GRIHA AH v.1

A GRIHA Council Publication

GRIHA FOR AFFORDABLE HOUSING ABRIDGED MANUAL

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ABRIDGED MANUAL

Making AFFORDABLE HOUSING SUSTAINABLE

A GRIHA Council Publication

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MESSAGE

President GRIHA Council

The urban population of India has been rising sharply over the past decade and is projected to reach 814 million by 2050. The exponential increase in the population is set to pose severe challenges in terms of providing affordable, safe and sustainable housing for all in the burgeoning urban centers all over the country.

Government initiatives such as the *Pradhan Mantri Awas Yojana* – Housing for All (Urban) strives to overcome the housing shortage by the year 2022. I am pleased to see the launch of a new rating variant, "GRIHA for Affordable Housing", aligned to the Government of India's target of providing affordable housing for all. This rating variant is specifically developed to ensure that the new construction under the scheme is not only affordable but also sustainable. The rating has been prudently designed to stimulate resource efficiency and enhanced occupant comfort in the affordable housing segment.

Since its inception, the GRIHA rating has been instrumental in driving India's green building movement. India's "Nationally Determined Contributions" (NDCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) highlight GRIHA as a tool to evaluate reduction in emission intensity through habitats. It is our endeavour at the GRIHA Council, to showcase indigenous strategies and easy to implement solutions which are not only sustainable but also economically viable for the end users.

I acknowledge the contribution of the technical team and industry experts, who shared their valuable insights throughout the development process. I hope that this rating will serve as a valuable learning resource for the building industry and developers to promote sustainable affordable housing for all.

Ajay Mathur

FOREWORD

CEO GRIHA Council

Affordable, climate resilient and sustainable buildings are the need of the hour. The GRIHA rating system was created to integrate resource efficiency, enhanced occupant comfort and efficient construction management in the building industry. So far, the GRIHA variants focused on all segments of new construction with its mission "Inspire, enable and engage with society to achieve sustainable habitats" and the existing building sector with the introduction of GRIHA for existing buildings.

We, at the GRIHA Council are pleased to introduce the "GRIHA for Affordable Housing" rating as a dedicated assessment cum rating tool to evaluate performance and provide solutions for enhanced energy and water efficiencies, increased thermal & visual comfort and social integration. While focusing on the above, the tool has been developed as a simplified system to assist in designing as well as rating the affordable housing projects.

This abridged version of "GRIHA for Affordable Housing" has been developed through a consultative process across all stakeholders, ranging from facility managers, green building consultants, academia and building practitioners. With the introduction of economically viable advanced technologies and practices, the rating would keep evolving over time. This would drive the affordable housing stock towards attaining higher levels of sustainability with better livability.

I gratefully acknowledge the support of all those associated with the development of this rating and look forward to their continued guidance for its enhancement.

Sanjay Seth

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Point weightage of the entire rating system is based on Analytic Hierarchy Process (AHP), which was conducted to define point thresholds. GRIHA council would like to thank all the participants of the survey for taking out their valuable time and sharing their responses. We would like to place our sincere gratitude to Mr. Rajan Rawal, Ar. Sanjay Prakash, Dr. Ajitabh Ambastha, Ms. Anamika Prasad, Mr. Nilesh Pojge, Ms. Chaitali Basu, Ms. Vaishali Tambat, Mr. Sunil Kumar Jyothi, Mr. Vikas Chand Sharma, Mr. Gurneet Singh, Ms. Mukta Rai Saxena, Mr. Jayesh Vira, Dr. Cesare Saccani, Ms. Kavita Gusain, Ar. Nilesh Gandhi, Ms. Shweta Manchanda, Mr. Dheeraj Kumar Yadav, Dr. Meenakshi Rathore, Ms. Swati Puchalapalli, Ms. Kanchan Sidhaye, Mr. Rana Pratap Poddar, Ms. Alankrita Soni, Ms. Sangita Das, Mr. Gaurav Shorey, and Ms. Swati Chokshi for sharing valuable inputs.

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ABBREVIATIONS

BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BMTPC	Building Materials & Technology Promotion Council
CAGR	Compound Annual Growth Rate
CFCs	Chlorofluorocarbons
CPCB	Central Pollution Control Board
CPWD	Central Public Works Department
CRRI	Central Road Research Institute
ECBC	Energy Conservation Building Code
EPD	Environmental Product Declaration
EPS	Expanded polystyrene
FR	Flow rate
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GFRG	Glass Fibre Reinforced Gypsum
GHG	Greenhouse gas
HCFCs	Hydro chlorofluorocarbons
HUDCO	Housing and Urban Development Corporation
HVAC	Heating, ventilation, and air conditioning IRC Indian Roads Congress
INDC	Intended Nationally Determined Contributions
IRC	Indian Roads Congress
KL	Kilolitres
KLPD	Kilolitres per Day
LGSFS	Light Gauge Steel Framed Structure
LGSFS-ICP	Light Gauge Steel Framed Structure with Infill Concrete Panels
LPF	Litres per Flush
LPM	Litres per Minute
MPD	Metres per Day
MT	Metric tonnes
NBC	National Building Code
NBCC	National Buildings Construction Corporation Limited
ODP	Ozone Depletion Potential
OPC	Ordinary Portland Cement
PSI	Pounds per Square Inch
STP	Sewage Treatment Plant
Sq.M	Square Metre
VOC	Volatile Organic Compound
UDI	Useful Daylight Illuminance
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

DEFINITIONS

Artificial groundwater recharge
Artificial recharge is the planned, human activity of augmenting the amount of groundwater available through works designed to increase the natural replenishment or percolation of surface waters into the groundwater aquifers, resulting in a corresponding increase in the amount of groundwater available for abstraction.

