, or backfill (e.g. backfill).
Cell 2	Insert the name of the manufacturer (e.g. Aggregate Co.). At a later date, proof of engagement of the elected manufacturer supplying the particular recycled product will have to be provided to the Estidama Assessor for review.
Cell 3	Insert the estimated volume (in m^3) of recycled aggregate to be used on-site (e.g. 18 m^3).
Cell 4	Insert the estimated volume (in m3) of recycled aggregate sources (e.g. 18 m^3).
Cell 5	The output will show the total amount of recycled aggregate procured and used in construction.

Related Credits:
SM-10: Recycled Materials.

Cement Replacement

As part of the concrete manufacturing process cement (usually Old Portland Cement (OPC)) is mixed with other materials (aggregates) and water to form concrete.

The construction industry is beginning to demand concrete with a lower percentage of OPC and a greater percentage of what is known as Supplementary Cementitious Materials (SCMs) which usually consist of fly ash, furnace slag and other materials. This is due to the environmental impact of processing OPC and the fact that SCMs are diverted from landfills.

By demonstrating the concrete mixes procured for the project contain embodied Green House Gas (GHG) emissions within the limits outlined in Table 10 below, 2 Credit Points can be achieved under Credit SM-10: Recycled Materials - Cement Replacement.

The contractor must demonstrate using the Estidama Concrete GHG Calculator that the concrete procured and used within the construction of the mosque meets the requirements listed in Table 10 to achieve 2 Credit Points.

Concrete manufactures will be able to provide the percentage composition breakdown of the concrete mix provided. The contractor must request proofs or formal documentation describing the post-consumer recycled content of the material supplied for the project.

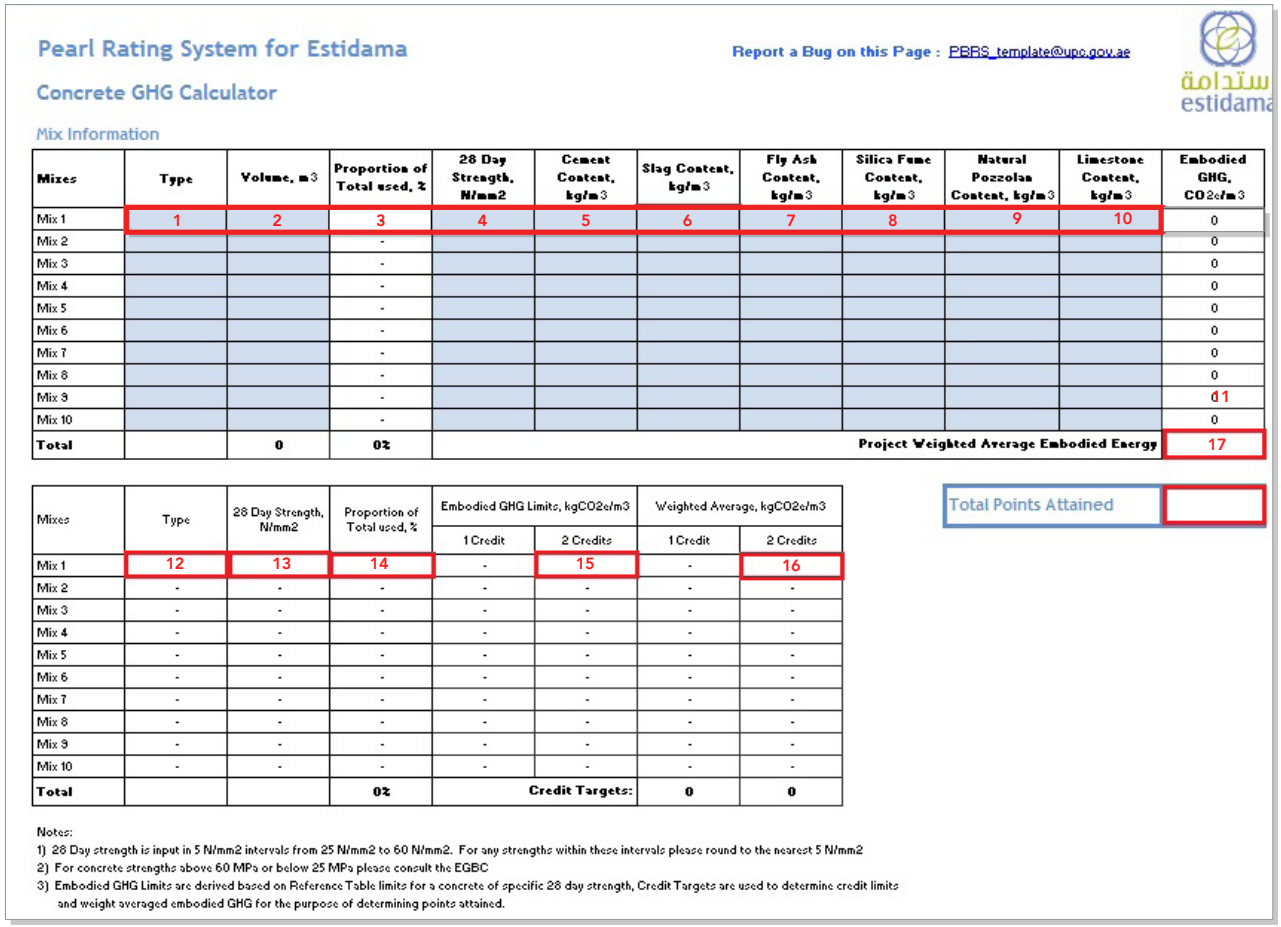
Row	Type	Strength Grade and Embodied GHG								Estidama Credits
		25	30	35	40	45	50	55	60	
Row B1	Cast in place	162	192	218	240	259	277	292	307	1 Credit
Row B2	Cast in place	121	144	163	179	194	206	218	229	2 Credits
Row C1	Precast	176	209	236	260	281	300	317	332	1 Credit
Row C2	Precast	149	176	199	220	237	253	268	281	2 Credits
Row D1	Stressed	183	217	245	270	292	312	329	345	1 Credit
Row D2	Stressed	162	192	218	240	259	277	292	307	2 Credits

Table 10: Green House Gas (GHG) Limits

Related Credits:
SM-10: Recycled Materials.

Cement Replacement Calculation Template

The details of each individual concrete mix procured for the project will be inserted into the Concrete GHG Calculator calculation template (refer to Figure 25).



Pearl Rating System for Estidama

Report a Bug on this Page : PBRS_template@upc.gov.ae

Concrete GHG Calculator

Mix Information

Mixes	Type	Volume, m3	Proportion of Total used, %	28 Day Strength, N/mm2	Cement Content, kg/m3	Slag Content, kg/m3	Fly Ash Content, kg/m3	Silica Fume Content, kg/m3	Natural Pozzolan Content, kg/m3	Limestone Content, kg/m3	Embodied GHG, CO2e/m3
Mix 1	1	2	3	4	5	6	7	8	9	10	0
Mix 2			-								0
Mix 3			-								0
Mix 4			-								0
Mix 5			-								0
Mix 6			-								0
Mix 7			-								0
Mix 8			-								0
Mix 9			-								11
Mix 10			-								0
Total		0	0%	Project Weighted Average Embodied Energy							17

Mixes	Type	28 Day Strength, N/mm2	Proportion of Total used, %	Embodied GHG Limits, kgCO2e/m3		Weighted Average, kgCO2e/m3	
				1 Credit	2 Credits	1 Credit	2 Credits
Mix 1	12	13	14	-	15	-	16
Mix 2	-	-	-	-	-	-	-
Mix 3	-	-	-	-	-	-	-
Mix 4	-	-	-	-	-	-	-
Mix 5	-	-	-	-	-	-	-
Mix 6	-	-	-	-	-	-	-
Mix 7	-	-	-	-	-	-	-
Mix 8	-	-	-	-	-	-	-
Mix 9	-	-	-	-	-	-	-
Mix 10	-	-	-	-	-	-	-
Total			0%	Credit Targets:		0	0

Total Points Attained

Notes:
1) 28 Day strength is input in 5 N/mm2 intervals from 25 N/mm2 to 60 N/mm2. For any strengths within these intervals please round to the nearest 5 N/mm2
2) For concrete strengths above 60 MPa or below 25 MPa please consult the EGBC
3) Embodied GHG Limits are derived based on Reference Table limits for a concrete of specific 28 day strength, Credit Targets are used to determine credit limits and weight averaged embodied GHG for the purpose of determining points attained.

Figure 25: Extract from Concrete GHG Calculator

Cell	Requirement
Cell 1	Select from a drop-down list of 3 types of cement to be procured and used for construction within the project: cast in place, precast, stressed (e.g. precast).
Cell 2	Insert the volume (in m^3) of concrete to be procured for the project (e.g. 600m^3).
Cell 3	The worksheet will output the total proportion of cement used on-site.
Cell 4	Insert the 28-day strength (N/m^2) of the cement product.
Cell 5-10	Insert the material content of the particular cement product. This information will be provided to the contractor by the cement manufacturer. At a later date, proof of engagement of the elected manufacturer supplying the particular cement product will have to be provided to the Estidama Assessor for review.
Cell 11-17	The worksheet outputs will show the average embodied energy within the concrete mix and applicable Credit Points.

Table 11: Worksheet Process

Other Recycled Materials

By demonstrating that any combination of materials with the following characteristics constitutes at least 10% of the total material cost, 1 Credit Point will be achieved under Credit SM-10: Recycled Materials - Other Materials:

- A minimum 30% post-consumer recycled content;
- A minimum 80% post-industrial content; and
- 50% agricultural waste by-product.

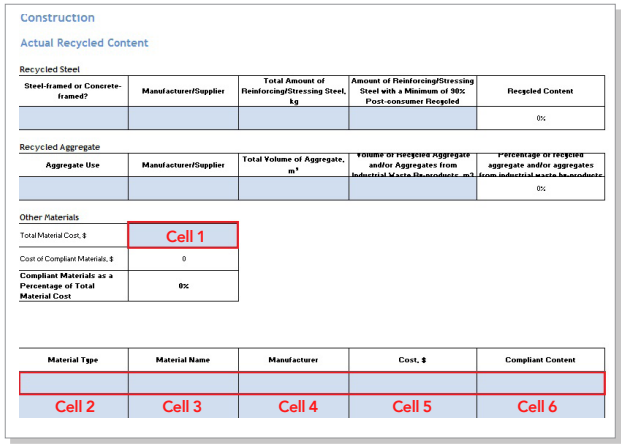
Proofs or formal documentation describing the recycled content of the material supplied for the project must be obtained by the contractor to comply with the requirements of Credit SM-10: Recycled Materials - Other Materials. In order to demonstrate compliance, the project team must calculate the percentage of recycled materials used on the project that meets the criteria above. The following equation and calculation template must be used:

Other Recycled Materials Calculation

Percentage of recycled material = (cost of recycled - content materials / total material cost) x 100

Other Recycled Materials Calculation Template

The details of each individual recycled item procured for the project will be inserted into this calculation template (refer to Figure 26).



Construction

Actual Recycled Content

Recycled Steel

Steel-framed or Concrete-framed?	Manufacturer/Supplier	Total Amount of Reinforcing/Stressing Steel, kg	Amount of Reinforcing/Stressing Steel with a Minimum of 90% Post-consumer Recycled	Recycled Content
				0%

Recycled Aggregate

Aggregate Use	Manufacturer/Supplier	Total Volume of Aggregate, m³	Volume of Recycled Aggregate and/or Aggregates from Industrial Waste By-products, m3	Percentage of recycled aggregate and/or aggregates from industrial waste by-products
				0%

Other Materials

Total Material Cost, $	Cell 1
Cost of Compliant Materials, $	0
Compliant Materials as a Percentage of Total Material Cost	0%

Material Type	Material Name	Manufacturer	Cost, $	Compliant Content
Cell 2	Cell 3	Cell 4	Cell 5	Cell 6

Figure 26: Extract from Recycled Material Worksheet

Cell	Requirement
Cell 1	Insert the estimated total material cost for the mosque project (e.g. AED 1 million).
Cell 2	Insert the material type of the elected recycled product (e.g. wool).
Cell 3 and 4	Insert the material name and the name of the manufacturer (e.g. Wool Co.). At a later date, proof of engagement of the elected manufacturer supplying the particular recycled product will have to be provided to the Estidama Assessor for review.
Cell 5	The estimated cost of recycled product (e.g. AED 50,000).
Cell 6	The output will be the percentage of compliant content within the particular recycled product.

Table 12: Worksheet Process

Related Credits:
SM-10: Recycled Materials.

5.5 Reused or Certified Timber

Reused timber is that which has been reused for the same purpose that it was previously used for (e.g. concrete form work) for mosque construction. Certified timber is timber that is certified under any one or any combination of the following certification schemes (with Chain of Custody Certification (CoC)):

- Forest Stewardship Council (FSC); or
- Program for the Endorsement of Forest Certification scheme (PEFC); or
- The following national schemes endorsed by PEFC:
  - the Canadian Standards Association (CSA);
  - the Sustainable Forestry Initiative (SFI); and
  - the Malaysian Timber Certification Scheme (MTCS).

The project design and development team should demonstrate that all timber is legally sourced and not on the CITES (Convention on International Trade in Endangered Species) list of endangered species.

The contractor should reuse timber where possible on-site. The contractor should procure certified timber and composite wood products for use on the project, including temporary construction timber. The cost of certified timber and composite wood products should constitute 70% of all timber products used in construction.

By demonstrating the above requirements, 2 Credit Points can be achieved under Credit SM-12: Reused or Certified Timber.

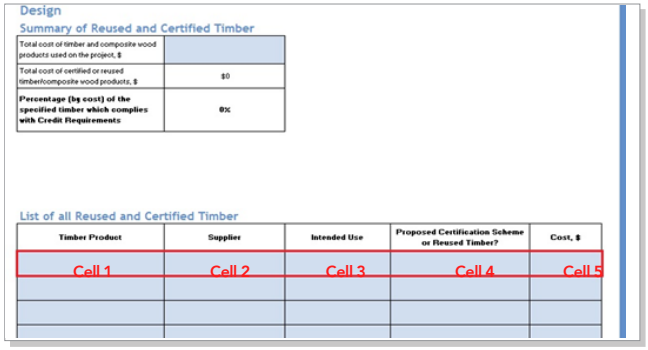
Related Credits:
SM-12 Reused or Certified Timber.

Reused or Certified Timber Calculation

Percentage of Certified Timber = (cost of certified or reused timber products / total material cost of all timber products) x 100

Reused or Certified Timber Calculation Template

The details of each individual timber product procured for the project will be inserted into this reused or certified timber calculation template (refer to Figure 27).


Design

Summary of Reused and Certified Timber

Total cost of timber and composite wood products used on the project, $	
Total cost of certified or reused timber/composite wood products, $	$0
Percentage (by cost) of the specified timber which complies with Credit Requirements	0%

List of all Reused and Certified Timber

Timber Product	Supplier	Intended Use	Proposed Certification Scheme or Reused Timber?	Cost, $
Cell 1	Cell 2	Cell 3	Cell 4	Cell 5

Figure 27: Extract from Reused or Certified Timber Template

Cell	Requirement
Cell 1	Insert the estimated total cost of wood products for the mosque project (e.g. AED 300,000).
Cell 2	Insert the product name (e.g. doors).
Cell 3	Insert the supplier name (e.g. Wood Co.).
Cell 4	Insert the product's intended use (e.g. front doors of rooms in mosque).
Cell 5	Insert the proposed certification scheme (i.e. FSC, PEFC, CSA, SFI or MTCS) and/or that the timber is reused. A drop-down list is provided, and the mosque designer will have to select 1 of the selections provided (e.g. SFI).
Cell 6	The output will indicate the cost of the nominated certified wood product that is in compliance with the Credit requirements (e.g. AED 19,265).

Table 13: Worksheet Process

5.6 Hazardous Materials

It is important to ensure that selected materials used for construction do not contain hazardous components excluded by Credit SM-R1: Hazardous Materials Elimination. The design team should be aware of the Credit requirements while designing all spaces.

The prohibition of hazardous materials should also be written into the project specification documents during the design stage and followed by the contractor during the construction stage. The mosque designer must:

- Specify that materials, including walls, insulation and interior materials, will not contain asbestos and that all asbestos containing materials have been removed from refurbished buildings; and
- Specify that wood materials located in the mosque building and within human reach, such as shading structures, playgrounds and decking, will not be treated with Chromated Copper Arsenate (CCA).

The following sections focus on Credits that pertain to the materials utilised in the interior of the mosque project.

5.7 Low Emissions

The mosque design and development team should avoid the use of building products that contain Volatile Organic Compounds (VOCs). These compounds react with sunlight and nitrogen oxides in the atmosphere and form ground-level ozone which has a harmful effect on indoor air quality and occupant health.

Adhesives and Sealants

In accordance with Credit LBi-2.1: Material Emissions: Adhesives & Sealants, the mosque designer should demonstrate that 100% of all adhesives and sealants used within the interior spaces of the mosque do not exceed the prescribed Volatile Organic Compounds (VOC) limits (refer to Figure 28).

The mosque design and development team should specify that the contractor must meet the material emission requirements within the contract tender documentation.

During construction, the contractor should request a Material Data Sheet (MDS) for each of the materials procured. The contractor should compile a list of all adhesives and sealants used within the interior of the mosque, the targeted VOC limit as described within this section, and the actual VOC limit for the adhesive and/or sealants used within the interior of the mosque. Where the mosque developer, designer and contractor meet the requirements of Credit LBi-2.1: Material Emissions: Adhesives & Sealants, 1 Credit Point can be achieved.

VOC Limit*, Less Water and Less Exempt Compounds in Grams per Litre

Architectural Applications	Current VOC Limit
Indoor Carpet Adhesives	50
Carpet Pad Adhesives	50
Outdoor Carpet Adhesives	150
Wood Flooring Adhesive	100
Rubber Floor Adhesives	60
Sub-floor Adhesives	50
Ceramic Tile Adhesives	65
VCT and Asphalt Tile Adhesives	50
Dry Wall and Panel Adhesives	50

Architectural Applications	Current VOC Limit
Cove Base Adhesives	50
Multipurpose Construction Adhesives	70
Structural Glazing Adhesives	100
Single Ply Roof Membrane Adhesives	250

Speciality Applications	VOC Limits and Effective Dates **			
	Current VOC Limit	1-1-05	7-1-05	1-1-07
PVC Welding	510			
CPVC Welding	490			
ABS Welding	400		325	
Plastic Cement Welding	350	250		
Adhesive Primer for Plastic	650		550	
Computer Diskette Manufacturing	350			
Contact Adhesive	80			
Special Purpose Contact Adhesive	250			
Tire Retread	100			
Adhesive Primer for Traffic Marking Tape	150			
Structural Wood Member Adhesive	140			
Sheet Applied Rubber Lining Operations	850			
Top and Trim Adhesive	540			250

** The specified limits remain in effect unless revised limits are listed in subsequent columns.

For adhesives, adhesive bonding primers, or any other primer not regulated by the above 2 tables and applied to the following substrates, the following limits shall apply:

Substrate Specific Applications	Current VOC Limit
Metal to Metal	30
Plastic Foams	50
Porous Material (except wood)	50
Wood	30
Fibreglass	80

If an adhesive is used to bond dissimilar substrates together the adhesive with the highest VOC content shall be allowed.

Sealants	Current VOC Limit
Architectural	250
Marine Deck	760
Non-membrane Roof	300
Roadway	250
Single-Ply Roof Membrane	450
Other	420

Sealants Primers	Current VOC Limit
Architectural	
Non Porous	250
Porous	775
Modified Bituminous	500
Marine Deck	760
Other	750

* For low-solid adhesives or sealants, the VOC limit is expressed in grams per litre of material as determined in paragraph (b) (32); for all other adhesives and sealants. VOC limits are expressed as grams of VOC per litre of adhesive or sealant less water and less exempt compounds as determined in paragraph (b) (31).

Figure 28: Extracts Illustrating the VOC Limits

Related Credits:
SM-R1: Hazardous Materials Elimination.
LBi-2.1: Material Emissions: Adhesives & Sealants.

Paints and Coatings

In accordance with Credit LBi-2.2: Material Emissions: Paints & Coatings, the mosque designer should demonstrate that 100% of all paints and coatings used within the interior spaces of the mosque do not exceed the prescribed VOC limits. A sample is shown in Figure 29 and Table 14.

The mosque developer should specify that the contractor must meet the material emission requirements within the contract tender documentation. During construction, the contractor should request an MDS for each of the materials procured. The contractor must compile a list of all paints and coatings used within the interior of the mosque, the targeted VOC limit as described within this section, and the actual VOC limit for the paints and coatings used within the interior of the mosque.



	LOW-EMITTING MATERIALS		
Date:	Revision 1	Ref:	
Manufacturer's Name	Product Name	VOC data (g/L)	Allowable VOC Limit (g/L)
ADHESIVES & SEALANTS			
PAINTS & COATINGS			

Figure 29: Illustration of the PBRS Material Tracking Sheet

Related Credits:
SM-R1: Hazardous Materials Elimination.
LBi-2.2: Material Emissions: Paints & Coatings.

Where the mosque developer, designer and contractor meet the requirements of Credit LBi-2.2: Material Emissions: Paints & Coatings, 1 Credit Point can be achieved.

	Product Subcategory	Type	Phase II (g/l(*)) (From 1.1.2010)
a	Interior matt walls and ceilings (gloss<25@60°)	WB SB	30 30
b	Interior glossy walls and ceilings (gloss >25@60°)	WB SB	100 100
c	Interior trim and cladding paints for wood and metal	WB SB	130 300
d	Interior trim varnishes and woodstains, including opaque woodstains	WB SB	130 400
e	Interior minimal build woodstains	WB SB	130 700
f	Primers	WB SB	30 350
g	Building primers	WB SB	30 750
h	One-pack performance coatings	WB SB	140 500
i	Two-pack reactive performance coatings for specific end-use, such as floors	WB SB	140 500
j	Multi-coloured coatings	WB SB	100 100
k	Decorative effect coatings	WB SB	200 200

Table 14: Maximum VOC Content Limit

Carpet and Hard Flooring

In accordance with Credit LBi-2.3: Material Emissions: Carpet & Hard Flooring, the mosque designer should demonstrate that:

- 100% of all carpets used within the interior spaces of the mosque meet or exceed the Carpet and Rug Institute Green Label or Green Label Plus Program requirements, or the Greenguard Indoor Air Quality Certification Program for Carpets requirements;
- 100% of all hard flooring systems and finishes have achieved a Floor Score Certification or completed the Greenguard Indoor Air Quality Certification Program for low emitting products; and
- 100% of wood flooring products do not exceed class E1 for formaldehyde content and do not exceed 5ppm for Pentachlorophenol (PCP) content.

The mosque developer should specify that the contractor must meet the material emission requirements within the contract tender documentation. During construction, the contractor should request an MDS for each of the materials procured. The contractor must compile a list of all carpets and hard flooring systems used within the interior of the mosque and provide the relevant certification demonstrating compliance with the above requirements.

Where the mosque developer, designer and contractor meet the requirements of Credit LBi-2.3: Material Emissions: Carpets & Hard Flooring, 1 Credit Point can be achieved.

Ceiling Systems

In accordance with Credit LBi-2.4: Material Emissions: Ceiling Systems, the mosque designer must demonstrate that suspended ceiling systems installed within a mosque comply with BS EN 13964: 2004 Section 4.5 and contain no asbestos, and where suspended ceiling systems contain formaldehyde, they must meet the requirements specified in Credit LBi-2.5: Material Emissions: Formaldehyde Reduction.

The mosque developer should specify that the contractor must meet the material emission requirements within the contract tender documentation. During construction, the contractor should request an MDS for each of the materials procured. The contractor must compile a list of all ceiling systems and provide the relevant certification demonstrating compliance with the above requirements.

The contractor must provide technical data sheets showing compliance with the asbestos and formaldehyde restrictions as described above.

Where the mosque developer, designer and contractor meet these requirements, 1 Credit Point can be achieved.

Formaldehyde Reduction

In accordance with Credit LBi-2.5: Materials Emissions: Formaldehyde Reduction, the mosque designer should demonstrate that 100% of all internal construction materials and all internal furniture do not exceed formaldehyde content class E1 levels.

The mosque developer should specify that the contractor must meet the material emission requirements within the contract tender documentation. During construction, the contractor should request an MDS for each of the materials procured. The contractor must compile a list of all construction materials containing formaldehyde and provide the relevant certification demonstrating compliance with the above requirements.

Where the mosque developer, designer and contractor meet the requirements of Credit LBi-2.5: Materials Emissions: Formaldehyde Reduction, 2 Credit Points can be achieved.

Related Credits:
SM-R1: Hazardous Materials Elimination.
LBi-2.3: Material Emissions: Carpet & Hard Flooring.
LBi-2.4: Material Emissions: Ceiling Systems.
LBi-2.5: Material Emissions: Formaldehyde Reduction.

Table E.1 - Formaldehyde Class E1		Panel Product		
		Unfaced	Unfaced	Coated or Overlaid
		Particleboard, OSB, MDF	Plywood, solid wood panels	Particleboard, OSB, MDF, plywood, solid wood panels, fibre boards (wet process) cement bonded particleboard
Initial Type Testing *	Test method	EN 717-1		
	Requirement	Release ≤ 0.124 mg/m^3 air		
Factory Production Control	Test method	EN 120	EN 717-2	
	Requirement	Content ≤ 8 mg/100g oven dry board	Release ≤ 3.5 mg/(m^2h) or ≤ 5mg/(m^2h) within days of production	Release ≤ 3.5 mg/m^2h

Table 15: Maximum VOC Content Limit

* For established products, initial type testing may also be done based on existing data from EN 120 or EN 717-2 testing, either from factory production control or from external inspection.

6.0
Design of Building Systems

6.0 Design of Building Systems

Through principles of passive design, the design team must arrive at the optimal mosque envelope and massing design based on the plot context. The design of the mechanical and ventilation, electrical and lighting systems and associated controls will have a large impact on the energy consumption of the mosque. As a result of the IDP, the indoor space of the mosque must be healthy, comfortable and functional.

For all building systems, the mosque designer should meet all the requirements detailed within the following sections of the Abu Dhabi International Energy Conservation Code:

- Section 503 – Building Mechanical Systems;
- Section 505 – Electrical Power and Lighting Systems; and
- Section 506 – Additional Efficiency Package Options.