Biomass energy
Biomass energy or ''bioenergy'' includes any solid, liquid or gaseous fuel, or any electric power or useful chemical product derived from organic matter, whether directly from plants or indirectly from plant-derived industrial, commercial or urban wastes, or agricultural and forestry residues.

Biodegradable Waste
Waste which is capable of being decomposed by the action of biological processes is categorised as biodegradable waste.

Carbon Footprint
A 'carbon footprint' is a measure of the greenhouse gas emissions associated with an activity, group of activities or a product.

Cool roof
A cool roof is designed to reflect more sunlight and absorb less heat than a standard roof. A high solar reflectance-albedo is the most important characteristic of a cool roof.

Cavity Wall
The term 'cavity wall' is applied to a type of masonry wall construction in which a continuous air space or cavity is provided inside the wall. A cavity wall therefore is actually two walls separated by an air space, but joined by means of metal ties for structural strength.

Courtyard
Courtyard can be defined as an enclosed area surrounded by a building or wall, which is open to the sky.

Day lighting
Day lighting is controlled admission of natural light, direct sunlight, and diffused-skylight into a building to reduce the need for electric lighting and to save energy. By providing a direct link to the dynamic and perpetually evolving patterns of outdoor illumination, day lighting helps create a visually stimulating and productive environment for building occupants, while reducing as much as one-third of total building energy costs.

Embodied energy
Embodied energy is the energy consumed by all of the processes associated with the production of a building or a product, from the acquisition of natural resources to product delivery, including mining, manufacturing of materials and equipment, transport and administrative functions.

Energy efficiency
Energy efficiency is the use of technology that requires less energy to perform the same function.

Fenestration
Products classified as either vertical fenestration or skylights and sloped glazing, installed in such a manner as to preserve the weather resistant barrier of the wall or roof in which they are installed. Fenestration includes products with glass or other transparent or translucent materials.

Geothermal energy
Geothermal energy is energy from the heat of the earth's core. Geothermal energy can be harnessed through direct use of heat, ground source heat pumps.

Greenhouse Effect
The exchange of incoming and outgoing radiation that warms the Earth is often referred to as the greenhouse effect. The greenhouse effect happens when certain gases—known as greenhouse gases—collect in Earth's atmosphere. These gases include carbon dioxide(CO2), methane, nitrous oxide (N_2O), fluorinated gases, and ozone.
Greenhouse gases let the sun's light shine onto the Earth's surface, but they trap the heat that reflects back up into the atmosphere. In this way, they act like the glass walls of a greenhouse. This greenhouse effect keeps the Earth warm enough to sustain life.

Light Shelf
Light shelf is a passive architectural element that serves the dual purpose of providing shade and reflecting light. The main component of the light shelf is a horizontal element that is positioned either on the exterior or interior side of window façade, or both.

Luminous efficacy
The total luminous flux emitted by the light source divided by the lamp wattage; expressed in lumens per watt (lm/W).

Ozone Depleting Potential
Ozone Depleting Potential is defined as "the integrated change in total ozone per unit mass emission of a specific ozone-depleting substance relative to the integrated change in total ozone per unit mass emission of CFC-11", i.e. the ratio of global loss of ozone due to a given substance and global loss of ozone due to CFC-11 of the same mass.

Passive Design
"Passive design" is an approach to building design that uses the building architecture to minimize energy consumption and improve thermal comfort. The building form and thermal performance of building elements (including architectural, structural, envelope and passive mechanical) are carefully considered and optimized for interaction with the local microclimate. The ultimate vision of passive design is to fully eliminate requirements for active mechanical systems (and associated fossil fuel-based energy consumption) and to maintain occupant comfort.

Renewable Energy
Renewable energy uses energy sources that are continually replenished by nature—the sun, the wind, water, the Earth's heat, and plants. Renewable energy technologies turn these fuels into usable forms of energy—most often electricity.

Solar Access
Solar access is the ability of one property to continue to receive sunlight across property lines without obstruction from another's property (buildings, foliage or other impediment).

Solar Reflectance Index
The Solar Reflectance Index (SRI) is a measure of the solar reflectance and emissivity of materials that can be used as an indicator of how hot they are likely to become when solar radiation is incident on their surface. The lower the SRI, the hotter a material is likely to become in the sunshine.

Surface runoff
Surface runoff is water, from rain, snowmelt, or other sources, that flows over the land surface, and is a major component of the water cycle.

Soil Erosion
Soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind.

Solar chimney
A solar chimney uses the sun's heat to provide cooling, using the stack effect. Solar heat gain warms a column of air, which then rises, pulling new outside air through the building. They are also called thermal chimneys, thermosiphons, or thermosyphons.

Shading Coefficient
The shading coefficient is a measure of the total amount of heat passing through the glazing compared with that through a single clear glass. Shading coefficient is defined as the ratio of the solar energy that passes through a glazed unit and the energy that passes through a 0.3 mm clear glass.

Solar Heat Gain Coefficient
Solar Heat Gain Coefficient (SHGC) is the ratio of total transmitted solar heat to incident solar energy. A value of 1.0 indicates that 100% of the solar gain enters the building. A value of 0.0 indicates no solar gain is entering the space.

Solar Wall
A solar wall is a South oriented black painted glazed wall. The wall catches the sun radiation and by the glass covering, the wall remains insulated from the climate outside so the heat is stored and migrates slowly to the inside.