Energy

The design of the building HVAC and lighting systems is driven by the requirements outlined in the Abu Dhabi International Energy Conservation Code - Sections 503 and 505. Compliance with Credit RE-R1: Minimum Energy Performance must be demonstrated by either following a prescriptive path or by dynamic simulation modelling of the proposed design as per the ASHRAE 90.1 Appendix G Performance Rating Method. The performance path must demonstrate a 12% improvement when compared with a baseline case.

Credit RE-R2: Energy Monitoring & Reporting, requires the installation of easily accessible and clearly labelled energy sub-meters to measure, at a minimum, 90% of the estimated annual energy consumptions of each fuel type (electricity, gas, etc.) for all energy end use categories, in both the Imam's residence (and Mu'athen's residence if applicable) and the public areas of a mosque. Metering is also required for all on-site energy generating systems and large plant items.

Through the careful selection and specification of common building appliances and light fixtures (internal and external), the mosque designer can reduce the energy consumption of the mosque. The designer can also minimise the impact on the environment through careful selection of refrigerants and fire suppression systems within the plot boundary. All refrigerants and gaseous fire suppression systems must have an ozone depletion potential of zero.

Water

Efficient water fixtures and metering are required as per Credits PW-R1: Minimum Interior Water Use Reduction and PW-R2: Exterior Water Monitoring.

The Estidama PBRS Manual provides maximum flow rates or quantities for water fixtures, fittings and appliances. Credit PW-R2: Exterior Water Monitoring requires the installation of easily accessible and clearly labelled sub-meters for the building's external water use. These sub-meters should have a pulsed output and be capable of remote monitoring.

Potable water demand should be minimised through:

- Minimising landscaping water demands through effective plant selection, irrigation strategies and the use of recycled water;
- Use of recycled water for heat rejection; and
- Minimising evaporative loss through the use of recycled water in exterior water features.

Legionella

The management of Legionella bacteria is discussed in Credit LBi-R3: Legionella Prevention. The PBRS requires the development and implementation of a Legionella Management Plan for all relevant water-based systems and must be set out in accordance with Part 1 of 'Legionnaire's Disease - The Control of Legionella Bacteria in Water Systems', Approved Code of Practice and Guidance (L8), 3rd Edition 2000, UK Health and Safety Executive.

Related Credits:
IDP-R1: Integrated Development Strategy.
LBi-R1: Healthy Ventilation Delivery.
LBi-R3: Legionella Prevention.
PW-R1: Minimum Interior Water Use Reduction.
PW-R2: Exterior Water Monitoring.
RE-R1: Minimum Energy Performance.
RE-R2: Energy Monitoring & Reporting.
RE-R3: Ozone Impacts of Refrigerants & Fire Suppression Systems.

6.1 Energy Systems

Air Conditioning and Mechanical Ventilation

Although the cooling requirements of a mosque will be reduced by minimising heat gain through windows, walls and roofs and by reducing infiltration, energy is still required to condition internal spaces. Efficient system performance is therefore a critical factor in achieving reductions in energy usage (refer to Section 7.0 in Volume 2 – Design).

For most buildings, the performance of the air conditioning system is based on:

- The efficiency of energy conversion from electricity to cooling, which is typically provided by localised units, central chillers or district cooling;
- The effectiveness of the fans providing air to the spaces (both fresh and re-circulated air);
- The selection of appropriate sensors and controls for various system elements in different zones (refer to Section 4.0);
- The response of the system to variation in thermal loads and occupant requirements (refer to Section 4.0); and
- The inclusion of energy recovery and other efficiency measures.

Related Credits:
LBi-R1: Healthy Ventilation Delivery.
RE-R1: Minimum Energy Performance.

Lighting

Good lighting design can reduce energy usage internally and externally. Internal lighting energy is restricted on a basis of power used per unit area. External lighting energy is also restricted in a similar way. Energy allowances are outlined in section 9 of ASHRAE Standard 90.1:2007.

Demonstrating Minimum Energy Performance Compliance

The mosque designer must demonstrate that the mosque energy performance is in compliance with the requirements of Credit RE-R1: Minimum Energy Performance. There are 2 paths to demonstrate compliance:

- Prescriptive Path: the mosque designer is required to fully comply with the design requirements outlined in Volume 2 – Design. Additional requirements on the envelope, HVAC systems and lighting to comply with Credit RE-R1: Minimum Energy Performance are listed in Attachment A of this appendix.
- Performance Path: the mosque designer is required to develop an energy model of the proposed mosque design using dynamic simulation modelling software. A minimum 12% performance improvement must be achieved when compared to a baseline building performance as per the building performance rating method outlined in Appendix G of ASHRAE Standard 90.1:2007.

6.2 Energy Metering

Metering facilities should be provided to allow the energy performance of the mosque to be recorded (refer to Volume 3 – Operations). This monitoring will provide an understanding of the use of energy within the mosque as well as providing useful information to allow the identification of design improvements and unexpected consumption patterns. Credit RE-R2: Energy Monitoring & Reporting has the following requirements:

- All sub-meters provided are to be clearly labelled and easily accessible;
- 90% of the estimated annual energy consumption of each fuel type is to be monitored. For the public areas, the equipment and systems described in Table 16 shall be sub-metered;
- Separate meters should be provided for plant exceeding the loads shown in Table 17;
- All sub-meters must have the capability to provide hourly, daily, weekly, monthly and annual energy consumption for each end-use and compare consumption for the different time frames; and
- All residential areas (e.g. the Imam's residence) should be sub-metered (optional) separately from the public areas, as well as any on-site energy generating systems.

Mosque Energy Use	Worshipper Areas			
	Prayer Hall	Ablution Area	Multi-purpose Hall	Qur'anic Classroom
Cooling	✓		✓	✓
Dehumidification	✓		✓	✓
Service water heating		✓	✓	✓
Motor control centres (fans)	✓	✓	✓	✓
Motor control centres (pumps)	✓	✓	✓	✓
Lighting	✓	✓	✓	✓
Receptacle and process loads				
Other major energy consuming items (kitchens, server rooms, lifts, etc.)			✓	

Table 16: Sub-metering Strategy

Plant Description	Load kW
Cooling installations comprising 1 or more units feeding a common distribution circuit	20
Motor control centres providing power to HVAC equipment	10
Final electrical distribution boards (power/lighting)	10

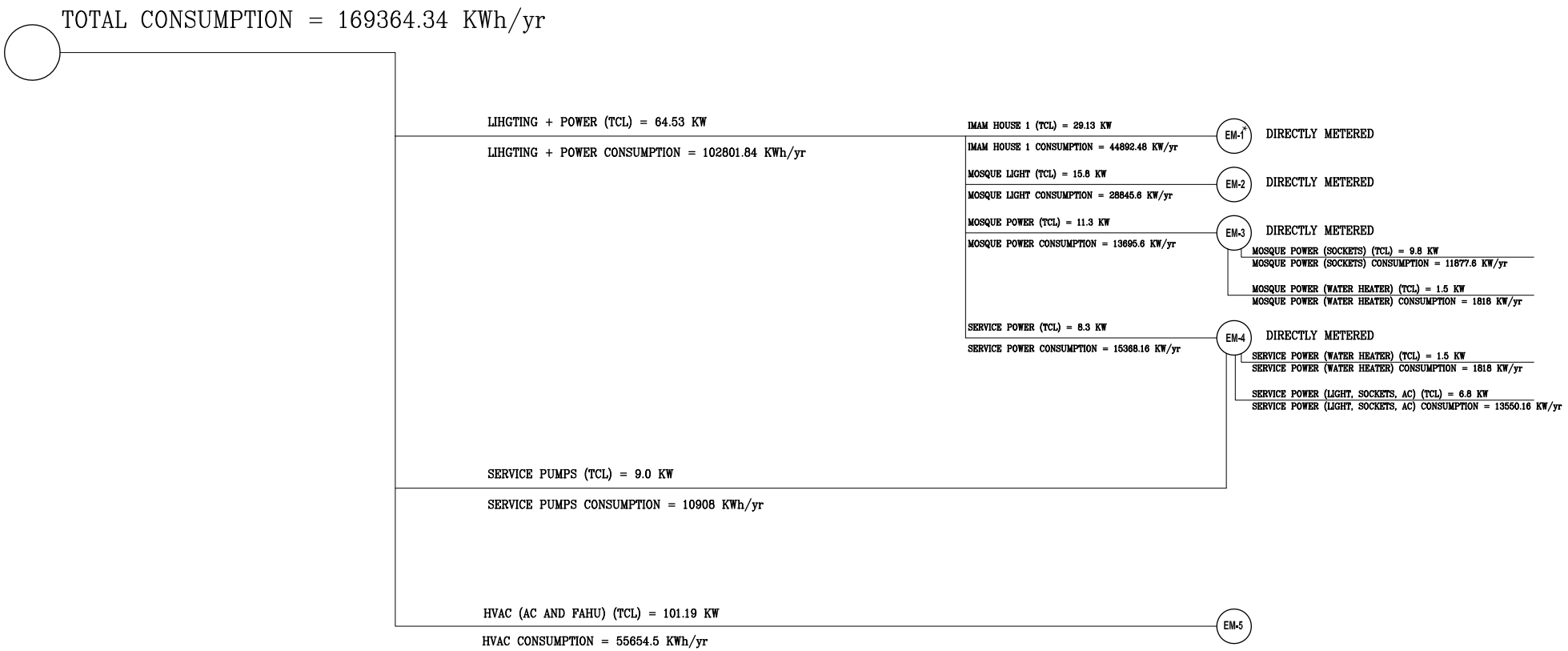
Table 17: Requirements for Separate Meters for Plant with Specific Loads

Guidance:
GIL 65: Metering Energy Use in New Non-Domestic Buildings.
CIBSE TM39 2009: Building Energy Metering.

Related Credits:
RE-R2: Energy Monitoring & Reporting.

Total Estimated Incoming Energy Electricity : 1,69,364.34 (kWh/yr) Percentage of Metered Load : 100%									
Energy			**Sub-Meters**		**Method**		**Meter location**		**Total connected load (KW)**
Incoming Energy	**Main end - use**	**Estimated end - use consumption (kWh/yr)**	**Sub-meter no/ code**	**End-use/area/ system/ circuit or tenancy to be measured**	**Measurement method and calculation (where appropriate)**	**Estimated consumption through each meter (kWh/yr)**	**List of physical meters**	**Location**	
Electricity = TE	Incoming	1,69,364.34					Electricity Meter		
	Light + Power	102,801.84	EM-1*	Imam House (Light, Power, Water heaters, AC)	Directly Metered	44,892.48	Electricity Meter-1	Electrical Room	29.13
			EM-2	Mosque (Light)	Directly Metered	28,845.6	Electricity Meter-2	Electrical Room	15.8
			EM-3	Mosque (Power)	Directly Metered	11,877.6	Electricity Meter-3	Electrical Room	9.8
				Mosque (Water Heater)	Directly Metered	1,818	Electricity Meter-3	Electrical Room	1.5
			EM-4	Service (Water Heater)	Directly Metered	1,818	Electricity Meter-4	Electrical Room	1.5
				Service (Light, Power, AC)	Directly Metered	13,550.16	Electricity Meter-4	Electrical Room	6.8
	Pumps	10,908		Service (Pumps)	Directly Metered	10,908	Electricity Meter-4	Electrical Room	9
	Cooling	55,654.5	EM-5	Mosque (AC, FAHU)	Directly Metered	55,654.5	Electricity Meter-5	Electrical Room	101.19
Total Metered Consumption (TM)						1,69,364.34	Percentage of Metered Load = Total Metered Consumption / Total Estimated End-use Consumption		
Total Estimated sub-metered Consumption						0			
Percentage of Metered Load = TM/TE x 100						100%			
* Typically, there is a separate ADDC Energy meter provided for the Imam House. Accordingly, the addition of a separate Estidama sub-meter is optional for the Imam house building.									

Table 16: Sub-metering Schedule



* Typically, there is a separate ADDC Energy meter provided for the Imam House. Accordingly, the addition of a separate Estidama meter is **optional** for the Imam house building.

Figure 30: Metering Diagram

6.3 Energy-efficient Appliances

Energy-efficient Appliances

Depending on the mosque typology, there will potentially be 2 residential areas within a mosque, the Imam's residence and the Mu'athen's residence. These residential areas are expected to have similar electrical appliances to the average home in Abu Dhabi.

All appliances specified within the Imam's or Mu'athen's residences should meet the requirements and be accredited through 1 of the following schemes:

- Energy Star (http://www.energystar.gov/);
- ESMA Energy Efficiency Standardization and Labelling (EESL) Program
- EU Energy Efficiency Labelling Scheme (a minimum A rating); and
- Comparable rating scheme where the appliance meets the equivalent rating of 1 of the above listed schemes.

Each of the following appliances must comply, where present within the mosque:

- Dishwasher;
- Ovens;
- Steam cookers;
- Televisions;
- Computers;
- Digital duplicators;
- External power adapters;
- Printers and scanners;
- Water coolers/heaters
- Refrigerators and freezers;
- Ice machines;
- Fryers/griddles;
- Washing machines/dryers;
- Copiers and fax machines;
- Enterprise servers; and
- Monitors.

By meeting the requirements of Credit RE-3: Energy Efficient Appliances, 3 Credit Points can be achieved (refer to Figure 31).

Related Credits:
RE-3: Energy Efficient Appliances.



Figure 31: Examples of Energy-Efficient Appliances

6.4 Lighting Fixtures

Internal Lighting Fixtures

Incandescent lamps produce light by heating an internal filament to approximately 2,500-3,000°C, the temperature at which visible light is emitted. As a result, incandescent lamps generate a lot of heat which places significant demand on a building's air conditioning system. Today, incandescent lamps are being phased out internationally in favour of more energy efficient lamps.

Fluorescent lamps have gained in popularity since the middle of the 20th century and are now commonplace in most buildings. Ever since fluorescent lighting was first introduced, there have been negative health complaints relating to headaches, eye strain and general eye discomfort. These complaints have been associated with the light flicker from these lights.

When compared to regular fluorescent lights, the use of high frequency electronic ballasts (20-60kHz) in fluorescent lights resulted in a significant drop in these complaints.

When designing and specifying high frequency electronic ballasts, the design team should engage with local supply chain professionals and together assess against the following criteria[1]:

- Starting method (e.g. rapid-start, instant-start, programmed start);
- Ballast factor;
- Power factor;
- Total harmonic distortion;
- Lamp-ballast compatibility;
- Inrush current; and
- Ballast reliability.

The design team should not specify the use of incandescent lamps in any part of the mosque building. In addition, all permanently installed fluorescent lighting installations should incorporate high frequency electronic ballasts. Projects will be eligible for 1 Credit Point in Credit LBi-6: High Frequency Lighting. In addition, the design team must ensure that lighting power densities and controls are provided that meet the requirements in Attachment A.

External Lighting Fixtures

The design team must ensure that all external lighting meets the requirements of ASHRAE Standard 90.1:2007. The key parameters are referenced in Attachment A along with a description of the requirements for external lighting controls.

Related Credits:
LBi-6: High Frequency Lighting.
RE-R1: Minimum Energy Performance.

[1]Guide to Specifying High-Frequency Electronic Ballasts, NLPIP, 1996, http://www.lrc.rpi.edu/nlpip/

6.5 Refrigerants and Fire Suppression Systems

The ozone layer protects the earth's surface from damaging radiation. Many of the refrigerants currently used in air conditioning systems cause damage to the ozone layer. This environmental impact can be reduced by the appropriate selection of refrigerants and fire suppression systems with a zero Ozone Depletion Potential (ODP).

Credit RE-R3: Ozone Impacts of Refrigerants & Fire Suppression Systems, requires that refrigerants and gaseous fire suppression systems installed within the plot have a zero ODP.

To further minimise impacts on the environment, refrigerants with a Global Warming Potential (GWP) of less than 10 and fire suppression systems with a GWP of less than 1 should be considered. In addition, refrigeration systems should consider leak detection and pump down systems to minimise refrigerant leakages to the atmosphere.

Chlorofluorocarbon	ODP	GWP	Common Building Applications
Hydrofluorocarbons			
HFC - 134a	0	1,430	CFC-12 or HCFC-22 replacement
HFC - 2227a	0	3,500	Fire suppression refrigerant
HFC - 245fa	0	1,030	Insulation agent, centrifugal chillers
HFC - 407c	0	1,700	HCFC - 22 replacement
HFC - 410a	0	1,900	Air conditioning
HFC - 417a	0	1,950	HCFC - 22 replacement
Natural Refrigerants			
Carbon Dioxide (CO2)	0	1.0	
Ammonia (NH3)	0	0	
Propane (C3H8)	0	3	
Isobutene	0	3	
Air	0	0	
Water	0	0	

Table 18: Refrigerants and Fire Suppression

Related Credits:
RE-R3: Ozone Impacts of Refrigerants & Fire Suppression Systems.
RE-7 Global Warming Impacts of Refrigerants and Fire Suppression Systems.

6.6 Water Fixtures and Appliances

Optimising Interior Water Consumption

The interior water consumption within the mosque is related to the efficiency of the water fixtures and appliances that are selected. The most significant interior water consumption patterns are likely to be attributed to ablution and toilet use so selecting units that improve upon the minimum requirements of the PBRS will have the biggest impact.

To comply with Credit PW-R1: Minimum Interior Water Use Reduction, the project must demonstrate that the proposed mosque's interior water consumption is less than or equal to the mosque's baseline interior water consumption. The baseline water consumption is set at the performance figures in Table 19. The Mosque Water Calculator must be used to demonstrate compliance with Credit requirements and can be obtained from https://dmt.gov.ae/Media-Centre/E-Library.

The following pages contain screenshots of the tabs within the Mosque Water Calculator (refer to Figure 32). This will help the design designer enter information correctly.

Water Demand Rates

'Trade-off' between water fixtures and fittings is not permitted, meaning that each fixture must at least equal the performance requirements shown in Table 19. The mosque designer must consider appropriate fixtures that meet these requirements and document compliance through the Mosque Water Calculator specifications that clearly list performance requirements, and/or product data sheets.

Fixture or Fitting	Maximum Flow Rate or Quantity
Bathroom taps, private	6 litres/min at 413.7 kPa (reference pressure)
Bathroom taps, public	1.9 litres/min at 413.7 kPa (reference pressure)
Showerhead	9.5 litres/min at 551.6 kPa (reference pressure)
Kitchen sink faucet	6 litres/min at 413.7 kPa (reference pressure)
Bidets/bidet sprays	6 litres/min at 413.7 kPa (reference pressure)
Urinals	0.5 litres/flushing cycle
Toilets (dual flush)	6/4 litres/flushing cycle (full/low)
Dishwashers	1.3 litres/place setting
Washing machines	8.5 litres/kg of dry load

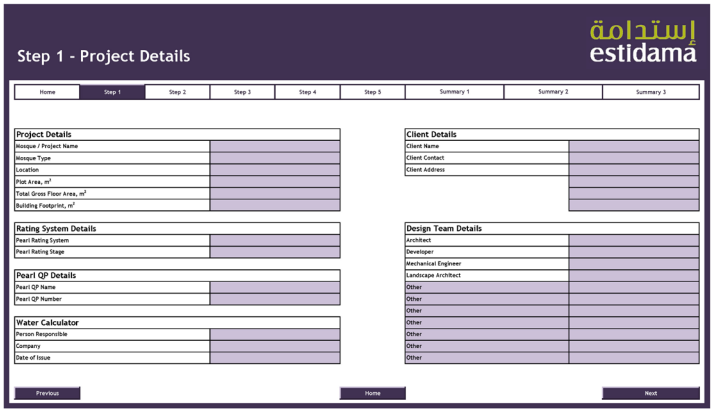
Table 19: Required Water Demand Rates

Condensation Recovery

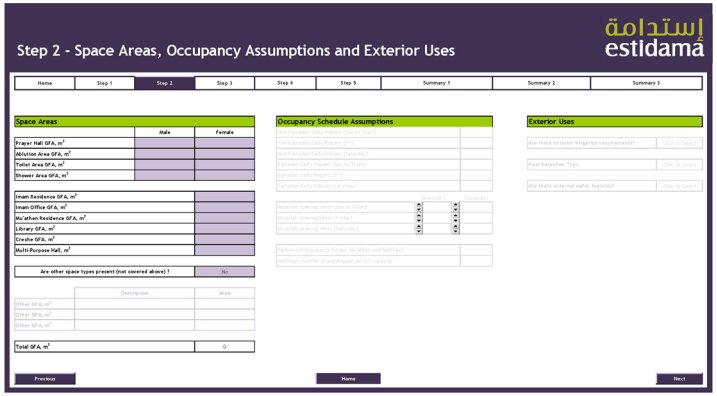
Condensate water comes from cooling systems such as Air Handling Units (AHU) and Fan Coil Units (FCU). The water which comes from these systems can contribute to further water savings to achieve Credit Points in Credit PW-1: Improved Interior Water Use Reduction, where feasible. This condensate water can be used for flushing toilets and urinals within the mosque building, or any form of irrigation.

Where feasible, condensate recycling will require all the condensate from the internal FCUs and AHUs to be piped back to a central storage area and then redistributed to the intended end use.

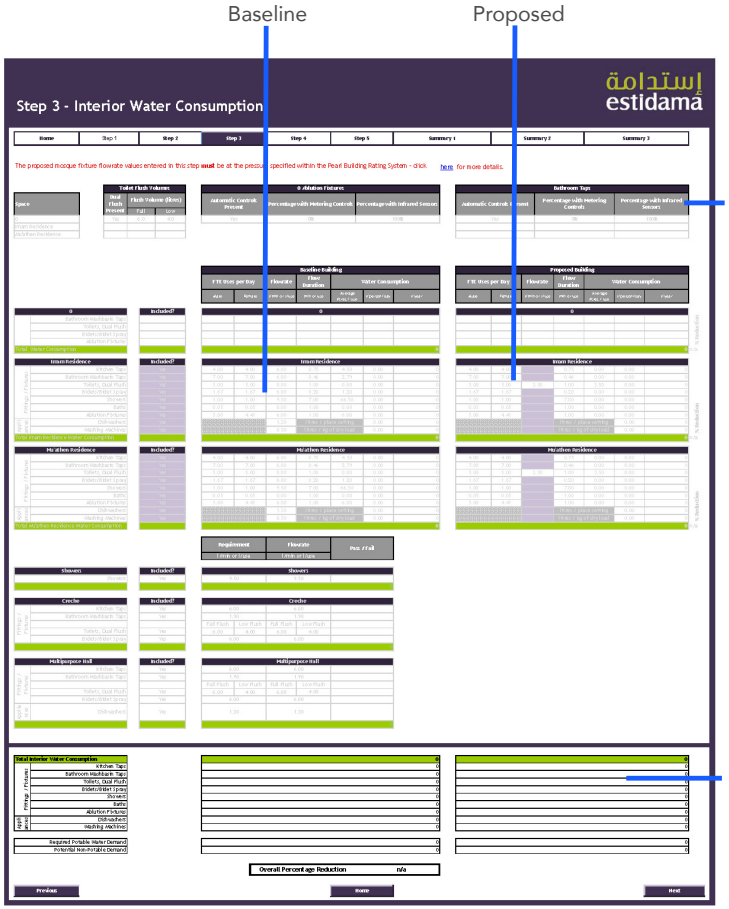
Related Credits:
PW-R1: Minimum Interior Water Use Reduction.
PW-1: Improved Interior Water Use Reduction.



Step 1: Insert mosque project details.

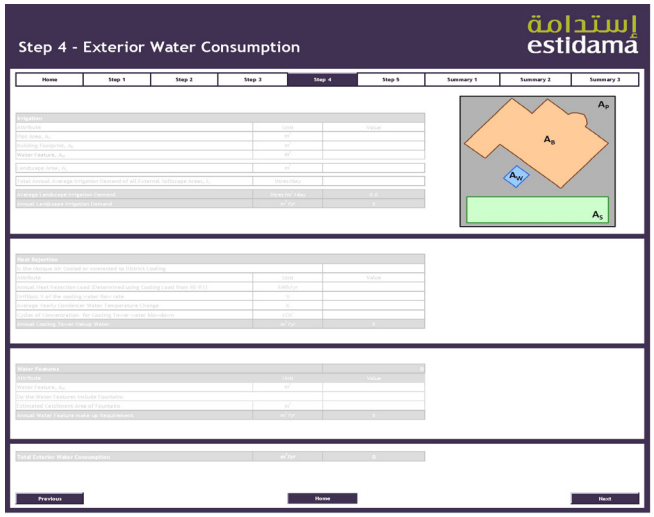


Step 2: Fill in detailed information regarding the mosque building (e.g. floor areas and exterior uses).

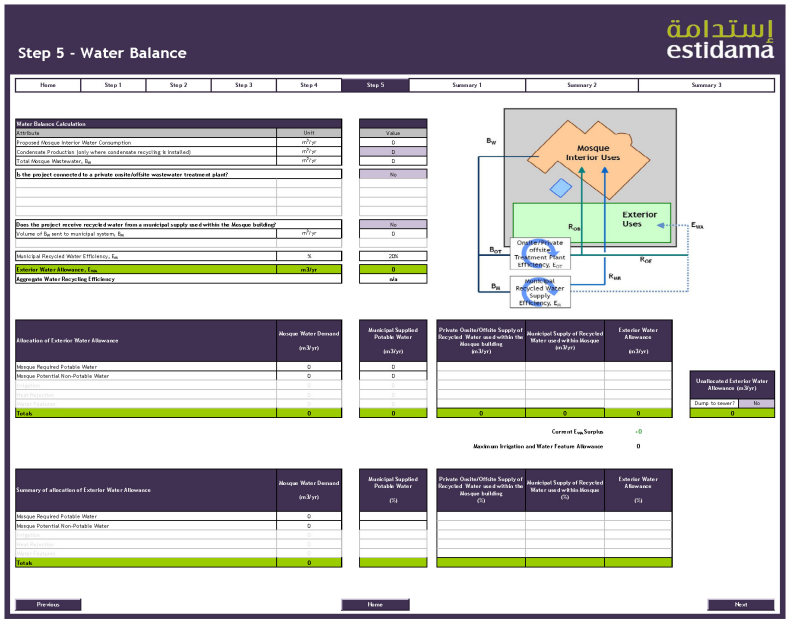


Step 3: Fill in detailed information on water fixture uses in the mosque and compare them with the baseline.