Solid Waste
Solid waste means any garbage or refuse, resulting from industrial, commercial, mining, and agricultural operations, and from community activities. Nearly all anthropogenic activities generate waste.

Solarium/ Sunspace
A sunspace—also known as a solar room or solarium—is a versatile approach to passive solar heating. It is a room or area in a building, with glass roof and walls, intended to maximize the power of the sun's rays. A sunspace optimizes heat gain and minimizes heat loss during cold times, and avoids excess heat gain during hot times.

Sustainable Drainage Systems
Sustainable Drainage Systems (SuDS) is a design philosophy that uses a range of techniques to manage surface water as close to its source as possible. To produce a workable and effective scheme, SuDS must be incorporated into the development at the earliest site-planning stage. SuDS include source control, pre-treatment, and retention.

Trombe Wall
Trombe wall is an "indirect-gain" system which works on the basic greenhouse principle that heat from

the sun in the form of shorter-wavelength & higher-energy U.V radiation passes through glass panel in front of the wall and is absorbed by the wall. The air in between the wall and glass is heated through conduction.

Urban Heat Island Effect
The term "Urban Heat Island Effect" describes built up urban areas that are hotter than nearby rural areas.

Urban Flooding
Urban flooding is essentially due to urbanization , which leads to developed catchments and increases the flood peaks from 1.8 to 8 times and flood volumes by up to 6 times. Consequently, flooding occurs very quickly due to faster flow times.

Useful Daylight Illuminance
Useful Daylight Illuminance is defined as the annual occurrence of illuminances across the work plane where all the illuminances are within the range 100-3000 lux.

U-value
The U-Value of a system is defined as the heat flow rate per unit area, divided by the temperature difference between the surroundings on each side of the system.

Visible Light Transmittance
The percentage of visible light that passes through a window or other glazing unit is called the Visible Light Transmittance (VLT).

Visual Comfort
Visual comfort criteria measure the ability of an individual to carry out tasks comfortably in terms of their photo-sensory perception of their environment. They are dependent on many factors including: light intensity, direction of light source, reflection of surfaces, contrast of surfaces, the nature of the task being undertaken and the photo-sensory response of the eye.

Volatile Organic Compound
Volatile organic compounds (VOC) mean any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions. These are organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure.

Wind Tower
A windcatcher/wind tower is an architectural device used for many centuries to create natural ventilation in buildings. The function of this tower is to catch cooler breeze that prevail at a higher level above the ground and to direct it into the interior of the buildings.

Vegetated Roof
A green roof or vegetated roof is a planted roof top that provides benefits of water harvesting, storm water management, energy conservation, pollution abatement and aesthetic value.

INTRODUCTION

Urbanisation has been the most prominent global trend of the last decade. The rapid growth of cities in the developing world, coupled with increasing rural to urban migration, has led to a boom in mega-cities. By 2030, the number of mega cities will increase to 41 and out of these, 7 will be in India.[1] It is expected that 40% of India population will be urban by 2030, as against 30% currently. This is going to create a huge demand for infrastructure including housing. The shortage of urban housing stood at 18.8 million units in 2012 and is expected to grow with a CAGR of 6.6% to 34.1 million units by 2022.[2] The Government of India has taken several steps to address this demand, one among many being the 'Housing for All' or *Pradhan Mantri Awas Yojana* (PMAY) scheme which aims to bring '*pukka*' house to every family in urban cities by 2022.

The demand and supply gap in terms of housing is especially prominent in the lower income groups of the country. Sky rocketing land prices and ever-increasing cost of building materials and labour have been some of the key challenges in bringing down the housing cost effectively and make housing affordable. The government is taking several steps to catalyse the affordable housing sector in India. Various working groups have been constituted under the PMAY to develop policy templates for house ownership and rental models to be adopted by the states. Schemes have also been launched to improve investment and provide financial support to low cost housing sector. There is a technology sub-mission to promote innovative technologies for low-cost and faster construction.

The construction activity though a necessity for the economic and social growth of the country, does have a negative impact on the environment. Until recently, environmental sustainability and affordable housing have been two separate policy objectives. However, the scenario is changing and environment sustainability is being integrated in most of the affordable housing policies globally. For instance, the Sustainable Development Goal 11, i.e. sustainable cities and communities, strives to minimize the environmental impact while ensuring access for all to adequate, safe and affordable housing. In the context of affordable housing, environmental sustainability serves two objectives. On one hand the negative impact on the environment is minimized and on the other hand adoption of green construction strategies significantly improves the living conditions of the poor by ensuring better thermal and visual comfort. Sustainable affordable housing thus is a habitat where the poor have the possibility and the desire to reside beyond the short-term, which is conducive to their socio-economic development and respectful of the natural environment.[3]

India is conscious that environmental and social considerations must be kept in mind while pursuing rapid economic growth. A comprehensive set of policies have been adopted by India to

1 World Cities Report 2016, Urbanization and Development: Emerging Futures, United Nations Human Settlements Programme (UN-Habitat), 2016, Nairobi

2 Report of the Technical Group on Urban Housing Shortage, Ministry of Housing & Urban Poverty Alleviation (MoHUPA), 2012, New Delhi

3 Sustainable Social Housing Initiative – Stakeholder Assessment Report, Development Alternatives (DA), 2014, New Delhi

move the country to a low-carbon growth path. One of the latest developments is the introduction of a new chapter on "Sustainability" in the National Building Code (NBC) of India established by the Bureau of Indian Standards (BIS), to lay guidelines for green construction in the country. Another major step towards exploiting energy efficiency potential in India was the enactment of the Indian Energy Conservation Act in 2001, under which a dedicated Bureau of Energy Efficiency (BEE) was created. The BEE has since launched a number of policies targeting the buildings sector, including the development of the Energy Efficiency Building Code (ECBC) to ensure minimum energy performance of commercial buildings, but ECBC for residential buildings is still under development.

Mandatory green building policies of the government are pushing the market for compliance with the minimum performance benchmarks while, at the same time, voluntary market driven mechanisms such as rating systems are creating a pull factor by encouraging the adoption of sustainability beyond the mandatory requirement.

Most of the internationally devised rating systems have been tailored to suit the building industry of the country where they were developed. In 2005, together with The Ministry of New and Renewable Energy (MNRE), Government of India, TERI developed the country's own green building rating system, GRIHA (Green Rating for Integrated Habitat Assessment), specifically tailored to suit the Indian climatic condition and building industry. GRIHA stresses passive solar techniques for optimizing visual and thermal comfort indoors, and encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort.

In line with its philosophy and with the purpose of taking sustainability to the masses, GRIHA has developed a new rating variant for "Affordable Housing" which is aligned to the *PMAY*. The GRIHA Rating variants so far have catered to the new and existing buildings to make them more resource efficient by minimizing the wastage of resources. In contrast to high end residential and commercial projects, design features are minimized in affordable housing projects for reducing as much cost as possible. Developing a green rating for affordable housing is a challenge considering that green buildings are commonly perceived to be more expensive. GRIHA for Affordable Housing strives to break this myth of perceived cost and hence the rating is tailor made to incorporate cost-effective sustainability measures. Unlike the commercial buildings and high-end residential projects, the affordable housing occupants do not have access to air-conditioners to ensure thermal comfort and GRIHA has always emphasized the importance of no-cost design interventions for enhancing performance.

This rating has been developed with special focus to reduce any additional cost that the project proponent incurs to obtain green certification. It has been experienced that one of the big costs incurred for certification is on expensive design assistance softwares. The rating will be available to the project proponents in the form of a simplified calculator based design tool offsetting the cost and dependency for softwares for analysis.

"Affordability" is a relative term and "Affordable Housing" may be perceived differently by different individuals. All projects that are in-line with the *PMAY* requirements will be eligible for GRIHA for Affordable Housing Rating, which shall strive to enhance the possibilities of the targeted residents and integrate sustainability in their residences in line with the *PMAY.*

RATING PROCESS

1 **Online Registration** – The project proponent can initiate the registration process by filling the expression of interest (EOI) form available on the GRIHA website. The registration is complete after the feasibility checklist is successfully completed by the project proponent. Once the project is registered, the project proponent will be provided with a username and password for documentation on the online panel.

2 **Orientation workshop** – The registration is followed by an orientation workshop conducted by GRIHA Council, which intends to provide detailed information of the rating along with all the criteria and to address specific queries of the project team. Orientation workshop is an optional service which can be availed by the project team on additional remuneration

3 **1st Due Diligence site visit** – A due diligence site visit shall be conducted by the GRIHA Council to validate site planning parameters during construction. The due diligence report shall be uploaded on the panel within 15 working days from the site visit, followed by upload of a compliance report by the project proponent within the next 15 working days.

4 **Submission of documents** – As the project is nearing completion, the project proponent will upload documents for all criteria on the online panel with the username and password provided during registration.

5 **Preliminary evaluation** – After online submission of documents, the preliminary evaluation is carried out by a team of professionals from GRIHA Council as well as external evaluators who are experts in the respective field. The documentation must be complete in all aspects for all attempted criteria. Any attempted criteria with incomplete documentation shall not be evaluated. Online calculators provided for specific criteria need to be filled in and submitted. The GRIHA Council professionals shall first review compliance of all criteria and establish compliance with mandatory criteria; followed by estimation of the total number of achievable points. A preliminary evaluation report shall be submitted within 25 working days after document submission.

6 **Final Due diligence site visit** – A due diligence site visit shall be conducted by GRIHA Council to verify the submitted documentation with onsite implementation. The visit will be done once the project is complete and all equipment's are installed. The due diligence report shall be uploaded on the panel within 15 working days from the site visit.

7 **Final evaluation** – GRIHA Council along with external evaluators shall evaluate submitted documentation and final due diligence site visit report in response to the preliminary evaluation. On the basis of this evaluation, GRIHA Council shall prepare a final score card within 25 working days after the project team furnishes requisite information sought during preliminary evaluation and due diligence site visit. Final rating will be awarded based on the final evaluation.

8 **Additional Due diligence site visit/Green Awareness Drive** – GRIHA Council shall conduct an additional Due Diligence Visit post rating, for green awareness and education amongst occupants. This awareness program will be organized post 70% occupancy of the project.

CRITERIA AND THEIR WEIGHTAGE

GRIHA Affordable Housing rating is a performance-oriented system where points are awarded for meeting the intent (appraisals) of the criteria. Each criterion has certain number of points assigned.

Compliances, as specified in the relevant criterion, have to be submitted in the prescribed format. While the intent for some of the criteria is self-validating in nature, there are other criteria such as facilities for construction workers, environmental awareness, energy and water metering, etc. which need to be validated on-site through due diligence visit conducted by GRIHA Council during construction. The points related to these criteria (specified under the relevant sections) are awarded after verification through monitoring, validation, and submitted documents/photographs to demonstrate compliance.