Figure 32: Mosque Water Calculator

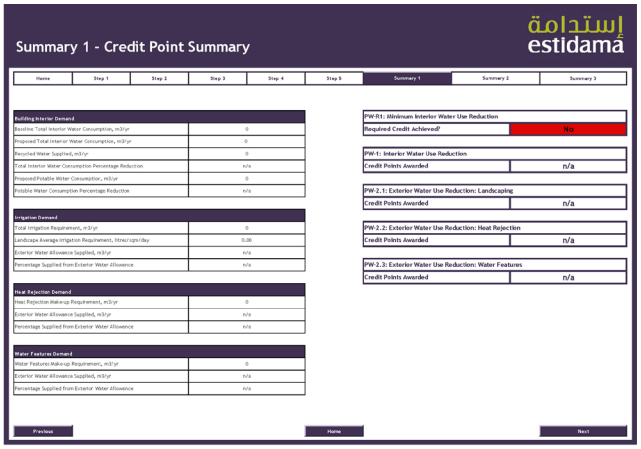


Step 4: Fill in Detailed Information on Mosque Plot Irrigation, Heat Rejection and Water Features.

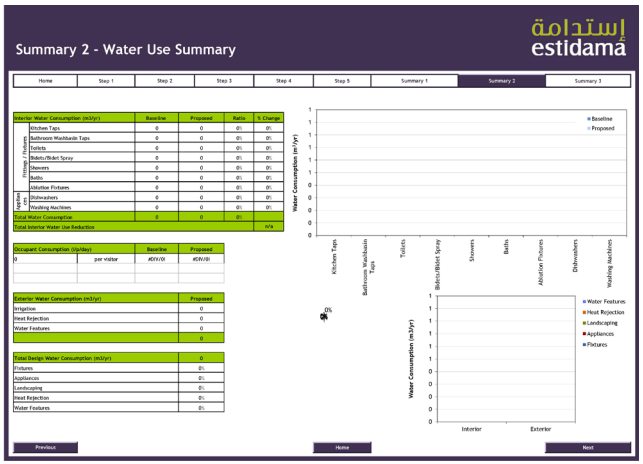


Step 5: Summary of the Different Elements of the Water Balance.

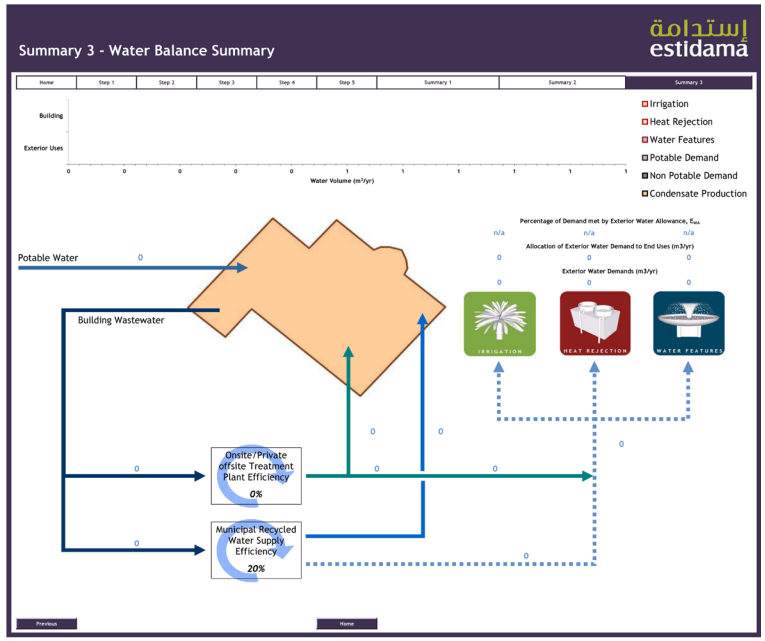
Figure 32 (Continued): Mosque Water Calculator.



Step 6: Summary of compliance with required Credits and number of Points awarded in optional Credits as well as summary of water demands for the different uses.



Step 7: Numerical and graphical summary of water demand for different uses.



Step 8: Graphical and schematic summary of the water balance.

Figure 32 (Continued): Mosque Water Calculator

6.7 Water Metering

Credit PW-R2: Exterior Water Monitoring requires easily accessible and clearly labelled water meters to be provided that are capable of monitoring all exterior water consumption. Where present, the following must be separately sub-metered where present (refer to Figure 33):

- Ablutions;
- Imam's residence (optional);
- Mu'athen's residence (optional);
- Irrigation systems;
- Heat rejection (Where Present); and
- Water features (Where Present).

The sub-meters are also required to have data logging capabilities and be connected to a central monitoring system so that the exterior water consumption may be recorded. This, and a better understanding of both interior and exterior water use, will help determine areas of high water consumption and identify unexpected consumption patterns, which may allow leaks to be identified quickly and pursue opportunities to save water (refer to Volume 3 – Operations).

It is important to note that utility companies will only provide the primary metering for plots. All sub-metering shall be provided by the design and development team.

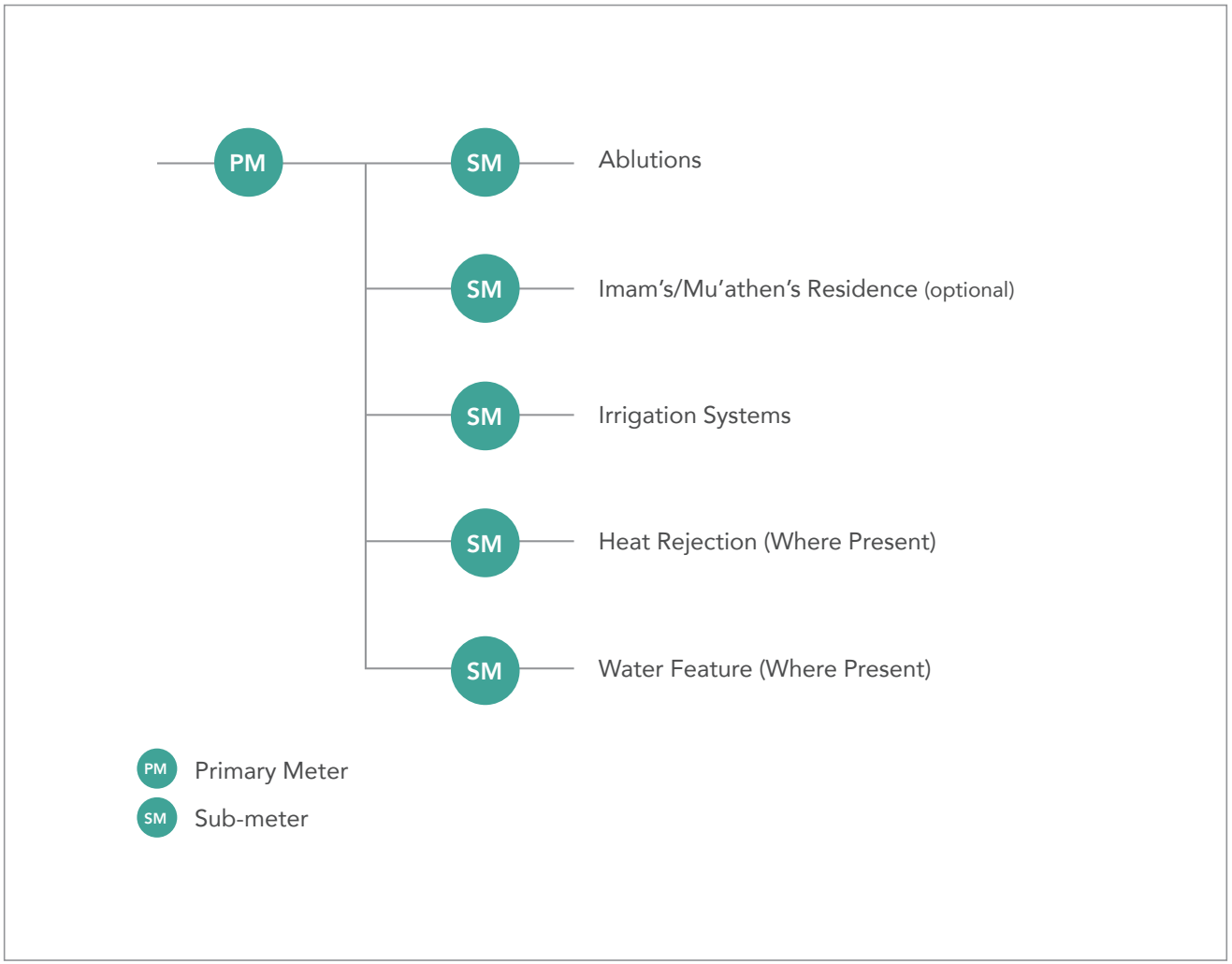


Figure 33: Water Metering Strategy

Related Credits:
PW-R2: Exterior Water Monitoring.

6.8 Design for Legionella Prevention

Legionnaires' disease is a potentially fatal form of pneumonia which can affect anybody, but which principally affects those who are susceptible because of age, illness, immune-suppression or smoking. People can catch Legionnaires' disease by inhaling small droplets of water suspended in the air which contain the bacteria. Legionella bacteria are commonly encountered in water systems, such as cooling tower systems and hot and cold water systems, and other items which use or store water.

The bacteria are dormant below 20°C and do not survive above 60°C. Certain conditions increase the risk from Legionella bacteria:

- A suitable temperature for growth, 20 to 45°C;
- A source of nutrients for the organism, e.g. sludge, scale, rust, algae and other organic matter; and/or
- A way of creating and spreading breathable droplets, e.g. the aerosol created by a cooling tower or spray nozzle.

To reduce the possibility of creating conditions in which the risk from exposure to Legionella bacteria is increased, it is important to control the risk. Hot and cold water systems should be designed to aid safe operation by preventing or controlling conditions which permit the growth of Legionella bacteria and allow easy cleaning and disinfection.

Since many critical decisions need to be made at the design stage, the design team must consider the following when developing the mosque and its facilities:

- Ensure water cannot stagnate anywhere in the system, e.g. remove redundant pipework and run taps/showers in unoccupied rooms;
- Keep pipework as short and direct as possible;
- Keep water cisterns covered, insulated, clean and free of debris;
- Adequately insulate pipework and keep away from hot ducting and other hot piping to prevent excessive temperature rises in the cold water supply; typically not more than a 2°C increase should be allowed;
- Hot water storage cylinders (calorifiers) should store water at 60°C or higher;
- Hot water should be distributed at 50°C or higher (thermostatic mixer valves need to be fitted as close as possible to outlets where a scald risk is identified);
- The pipe branches to the individual hot taps should be of sufficient size to enable the water in each of the hot taps to reach 50°C within one minute of turning on the tap;
- Cold water storage tanks should be sited in a cool place and protected from extremes of temperature by thermal insulation. Cold water should be stored and distributed below 20°C;
- Ensure that calorifiers are fitted with shunt pumps to prevent thermal stratification within the calorifiers;
- Advise maintenance staff working on the system about the risks and how to minimise them; and
- Advise tenants about the risks and the control measures/precautions they can take, such as flushing through showers following a period of non-use.

Related Credits:
LBi-R3: Legionella Prevention.

7.0
Mosque Construction

7.0 Mosque Construction

After completion of design and award of the PBRS Design Rating, the mosque design and development team must ensure that all PBRS performance criteria targeted during design are adequately addressed and implemented during construction. Appropriate handover and integration between the design and construction team is required as per the requirements of Credit IDP-R1: Integrated Development Strategy.

During construction, it is essential that the design and development team establishes a robust procurement procedure to ensure that the materials and products used meet the requirements of the recommended optional Credits (e.g. RE-R1 Minimum Energy Performance, PW-R1 Minimum Interior Water Use Reduction, SM-9 Regional Materials and SM-10 Recycled Materials).

The procurement procedure must ensure that compliance is achieved from specification, throughout tender and through to delivery and installation. In addition, the contractor is responsible for minimising the negative impact of construction operations throughout the duration of the project in relation to the following:

- Credit IDP-3: Construction Environmental Management;
- Credit NS-R2: Natural System Protection; and
- Credit SM-R2: Basic Construction Waste Management.

Related Credits:
IDP-R1: Integrated Development Strategy.
IDP-3: Construction Environment Management.
SM-R2: Basic Construction Waste Management.
SM-R1: Hazardous Materials Elimination.
SM-5: Modular Flooring Systems.
SM-6: Design for Durability.
SM-9: Regional Materials.
SM-10: Recycled Materials.
SM-12 Reused or Certified Timber.
LBi-2.1: Material Emissions: Adhesives & Sealants.
LBi-2.2: Material Emissions: Paints & Coatings.
LBi-2.3: Material Emissions: Carpet & Hard Flooring.
LBi-2.4: Material Emissions: Ceiling Systems.
LBi-2.5: Material Emissions: Formaldehyde Reduction.

7.1 Construction Environmental Management

Works undertaken by the mosque contractor during the building stage may adversely impact amenities, traffic or the environment of the surrounding area if site-specific and implementable procedures and mitigation measures are not put in place to monitor and control these environmental impacts throughout the construction phase.

The Federal Environment Law No. 24 of 1999 for the Protection and Development of the Environment (Federal Law 24) stipulates the need to evaluate the environmental impacts of all development projects undertaken in the UAE. In accordance with the Law, the Environment Agency – Abu Dhabi (EAD), is responsible for determining the environmental permitting requirements for all new developments within the Emirate of Abu Dhabi.