GRIHA Affordable Housing rating system is a 100 point system consisting of 30 criteria categorized under six sections such as, Site Planning, Energy & Occupant Comfort, Water Saving, Waste Management, Sustainable Building Materials, Social Aspects and Bonus Points. Out of these 30 criteria, three are mandatory and eight are partly mandatory, while the rest are optional. Each criterion except for the mandatory criteria; has points assigned to it. It means that a project intending to meet the criterion would qualify for the points.

Different levels of certification (one star to five stars) are awarded based on the number of points earned. The minimum points required for certification is 25.

Table A: Rating thresholds under GRIHA for Affordable Housing

Rating threshold	GRIHA for Affordable Housing rating
25 – 40	*
41 – 55	**
56 – 70	***
71 – 85	****
86 and above	*****

Table B: List of criteria under GRIHA for Affordable Housing

Sr. No.	Criterion	Appraisal	Points
	Eligibility for AH rating		
A	Liveability index (AH built up area thresholds)	Essential	—
B	Site Selection	Mandatory	—
C	Optimum availability of water	Indicative	—
	1. Site Planning		**16**
1	Low Impact Design	—	6
2	Design to mitigate UHIE	—	3

Sr. No.	Criterion	Appraisal	Points
3	Preservation and Protection of Landscape during Construction	Partly mandatory	3
4	Storm Water Management	Partly mandatory	2
5	Reduction in Air and Soil Pollution during Construction	Partly mandatory	2
2. Energy & Occupant Comfort			**25**
6	Envelope Thermal Performance	–	8
7	Occupant Visual Comfort (Daylight)	Partly mandatory	5
8	Efficient Lighting	–	2
9	Energy Efficient Equipment	–	2
10	Renewable Energy	–	6
11	Energy Metering	Partly mandatory	2
3. Water Savings			**19**
12	Efficient use of water during construction	–	2
13	Optimization of building & Landscape water demand	Partly mandatory	9
14	Water reuse	–	7
15	Water Metering	Partly mandatory	1
4. Waste Management			**7**
16	Construction waste management	–	1
17	Post construction waste management	–	6
5. Sustainable Building Material			**17**
18	Reduction in environmental impact of construction	–	6
19	Use of low-environmental impact materials in building interiors	–	5
20	Use of recycled content in roads and pavements	–	4
21	Low VOC paints, adhesives, sealants and composite wood products	–	2
22	Zero ODP materials	Mandatory	–
6. Social Aspects			**16**
23	Facilities for Construction workers	Partly mandatory	1
24	Universal accessibility	–	2
25	Proximity to Transport and Basic Services	–	10
26	Environmental awareness	–	2
27	Tobacco Smoke Control	Mandatory	–
28	Water Quality	Mandatory	–
29	Provision of access to clean sources of cooking fuel	–	1
30	Bonus Points	–	4
	Total points		**104**

ELIGIBILITY FOR AH RATING

1. **Livability index (Affordable housing built-up area thresholds) - Essential**

   Approval letter issued by government agency (Central/State) confirming that the project is being developed as per *Pradhan Mantri Awas Yojana* scheme/guidelines must be submitted.*

2. **Site Selection - Mandatory**

   The site plan must be in conformity with the development plan/master plan/UDPFI guidelines. Compliance must be demonstrated with the provisions of eco-sensitive zone regulations, coastal zone regulations, heritage areas (identified in the master plan or issued separately as specific guidelines), water body zones (in such zones, no construction is permitted in the water spread and buffer belt of 30 meter minimum around the FTL), various hazard prone area regulations, and others if the site falls under any such area.

3. **Optimum availability of water - Indicative**

   Total water requirement estimation for the site and approval document (with assurance on the supply of the required water quantity) from the local municipal authority highlighting the total water which will be available for the development must be submitted.

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* As on the date of registration

SECTION I

Site Planning

Section Intent:

Construction sector contributes to about 23% of air pollution, 40% of water pollution, and 50% of landfill wastes.[1] According to the estimates of McKinsey Global Institute's report on India's urbanisation, 700-900 million square meters of commercial and residential space needs to be built and 2.5 billion square meters of roads will have to be paved by 2030.[2] The paved roads along with the choked drainage systems will add to the recurring urban flooding issue. The unprecedented growth of the construction sector will have only adverse effects if we follow 'business as usual' approach. Therefore, preventive design approach is needed instead of the cost intensive curative approach.

Sustainable site design imbibes the physical characteristics of the site, functional design objectives and sensitivity towards the environment to ensure protection of existing natural resources on site, manage the storm water runoff on site, reduce the pollution caused due to construction activities, harness the micro climate of the surroundings and reduce the contribution to the Urban Heat Island Effect. If site planning is done sensibly and the building design respects the prevailing site conditions, it can save up to 40-50% of total project cost which is incurred due to installation of equipment and their operation and maintenance.

This section suggests cost-effective guidelines to avail maximum advantage of the existing natural site features while preserving them to the extent possible. It rewards measures promoting building design according to the site conditions, balance of perviousness and imperviousness on site to check heat gain and urban flooding, preservation of natural site features to maintain a healthy ecosystem and better site management during construction to check any form of pollution arising out of it. All these measures will have greater probability of providing occupant comfort while encouraging interaction with the natural surroundings

This section consists of five criteria as mentioned in the table below:

Table 1.1: Site planning criteria

Criterion Number	Criterion Name	Maximum Points
Criterion 1	Low-impact design	6
Criterion 2	Design to mitigate UHIE	3
Criterion 3	Preservation and protection of landscape during construction	3
Criterion 4	Storm water management	2
Criterion 5	Reduction in air and soil pollution during construction	2
	Total Weightage	**16**

[1] http://www.initiafy.com/blog/how-does-construction-impact-the-environment

[2] McKinsey Global Institute (2010). India's urban awakening: Building inclusive cities, sustaining economic growth. McKinsey & Company.

Criterion 1

LOW-IMPACT DESIGN

Intent: To adopt passive architectural design strategies in the building design and incorporate natural site features (topographical/microclimatic) to create climate sensitive design with reduced energy consumption while maintaining occupant comfort

Maximum Points: 6

1.1 Appraisals:

1.1.1 Demonstrate reduction in environmental impact through design by adoption of various passive design and low-impact site planning strategies. **–4 points**

Table 1.2: Point weightages for number of strategies adopted (Refer Appendix Table 1A)

No. of strategies adopted	Points
2	1
3	2
4	4

1.1.2 Demonstrate use of active, low-energy cooling/heating systems in the building. **– 2 points**

1.2 Compliances:

1.1.2 Submit architectural drawings highlighting key passive design measures and active, low-energy cooling/heating systems adopted in the building.

1.2.2 Submit narrative, supported by calculations, conceptual sketches, and assumptions used for the adopted strategies.

Criterion **2**

DESIGN TO MITIGATE UHIE

Intent: To ensure incorporation of site design strategies which assist in reduction of hard paving on site to mitigate Urban Heat Island Effect (UHIE).

Maximum Points: 3

2.1 Appraisals:

2.1.1 More than 25% of the site surfaces visible to sky (including building roofs but not the landscape area*) are either soft paved/covered with high SRI coating (SRI > 0.5)/shaded by trees/shaded by vegetated pergolas/shaded by solar panels or any combination of these strategies. **– 1 Point**

2.1.2 More than 50% of the site surfaces visible to sky (including building roofs but not the landscape area*) are either soft paved/covered with high SRI coating (SRI > 0.5)/shaded by trees/shaded by vegetated pergolas/shaded by solar panels or any combination of these strategies. **– 3 points**

2.2 Compliances:

2.2.1 Submit calculations to demonstrate compliance with Appraisal 2.1.1/2.1.2.

2.2.2 Submit site plan, with area statements, highlighting the site surfaces (as mentioned in Appraisal 2.1.1/2.1.2) which are soft paved/covered with high SRI coating/shaded by trees/ vegetated pergolas/solar panels.

2.2.3 Submit purchase orders for high SRI paints/tiles (if used in the project).

2.2.4 Submit photographs, with description, of the measures implemented.

* Landscape area in this criterion refers to green/vegetated area

Criterion **3**

PRESERVATION AND PROTECTION OF LANDSCAPE DURING CONSTRUCTION

Intent: To ensure preservation of mature trees and fertile top soil on site, thereby minimizing the impact of construction activities on existing landscape.

Maximum Points: 3

Non-applicability:

If there are no existing mature trees on site, then the project is exempt from appraisal 3.1.1 and 3.1.2.

If top soil (top 8 inches) present on site is not fertile and cannot be made fertile by adding organic manure then the project is exempt from appraisal 3.1.3.

3.1 Appraisals:

3.1.1 Ensure that no existing mature tree is cut on site.
OR
Transplant mature trees within the site and ensure their survival.
OR
Plant 3 trees of native/naturalised species for every 1 tree cut.
OR
Any combination of these for all existing mature trees on site. **– Mandatory**

3.1.2 Increase total number of trees on site by 25% above the pre-construction phase.
OR
Plant 4 trees of native/naturalised species for every 1 tree cut. **– 1 Point**

3.1.3 Preserve top soil during construction; maintain its fertility (during construction phase) and use for landscape post-construction (Refer Appendix Table 2A). **– 2 Points**

3.2 Compliances:

3.2.1 Submit site plan highlighting (in different colour coding/layer) the following:

- Existing trees which have been protected and preserved, along with table listing their species.

- Existing trees which have been transplanted.
- Existing trees which have been cut.
- Area from where top soil has been removed.
- Location on site (or off-site) where top soil will be preserved.

3.2.2 3.2.2 Submit AutoCAD drawing of proposed landscape plan highlighting (in different colour coding/layer) the following:

- Compensatory plantation of new trees in the ratio of 1:3 for each tree which has been cut, with details about the species that have been planted.
- Compensatory plantation of new trees done in excess of 25% than the minimum requirement, with details of the species that have been planted.
- Landscape area where top soil has been reapplied.

3.2.3 Submit soil fertility test report of site's top soil from an ICAR (Indian Council of Agricultural Research) accredited laboratory.

3.2.4 Submit date stamped photographs, with description, of the measures implemented.

Criterion 4

STORM WATER MANAGEMENT

Intent: To ensure that storm water runoff from the project site, prior to and post construction, remains the same to avoid urban flooding.

Maximum Points:2

4.1 Appraisal :

4.1.1 Ensure that the excess runoff generated above the pre-construction run off is managed within the site. **– 1 Point**

4.1.2 Ensure that 100% post construction storm water runoff quantity is managed within project premises. **– 1 Point**

4.2 Compliances:

4.2.1 Submit narrative of strategies being implemented for managing surplus storm water runoff post construction.

4.2.2 Submit drawings of storm water runoff management system design and supply scheme of delivery for harvested rainwater to designated areas of use.

4.2.3 Submit date stamped photographs of installed storm water runoff management system.

4.2.4 Perform calculations in the in-built calculators made available on the online panel to demonstrate compliance.

Criterion **5**

REDUCTION IN AIR AND SOIL POLLUTION DURING CONSTRUCTION

Intent: To minimize air and soil pollution during construction on site.