They are also responsible for evaluating Environmental Permit Applications (EPA) for all new construction projects prior to commencing any construction works. Following this and depending on the complexity, location and existence of sensitive receptors in the proximity of the proposed mosque, the EAD may require various studies to be prepared and submitted for review and approval (more details on these can be found at: http://www.ead.ae/en/portal/environmental.permitting.aspx) before issuing the contractor with the building permit.

Amongst the required studies, the EAD may require the mosque developer and contractor to prepare and implement a Construction Environmental Management Plan (CEMP) in accordance with the EAD's Technical Guidance for CEMP.

The PBRS also requires that the design and development team assess the impact of construction and recommend that a CEMP is completed.

Related Credits:
IDP-3: Construction Environmental Management..

Developer Requirements

The Environmental Permit Application should be submitted to the EAD by the mosque developer prior to construction works commencing on site. After reviewing the EPA, the EAD will issue a response to the mosque developer, either issuing a 'No Objection Certificate' (NOC) or requesting the preparation and implementation of an Environmental Study to issue the necessary permit.

To comply with the requirements of Credit IDP-3: Construction Environmental Management, the mosque developer should include within the tender documentation the requirement that all contractors tendering for the mosque construction develop and implement a CEMP that meets the Credit requirements.

Contractor Requirements

Similarly, the mosque contractor should take into account the requirement to prepare and implement a CEMP for the mosque development prior to any construction works commencing on-site.

In the case that the EAD issues a formal request to prepare a CEMP for the mosque development, the contractor should have a CEMP prepared by an EAD-approved and registered consultant in accordance with the EAD's Technical Guidance for CEMP and obtain EAD's approval on the CEMP.

In the case that the EAD does not require a CEMP to be prepared for the mosque development, the contractor should still have a CEMP prepared by an EAD-approved and registered consultant in accordance with the EAD's Technical Guidance for CEMP.

In both cases, if the above is fulfilled to the requirements of Credit IDP-3: Construction Environmental Management, 1 Credit Point can be achieved.

7.2 Construction Waste Management

Before starting any demolition or construction, it is necessary to develop a Construction and Demolition (C&D) Waste Management Plan (refer to Figure 34). This should incorporate:

- Estimates of waste generation. The Building Waste Calculator (refer to Figure 35) will help to estimate the type and amount of waste expected for the project. This can be downloaded from the Estidama website;
- A destination for each waste type leaving the plot. For example, specify that aggregates will be transported to the municipal C&D recycling facility, or that fit-out leftovers will be disposed to landfill;
- Identification of materials to be salvaged or recycled. At least 30% of the estimated waste generation by weight has to be salvaged or recycled; and
- A location for storing waste on site during construction. This should be conveniently located near the area where construction materials are delivered and has to be large enough to allow for separating, at least, aggregates and other waste streams.

It is important for a contractor to ensure that the rates of diverted waste are as high as possible early on in the construction process, where typically, larger volumes of waste are generated. If this is not achieved, it may be difficult to achieve the diversion rates required to be diverted to meet Credit SM-R2: Basic Construction Waste Management.

Landfilled Construction and Demolition Waste Calculation in Tonnes		
Landfill Material Description	Landfill Haulier or Location	Quantity of Landfilled Waste (Tonnes)
General waste, March 2010	Al Dhafra Landfill	15
General waste, April 2011	Al Dhafra Landfill	31
General waste, May 2011	Al Dhafra Landfill	70
General waste, June 2012	Al Dhafra Landfill	65
Pallets, April 2010	Al Dhafra Landfill	10
Pallets, May 2010	Al Dhafra Landfill	5
Pallets, June 2010	Al Dhafra Landfill	15

Diverted Construction and Demolition Waste Calculation in Tonnes		
Diverted/Recycled Material Description	Diversion/Recycling Haulier or Location	Quantity of Diverted/Recycled Waste (Tonnes)
Concrete from demolition, March 2010	Municipal C&D plant	150
Concrete from demolition, April 2010	Municipal C&D plant	200
Metal, March 2010	Local metal recycler	4
Metal, April 2010	Local metal recycler	3
Metal, May 2010	Local metal recycler	1
Metal, June 2010	Local metal recycler	1

Salvaged Construction and Demolition Waste Calculation in Tonnes		
Diverted/Recycled Material Description	Diversion/Recycling Haulier or Location	Quantity of Diverted/Recycled Waste (Tonnes)
Spandrel panels from façades, June 2010	Reused in new building	15

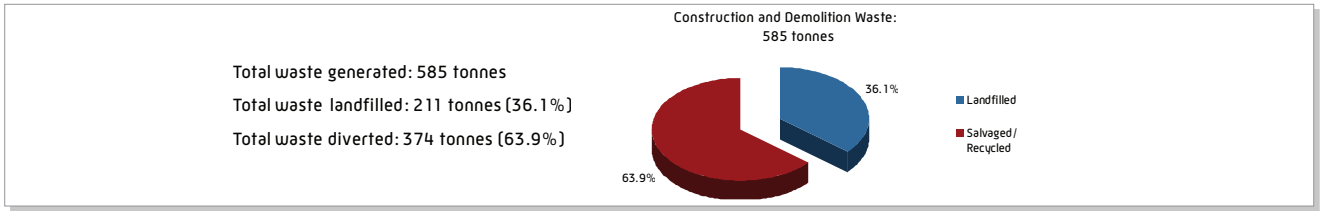


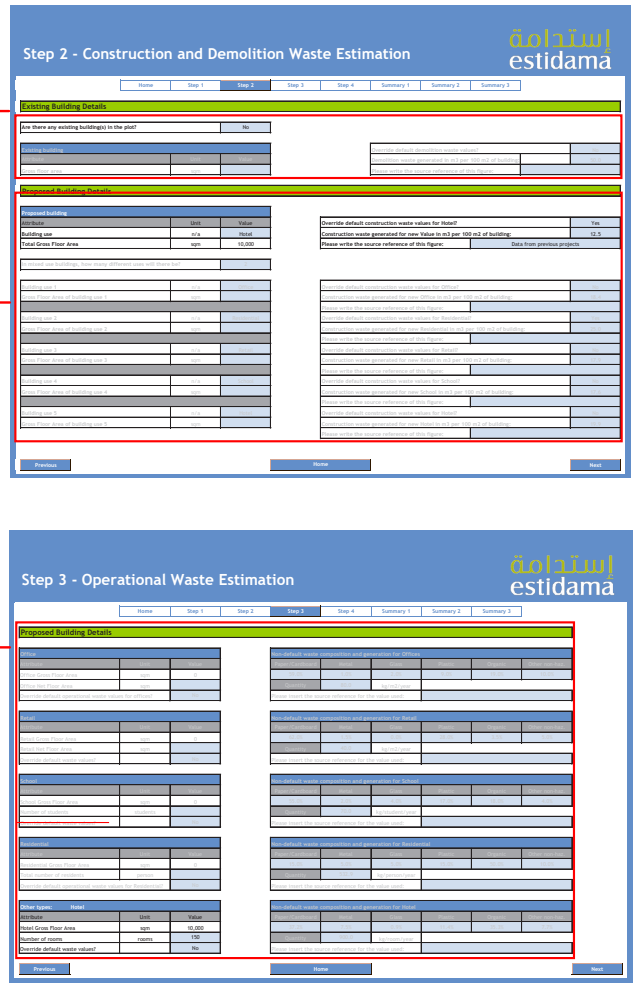
Figure 34: Schedule of Items Reclaimed/Recycled

Related Credits:
SM-R2: Basic Construction Waste Management.

Enter details of existing building (if applicable).

Enter details of proposed building. Use the 'mixed-use' option for buildings with more than 1 use.

Enter waste generation details for the building use. Default values can be overridden if required.



Enter operational waste management procedures.

Default capture rates can be overridden if required.

Enter construction and demolition waste management procedures.

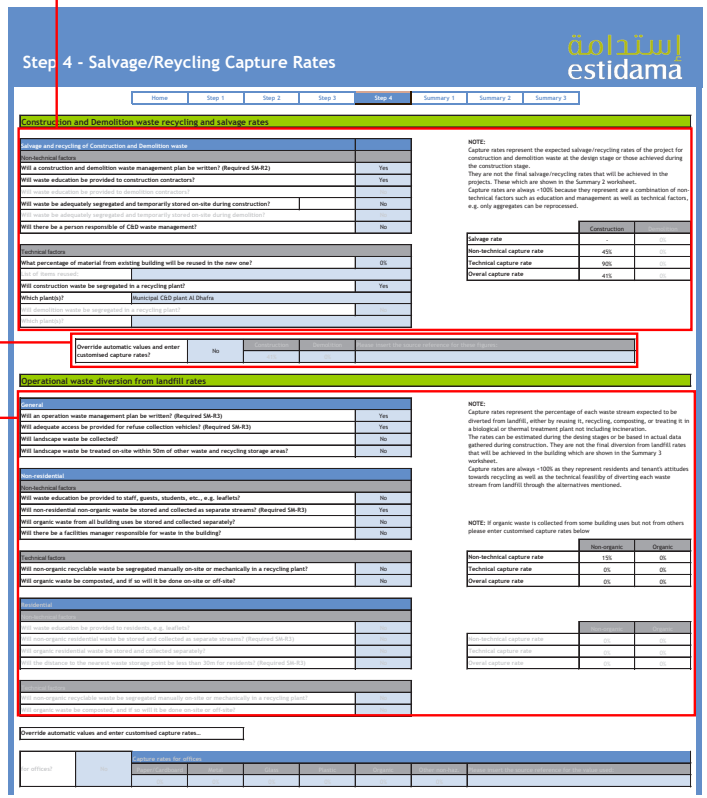
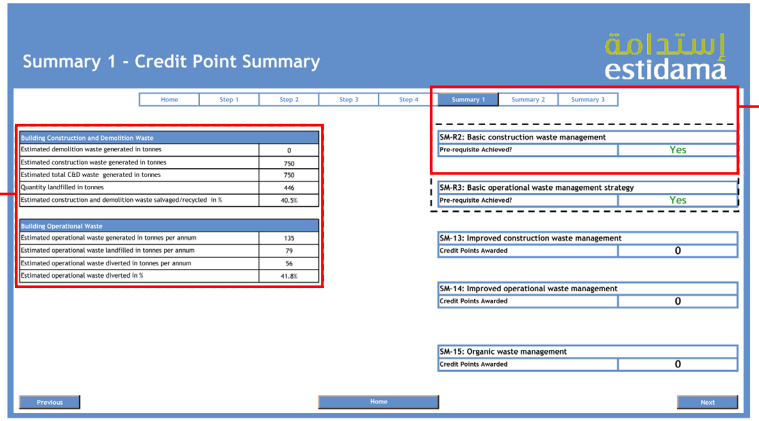


Figure 35: Building Waste Calculator

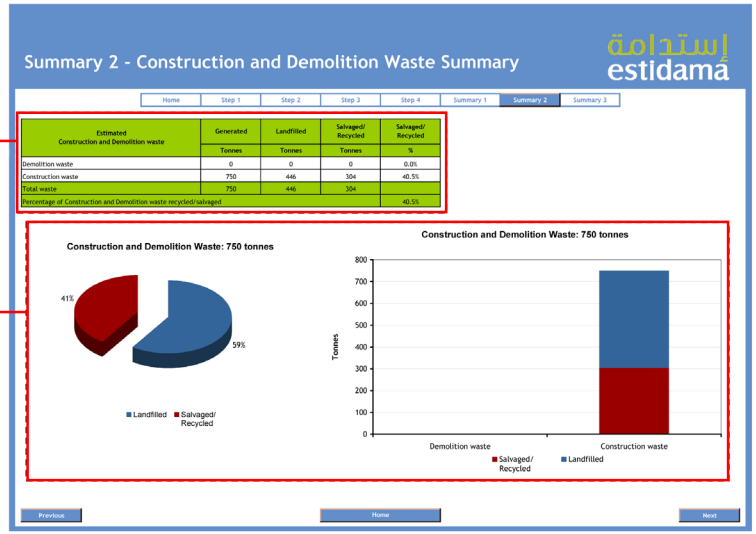
Summary of construction and demolition as well as operational waste estimates and diversion from landfill and incineration rates.



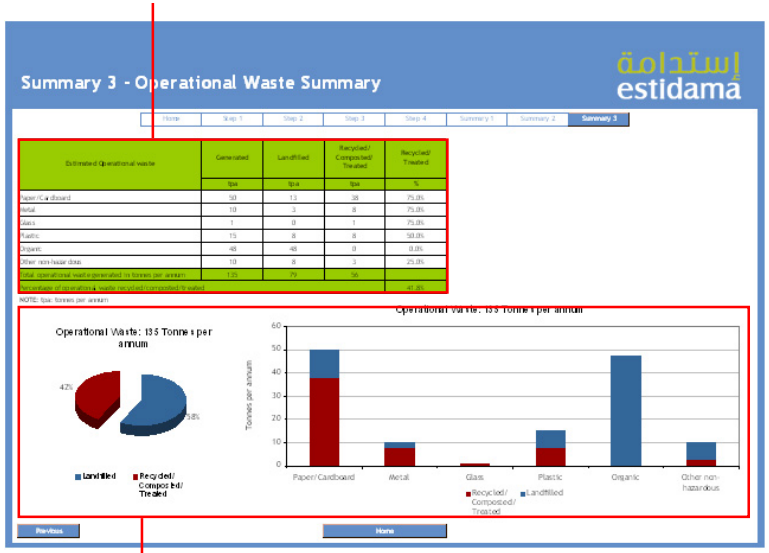
Summary of compliance with required Credits in the Stewarding Materials Section of the PBRS.