Maximum Points: 2

5.1 Appraisals:

5.1.1 Adopt at least 3 measures on site to curb air pollution during construction **– Mandatory**

- Provision of 3 meter high barricading around the construction area. **– Mandatory**
- Wheel washing facility at the vehicular entrance/exit of the site.
- Covering of fine aggregate and excavated earth on site with plastic/geotextile sheets.
- Water sprinkling on fine aggregate (sand) and excavated earth.
- All diesel generator sets on site to have proper chimneys with their outlet covered from above to disperse smoke equally in all directions.

5.1.2 Develop and implement a spill prevention plan (to control effects of spill from hazardous materials like bitumen, diesel etc.) on site. **– 1 Point**

5.1.3 Adopt staging during construction on site, and strategies to prevent/reduce movement of soil (not top soil) outside the site through adoption of various strategies (like soil erosion channels, sedimentation control etc.)

– 1 Point

5.2 Compliances:

5.2.1 Submit relevant sections of tender document showing that air pollution prevention measures are required to be implemented by the contractor during construction on site.

5.2.2 Submit narrative describing the spill prevention plan, with description of spill control measures, adopted on site.

5.2.3 Submit date stamped photographs, with description, of the measures implemented.

5.2.4 Submit narrative detailing the following practices on site:

- Staging practices adopted during construction.
- Strategies implemented to reduce soil erosion from site.

5.2.5 Submit a site plan highlighting the following:

- Site boundary, proposed building footprint and staging boundary on site.
- Location of measures, such as sedimentation tank, soil erosion channels etc. implemented to check soil erosion from site.

SECTION II

Energy & Occupant Comfort

Section Intent:

Electricity consumption of residential sector in India has increased threefold over a decade, in line with the increasing number of electrified households.[1] Thus, promotion of energy efficiency measures in households has become crucial, to reduce the energy cost burden on the occupants. Considering massive construction under the affordable housing segment in near future, ensuring comfort to the building occupants through integration of passive design strategies is desirable.

In this section, thermal performance of the envelope is assessed for buildings such that, the geographical location of the city, temperature variations over a period of time, climatic conditions, etc. are accounted to compute the overall heat gain. Correspondingly, passive design strategies are encouraged to harness optimum amount of daylight ensuring thermal and visual comfort to the occupants.

Further, the section thrusts on use of energy efficient lighting and equipment in order to reduce the building energy consumption. It fosters the use of renewable energy technologies to enable on-site energy generation to offset project's dependency on conventional sources of energy, which is in sync to the government's initiatives. Finally, monitoring through metering is emphasized to further optimize and manage the energy consumption.

This section consists of six criteria as mentioned in the table below:

Table 2.1: Energy & Occupant Comfort criteria

Criterion Number	Criterion Name	Maximum Points
Criterion 6	Envelope Thermal Performance	8
Criterion 7	Occupant Visual Comfort (Daylight)	5
Criterion 8	Efficient Lighting	2
Criterion 9	Energy Efficient Equipment	2
Criterion 10	Renewable Energy	6
Criterion 11	Energy Metering	2
	Total Weightage	**25**

[1] http://www.cea.nic.in/reports/monthly/executivesummary/2017/exe_summary-01.pdf

Criterion 6

ENVELOPE THERMAL PERFORMANCE

Intent: To ensure thermal comfort by minimizing the overall heat gain from the envelope through suitable construction materials and optimal fenestration design.

Maximum Points: 8

6.1 Appraisals:

6.1.1 Ensure peak heat gain through building envelope meets the thresholds of Building Envelope Peak Heat Gain Factor. **– 2 points**

Table 2.2: Building Envelope Peak Heat Gain Factor (W/sq.m)

Climate	Threshold
Composite	55
Hot & Dry	50
Warm & Humid	40
Moderate	30

6.1.2 Demonstrate reduction in peak cooling load (percentage) over the base case as mentioned below. **– 6 points**

Table 2.3: Peak Cooling Load (W/sq.m)

Climate	Threshold
Composite	210
Hot & Dry	270
Warm & Humid	350
Moderate	220

Table 2.4: Points distribution for Peak Cooling Load reduction

% Reduction in cooling load	Points
3	1
6	2
9	4
12	6

6.2 Compliances:

6.2.1 Submit building drawings with elevations, sections, floor plans, and Door & Window schedule.

6.2.2 Submit electrical ceiling plan highlighting internal lighting (including common areas) and ventilation fans.

6.2.3 Submit technical specification sheet/test report of all materials used in the building envelope highlighting their respective U values.

6.2.4 Submit section drawings for each type of window.

6.2.5 Submit technical specification sheet/ test report of glass used in the fenestration highlighting VLT, U value, SC/SHGC.

6.2.6 Submit purchase orders and BOQs of all materials used in the building envelope.

6.2.7 Submit occupancy calculation for all dwelling units in the project.

6.2.8 Submit technical specification sheet, BOQ and purchase order for all internal lighting fixtures and ventilation fans installed.

6.2.9 Submit photographs of the building materials as installed on site.

Criterion **7**

OCCUPANT VISUAL COMFORT (DAYLIGHT)

Intent: To harness the available daylight and provide adequate, equally distributed and diffused day light for better visual comfort.