Summary of construction and demolition waste estimates in numerical format.

Summary of construction and demolition waste estimates in graphical format.



Summary of operational waste estimates in numerical format.



Summary of operational waste estimates in graphical format.

Figure 35(contd.): Building Waste Calculator

7.3 Procurement During Construction

The construction materials chosen will require dedicated attention during the procurement process to ensure compliance with the requirements of the targeted Credits including:

- Materials required to meet certain performance standards (e.g. SRI values of a reflective material, COP of chillers, U-value of walls, etc.), such as:
  - RE-R1: Minimum Energy Performance;
  - PW-R1: Minimum Interior Water Use Reduction;
  - LBo-R3: Outdoor Thermal Comfort Strategy;
  - LBo-1: Improved Outdoor Thermal Comfort; and
  - RE-2: Cool Building Strategies.
- Materials whose elimination is essential to avoid harmful effects on worshipper and environmental health, such as:
  - LBi-2.1: Material Emissions: Adhesives & Sealants;
  - LBi-2.2: Material Emissions: Paints & Coatings;
  - LBi-2.3: Material Emissions: Carpet & Hard Flooring;
  - LBi-2.4: Material Emissions: Ceiling Systems;
  - LBi-2.5: Material Emissions: Formaldehyde Reduction;
  - RE-R3: Ozone Impacts of Refrigerants & Fire Suppression Systems;
  - SM-R1: Hazardous Materials Elimination; and
  - SM-1: Non-Polluting Materials.
- Materials that come from sustainable sourcing, such as:
  - SM-8: Material Reuse;
  - SM-9: Regional Materials;
  - SM-10: Recycled Materials;
  - SM-11: Rapidly Renewable Materials; and
  - SM-12: Reused or Certified Timber.

The mosque contractor should consider implementing the steps outlined in Figure 36 during the procurement process to ensure suitable materials have been procured for constructing the mosque.

Step 1: Receive the project specification from the mosque designer and check that it includes performance criteria for all material categories related to the targeted Credit Points for the mosque.

Step 2: Prepare tender documents and include PBRS requirements as part of the selection criteria. Highlight that the contractor is responsible for procuring compliant products and documenting compliance.

Step 3: Consider PBRS requirements as part of tender selection and evaluate the impact of different options on the overall project rating. Contractors should require product suppliers to fill out compliance questionnaires.

Step 4: Require suppliers to provide product sheets and applicable certificates as well as any other evidence required to illustrate compliance before proceeding with the product purchase.

Step 5: Establish a staging area and verification procedure to double-check compliance at product delivery. Keep a log of delivered products and associated delivery notes and receipts.

Step 6: Ensure performance integrity during storage.

Step 7: Ensure effective installation according to manufacturer's requirements and document the installation process using photographs (where relevant).

Figure 36 Procurement process

8.0
Performance Verification

8.0 Performance Verification

The key to ensuring the sustainable performance of a mosque is to verify that the building performs according to the design criteria.

As per the requirements of Credit IDP-R3: Basic Commissioning, an independent commissioning agent must verify that the building performs as designed to protect occupant health and to ensure on-going building efficiency. This agent must be engaged from the beginning of design through to the completion of construction and commissioning. The design and construction documentation must be reviewed by the commissioning agent prior to the start of construction works.

Information collected from the energy and water sub-meters, required by Credits RE-R2: Energy Monitoring & Reporting and PW-R2: Exterior Water Monitoring, must be used to inform the Awqaf-appointed maintenance contractor of any performance problems. As per the Integrated Development Process implementation strategy, the Awqaf-appointed maintenance contractor must take remedial action and ensure optimum operations as per the design intent.

A noise field test should be conducted to ensure that acoustic conditions are compliant with the requirements of Credit LBi-9: Indoor Noise Pollution.

Related Credits:
IDP-R1: Integrated Development Strategy.
IDP-R3: Basic Commissioning.
LBi-9: Indoor Noise Pollution.

8.1 Commissioning

Basic commissioning aims to ensure that the building performs as designed to protect occupant health, provide comfort and ensure ongoing building efficiency. An independent commissioning agent, reporting to the project owner, with at least 2 years commissioning experience, must be engaged as part of the project design team from the beginning of design through to the completion of construction and commissioning (refer to Figure 37).

The commissioning process must check, at a minimum, the following systems:

- Heating, ventilation, air conditioning and refrigeration;
- On-site energy generation (including co-generation);
- Building Management Systems;
- Lighting and lighting controls;
- Domestic hot and cold water systems;
- On-site water treatment systems; and
- Automated control features such as blinds.

Within the mosque Operations and Maintenance Manuals, the following sections would normally be expected:

- Annual review and updates to the manuals;
- Purpose and responsibilities;
- Links to other key documents;
- Main contacts;
- Commissioning, handover and compliance;
- Overall building design;
- Summary of areas/occupancy;
- Summary of main MEP plant;
- Overview of controls/BEMs;
- Builder user information (requirement dependent on building typology);
- Metering, monitoring and targeting strategy;
- Building performance records;
- Summary of maintenance requirements;
- Major alterations;
- Results of in-use investigations; and
- Appendices – all relevant certificates/tests.

A commissioning plan should include the following:

- Commissioning programme overview;
- List of systems and assemblies included in commissioning process and activities;
- Commissioning team and responsibilities;
- Management, communication and reporting of commissioning process;
- Overview of commissioning process activities through the design, including:
  - Design and construction document review;
  - Basis of design review;
  - Owner's (donor/Awqaf) project requirements;
  - Submittals documentation and process; and
  - Functional performance test development and implementation.

Related Credits:
IDP-R3: Basic Commissioning.
LBi-9: Indoor Noise Pollution.

8.2 Acoustic Verification

The purpose of a mosque is to provide a quiet and comfortable place for worshippers to pray without distractions from the outside world. It is also imperative that the words from the Imam can be heard clearly.

The contractor should submit testing results of noise monitoring that demonstrate the following:

- Internal ambient noise levels do not exceed 50 dB(A) Leq within the public prayer areas; and
- Internal ambient noise levels do not exceed 35 dB(A) Leq (8-hour) and 45 dB(A)Leq max in the bedrooms of the Imam's and Mu'athen's residences and less than 40 dB(A)Leq in all other areas of the residences.

During testing, only noise from building services and external noise sources should be included and the test should represent the noisiest area of the buildings. This testing process must be signed off by a qualified acoustics engineer.

Commissioning Responsibility Matrix

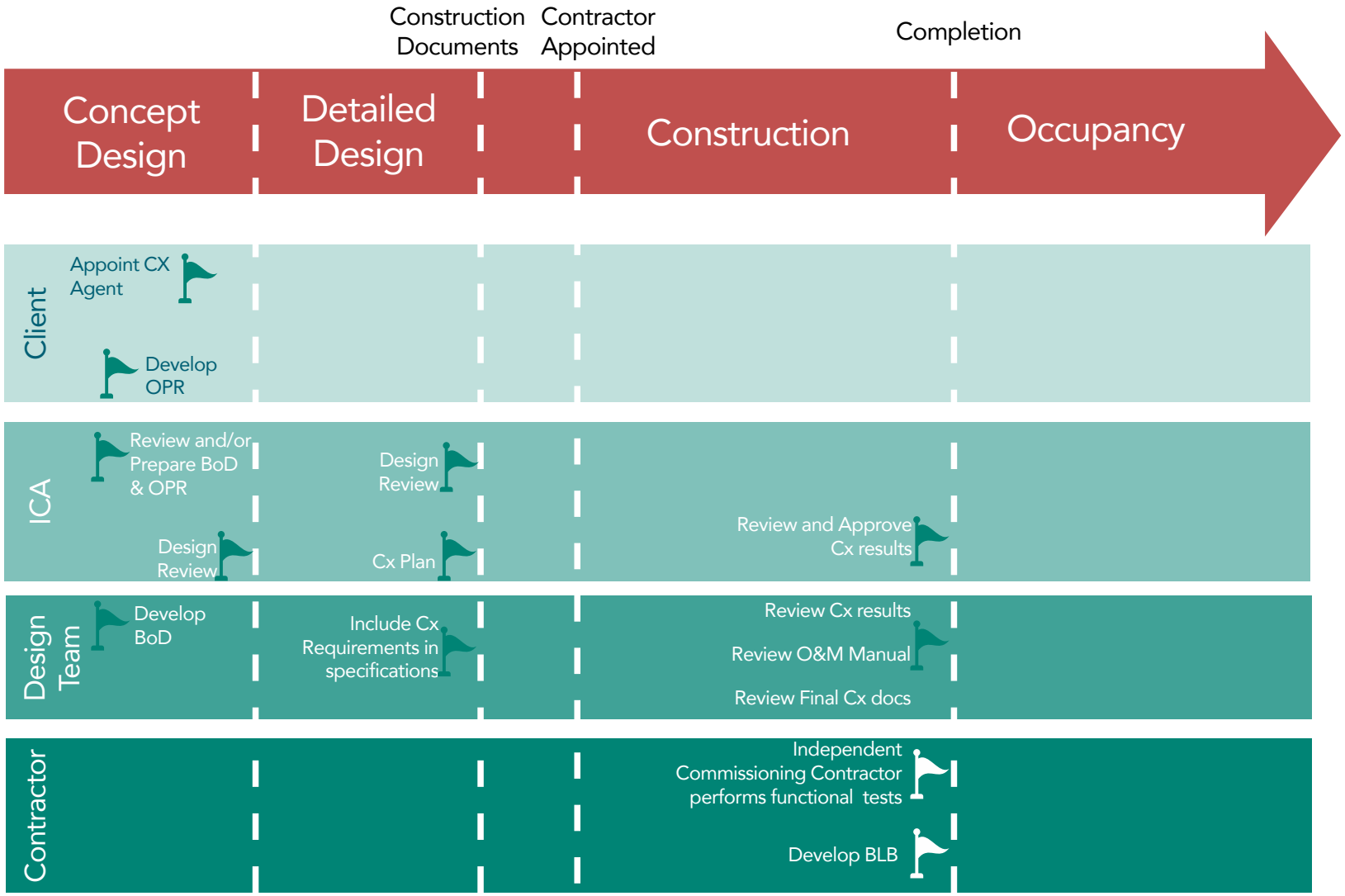


Figure 37: Commissioning responsibility matrix

9.0
Mosque Operation

9.0 Mosque Operation

This section addresses the operations and maintenance aspects related to the mosque. Once the mosque has been built according to the sustainability features established during design, it is important to ensure that these sustainability measures are maintained for the life of the mosque to ensure that the mosque continually operates efficiently.

The operation and maintenance of the mosque is likely to be undertaken by 2 parties: the Imam and the Awqaf-appointed maintenance contractor. It is important throughout the design process that a representative from the Awqaf-appointed maintenance contractor is made aware of any major design considerations that are likely to have specific operation and maintenance requirements for the mosque (refer to Volume 3 – Operations).

The operation of the mosque must follow the principles of Estidama in the following key areas:

- Communication of sustainable design features and operational requirements;
- Management of natural systems according to the Natural Systems Design and Management Strategy;
- Waste management; and
- Legionella management.

There may be documents or processes which have been produced or followed for Estidama submission. The following section outlines these for the mosque operators.

Related Credits:
IDP-R1: Integrated Development Strategy.
IDP-6: Sustainability Communication.
NS-R3: Natural Systems Design & Management Strategy.
LBi-R2: Smoking Control.
SM-R3: Basic Operational Waste Management.
SM-14: Improved Operational Waste Management.
LBi-R3: Legionella Prevention.

9.1 Sustainability Communication

In order for the mosque to operate efficiently and perform to the criteria set out in the design stage for mosque development, it is vital that the mosque occupants are made aware of the effect they have on the performance of the mosque. Water usage through ablution and waste generation are some of the key areas that are impacted by worshipper behaviour.

Approach

It is expected that all mosques will provide a form of communication to worshippers regarding the building performance. The developer should propose a medium which allows the performance of the mosque to be communicated to worshippers.

Digital Feedback System

To obtain Credit Points under Credit IDP-6: Sustainability Communication, the mosque developer can, install a digital feedback system with a dashboard display which communicates the following to worshippers:

- Mosque energy consumption: separating out the usage against targets of the separately metered areas (e.g. prayer halls, a/c, as required by Section 6.2 energy metering); and
- Mosque water consumption: separating out the usage against targets of the separately metered areas (e.g. ablutions, Imam's/Mu'athen's residences and irrigation).

The digital feedback system should be located in prominent areas with high visibility to all worshippers (e.g. the mosque entrance) but must not distract or interfere with prayer (refer to Volume 2 – Design).

The provision of a digital feedback system will communicate the performance of the mosque to worshippers and empower them to change their behavioural attitudes when it comes to energy and water saving. If a worshipper sees that their mosque is performing below a pre-established benchmark, they should be encouraged to positively alter their behaviour.

Related Credits:
IDP-6: Sustainability Communication.

9.2 Indoor Waste and Recycling Storage

Internal Waste Storage

Mosques have 2 separate 'areas' in relation to waste storage and the type of waste generated (refer to Figure 38). There are the public prayer areas, and the Imam's/Mu'athen's residences.

- Public Areas: A suitable number of waste storage bins must be provided in appropriate locations (e.g. away from prayer areas or near the mosque entrance) within the public areas. These waste storage bins must only provide for the collection of light personal waste and must be signed appropriately.
  The mosque designer must provide an adequately sized and accessible external recycling storage area with clearly labelled bins which allow for segregation of waste. This area must be appropriately signed as described within Section 3.5 External Waste and Recycling Storage.
- Imam's/Mu'athen's Residences: In relation to the PRS structure, the Imam's and Mu'athen's residences are subject to the requirements of the Pearl Villa Rating System (PVRS). The management of operational waste in the Villa Guidelines is covered under Credit SM-R3: Storage and Collection of Waste and Recyclables. The provision of adequately sized cupboard space in the kitchen area of the private residences is required for a minimum of 3 litter bins, or 1 combi-litter bin, with a minimum of 3 compartments, to facilitate source-segregation.

Collection

The collection and transportation of waste from waste storage bins to the external recycling storage area must be undertaken as follows:

- Public Areas: The Awqaf-appointed maintenance contractor will be responsible for the operation and maintenance of the mosque and therefore will be responsible for the collection and transfer of all waste from the public areas of the mosque to the external recycling storage area. The mosque developer/designer must discuss the waste management for the mosque's public areas with the Awqaf-appointed maintenance contractor and develop an appropriate Operational Waste Strategy.
- Imam's/Mu'athen's Residences: The collection and transfer of waste from the Imam's/Mu'athen's residences to the external recycling storage area will be the responsibility of the occupants (e.g. Imam/Mu'athen). They will be responsible for the segregation, collection and transfer of waste into the appropriate labelled storage bins located in the external recycling storage area.





Figure 38: Example of Waste Segregation at Source

Related Credits:
SM-R3: Basic Operational Waste Management.
SM-R3: Storage & Collection of Waste and Recyclables (1 Pearl Villa Rating System).

9.3 Legionella Management

Legionnaires' disease is a potentially fatal form of pneumonia which is caused by Legionella pneumophila, a waterborne bacterium that grows in slow moving or still water.

HSE Approved Code of Practice (ACoP) L8: Legionnaires' Disease - The Control of Legionella Bacteria in Water Systems (refer to Figure 39) applies to plant and water systems which may present a particular potential risk by releasing a spray or aerosol during operation or maintenance.

Relevant water-based systems include, but are not limited to:

- Water systems incorporating a cooling tower or an evaporative condenser;
- Hot and cold water systems;
- Other plant and systems containing water which is likely to exceed 20°C and which may release a spray or aerosol during operation or during maintenance;
- Humidifiers;
- Air washers;
- Wet scrubbers;
- Fountains and water features (indoor and outdoor);
- Sprinkler and hose reel systems; and
- Spray nozzles on water fixtures.

Related Credits:
LBi-R3: Legionella Prevention.

Ablution and Toilet Fixtures

All ablution and toilet fixtures within the mosque must contain a spray tap to optimise water consumption. Spray taps however present a potentially high risk of harbouring Legionella bacteria. The design team must specifically address these items in the Legionella Management Plan.

Roles and Responsibilities

The design engineers should support the client in developing a Legionella Management Plan including the design intent and Operations Manual.

HSE ACoP L8 requires the appointed operations manager (in this instance the Awqaf-appointed maintenance contractor) to ensure that all responsibilities are clearly defined, formally allocated and control procedures are carried out to prevent the growth of Legionella bacteria through the implementation of the Legionella Management Plan.

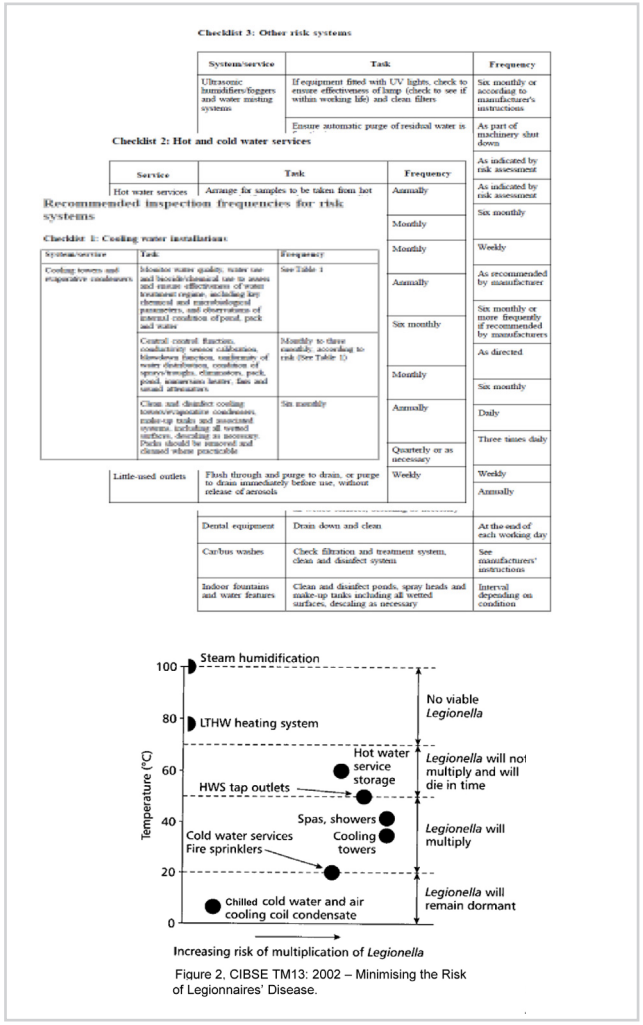


Figure 39: Control of Legionella bacteria
Source: Appendix 1, HSC - Legionnaires' Disease. The control of Legionella bacteria in water systems. Approved Code of Practice and Guidance.

Legionella Management Plan

At all stages of the mosque development, adequate measures should be implemented to minimise the risk of contamination. A Legionella Management Plan must be developed at the outset of the project and should address the following (refer to Figure 40 and Figure 41):

1. Identify and assess the level of risk associated with water systems in the design and operation of the mosque. If the risks are insignificant, no further action needs be taken, other than periodical reassessment in case of changes in the system.
2. If a risk is identified, proper controls must be introduced and documented within the Legionella Management Plan. Risks can be controlled by careful planning, management policy, competent staff and adherence to proper control strategies.
3. Prevent or control the risk of exposure to Legionella bacteria. Consideration should be given to:
   - Ensure that the release of water spray is properly controlled;
   - Keep the system and the water in it clean;
   - Avoid conditions that favour the growth of Legionella bacteria and other micro-organisms, water stagnation and materials encouraging growth;
   - Treat water to either kill Legionella bacteria (and other micro-organisms), limit their ability to grow, or use a biocidal treatment if applicable;
   - Continually monitor all water systems where sources of Legionella could occur; and
   - Ensure easy access for inspection, draining, dismantling and cleaning of all systems.
4. Records need to be kept of the Plan and who is responsible for managing it, these should also be kept with the results of the routine monitoring.
5. Ensure that information from manufacturers, suppliers and installers provides guidance and includes risks to users.

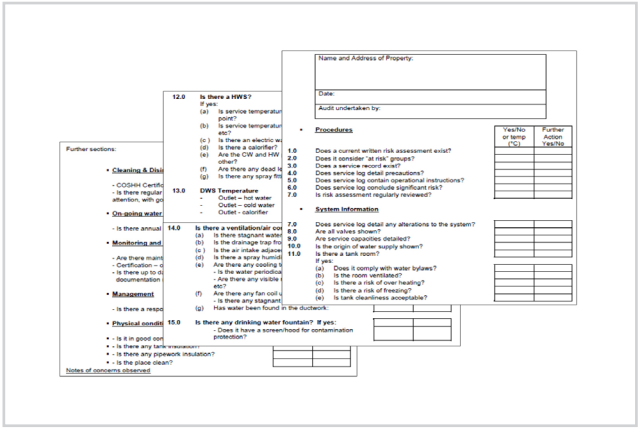


Figure 40: Typical Legionella bacteria risk report

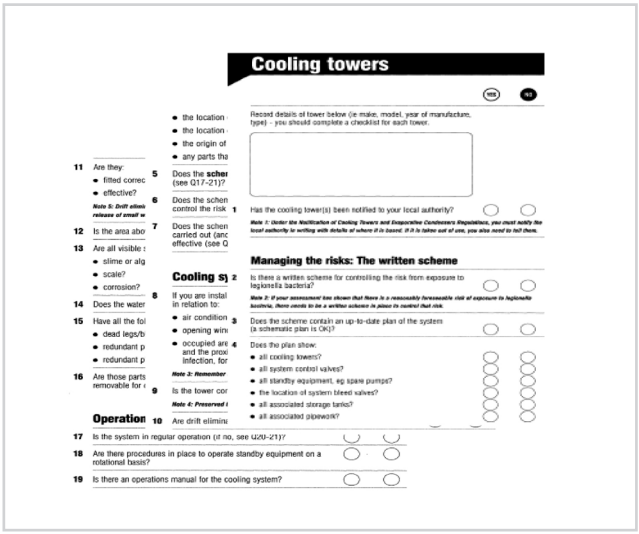


Figure 41: HSC – Control of Legionella Bacteria in Water Systems: Audit Checklist

Related Credits:
LBi-R3: Legionella Prevention.

Attachment A:

Energy Prescriptive Method Parameters

Attachment A: Energy Prescriptive Method Parameters

Internal Set Point Temperature

- Recommended: 23°C

Internal Set Back Temperature

- Recommended: 28°C

Internal Relative Humidity

- Recommended: RH 50% +/- 10%

Maximum Window (Glass and Frame) Area per Façade Orientation

- The maximum area of all windows in the mosque's façades shall not exceed 16%. A maximum window area of 30% is permitted on any individual façade when traded off, so that the sum of all window areas does not exceed 16%.

Horizontal Windows – Skylights

- Not permitted.

Infiltration Air Changes per Hour

- 0.35 Air Changes per Hour (ACH)

Opaque Element U-Value

Construction Type	Maximum Average U-value ($W/m^2.K$)
Roof	0.22
Wall	0.32

Vertical Windows

Option 1

Component	Requirement	Limit
Frame (with thermal break)	Maximum U-value	4.0
Glass	Maximum Centre Pane U-value	1.8
	Maximum Solar Heat Gain Coefficient	0.40
	Minimum Light Transmission	0.55

Option 2

Component	Maximum U-value	U-value
Window (Glass and Frame) averaged over all windows	Maximum Window U-value	2.2
Glass SHGC	Maximum Solar Heat Gain Coefficient	0.40
Glass Light Transmission	Minimum Light Transmission	0.55

Internal Lighting Maximum Power Densities

- Imam's/Mu'athen's residences: 8.6 W/m^2
- Office/library: 10.76 W/m^2
- Religious prayer space: 10.0 W/m^2
- Toilets/ablution areas: 9.0 W/m^2

Internal Lighting Controls

- All multi-occupant spaces must have occupancy-based lighting controls with adjustable time delay functionality (for example time delay increments of 15 minutes (15,30,45 etc.) should be specified to minimize worshipper dissatisfaction)..

External Lighting Maximum Power Densities

- Building façades: 2.2 W/m² for each illuminated wall or surface or 16.4 W/linear metre for each illuminated wall or surface length.
- Main entrances: 98 W/linear metre of door width.
- Other doors: 66 W/linear metre of door width.
- Building grounds.

1. Walkways less than 3 m wide: 3.3 W/linear metre
2. Walkways 3 m wide or greater: 2.2 W/m²
3. Plaza areas: 2.2 W/m²
4. Special feature areas: 2.2 W/m²
5. Stairways: 10.8 W/m²
6. External parking: 1.6 W/m²
7. Canopies and overhangs: Canopies (free standing and attached and overhangs) 13.5 W/m²

External Lighting Controls

- All external lighting, except safety and security lighting must be controlled by photocell with time-based controller overrides.

Fresh Air

- Refer to Table 6: Mechanical Ventilation System in page 40.

Energy Efficiency – HVAC Equipment and Systems

Plant Efficiency – COP

The air conditioning plant shall have a minimum COP of 3.4.

System Fan Power

Central mechanical ventilation, including heating and cooling	**1.8 W/l/s**
Zonal supply system where fan is remote from zone, i.e. ceiling or roof mounted	**1.2 W/l/s**
Zonal extract system where fan is remote from zone	**0.6 W/l/s**
Zonal supply and extract ventilation units such as ceiling void or roof units serving single room/zone with heat recovery	**2.0 W/l/s**
Local supply and extract ventilation units such as wall/roof units serving single room/zone with heat recovery	**1.8 W/l/s**
Local supply and extract ventilation units such as window/wall/roof units serving single area (e.g. toilet extractor unit)	**0.4 W/l/s**
Other local ventilation units	**0.6 W/l/s**
Fan coil units (weighted average)	**0.6 W/l/s**

Heat Recovery

Individual fan systems that meet the following criteria shall have an energy recovery system with at least 50% efficiency:

- Supply air rate above 2400 l/s; and
- Fresh air rate of at least 70% of the total supply air.

Demand Control Ventilation

Required in all multi-occupant spaces including prayer halls, Qur'anic classes, multi-purpose halls and crèches.

HVAC systems controls

The systems shall be capable of controlling each thermal zone independently.

Abu Dhabi Mosque Development Regulations

Appendix 1 - Estidama

Version 3.0 - 2025