Maximum Points: 5

7.1 Appraisals:

7.1.1 Ensure that a minimum percentage of total built up area meets the UDI requirement for 90% of the potential day light time as per the below mentioned thresholds. **– 5 Points**

Table 2.5: UDI requirement thresholds

Percentage of area meeting UDI requirements	Points
25%	1
50%	2
75%	3
90% and above	5

7.2 Compliances:

7.2.1 Submit the Door & Window schedule for typical design cases.

7.2.2 Submit manufacturer cut sheet/ technical specifications of the glass/fenestration.

7.2.3 Perform calculation on the lighting calculator provided on GRIHA's website.

7.2.4 Submit photographs, with description of the measures implemented.

Method for Calculation of daylit area:

The method for calculation of daylight area has been developed in accordance with ECBC 2017.
Percentage Daylight area meeting UDI = [[(X1*X2)*(Y+2)]/(Area of the Room)]*100

Where: X1: DEF - Daylight Extent Factor; X2: Head height of Window; Y: Width of the fenestration
DEF: Daylight Extent Factor (DEF) can be defined as the ratio of light level inside the structure to the light level outside the structure, and depends on the orientation of the opening, glazing and projection factor (PF)/shading type used in the building.

PF: Projection Factor (PF) can be defined as the ratio of the distance the overhang projects from the window surface (H) to its height above the sill of the window it shades (V).

PF = H/V

Criterion **8**

EFFICIENT LIGHTING

Intent: To promote use of energy efficient lighting in outdoor spaces and indoor common areas.

Maximum Points: 2

8.1 Appraisals:

8.1.1. All lighting fixtures installed in outdoor spaces and indoor common areas shall have a minimum luminous efficacy of 75 lumen/watt. **– 2 points**

8.1.2. Automatic controls must be provided for 100% of outdoor lights **– Mandatory**

8.2 Compliances:

8.2.1 Submit specification sheet of each type of lighting fixture installed in outdoor spaces and indoor common areas.

8.2.2 Submit site and building plans indicating locations of all types of fixtures.

8.2.3 Submit outdoor lighting layout with manufacturers' details of lamps, ballasts, luminaires, automatic controls, wiring diagram and placement of automatic switch (es) for outdoor lighting.

Method for Calculation of Luminous efficacy:

Luminous efficacy of a lamp/ballast combination is usually mentioned in lamp specifications by the manufacturer.

It can also be calculated from other specifications provided by the manufacturer, namely the lamp lumen output and wattage.

Further, the ballast losses may be added to the total wattage to determine the total wattage.

Total lamp wattage = rated lamp wattage + (% loss from ballast x rated lamp wattage)

Luminous efficacy (lm/W) = lamp lumen output / total lamp wattage

Criterion 9
ENERGY EFFICIENT EQUIPMENT

Intent: To promote use of energy efficient equipment.

Maximum Points: 2

9.1 Appraisals:

9.1.1 All the following equipment falling under the scope of the developer must be at least BEE 3-star rated/labelled: **– 2 points**

- Motors
- Transformer(s)

9.2 Compliances:

9.2.1 Submit specification sheet of all motors and transformer(s) installed.

Motors:

The BEE rates induction motors as per standard efficiency classes.

Table 2.6: Efficiency class of motors for respective BEE star ratings**

Star rating	Motor efficiency class
1 star	≥IE2 & <IE2(+)*
2 star	≥IE2(+) & <IE3
3 star	≥IE3 & <IE3(+)
4 star	≥IE(+) & IE(++)
5 star	≥IE3(++)

* IE = International Efficiency

Source: https://www.beestarlabel.com/Content/Files/Schedule6-InductionMotors.pdf

Transformer(s):

The BEE rates distribution transformers on basis of half-load and full-load losses. The following table describes the rating scheme:

Table 2.7: Rating Schemes for Transformers**

Rating (kVA)	1 star		2 star		3 star		4 star		5 star	
	Max losses at 50% load (Watts)	Max losses at 100% load (Watts)	Max losses at 50% load (Watts)	Max losses at 100% load (Watts)	Max losses at 50% load (Watts)	Max losses at 100% load (Watts)	Max losses at 50% load (Watts)	Max losses at 100% load (Watts)	Max losses at 50% load (Watts)	Max losses at 100% load (Watts)
16	200	555	165	520	150	480	135	440	120	400
25	290	785	235	740	210	695	190	635	175	595
63	490	1415	430	1335	380	1250	340	1140	300	1050
100	700	2020	610	1910	520	1800	475	1650	435	1500
160	1000	2800	880	2550	770	2200	670	1950	570	1700
200	1130	3300	1010	3000	890	2700	780	2300	670	2100

**This table is indicative and will change with respect to the amendments made in the applicable codes.
Source: https://www.beestarlabel.com/Content/Files/Schedule4_DT.pdf

Criterion 10
RENEWABLE ENERGY

Intent: The intent of this criterion is to promote the use of renewable energy technologies and enable energy generation on site*.

Maximum Points: 6

10.1 Appraisals:

10.1.1 Rated capacity of the renewable energy system (Solar PV/Solar hot water** system/ Biomass/Geothermal/Wind turbine) installed on site conforms to installation @1kWp per 500 sq.m of total built-up area thresholds as established in the table below:

Table 2.8: Point thresholds for total calculated installation

Percentage of total calculated installation @1kWp per 500 sq.m (on site only)	Points
25%	1
50%	2
75%	4
100%	6

10.2 Compliances:

10.2.1 Submit purchase order (reflecting full quantities) of the renewable energy system installed along with its technical specification sheet highlighting the panel performance (as tested under standard test conditions).

10.2.2 Submit drawings demarcating the location of renewable energy systems.

10.2.3 Submit photographs, with description, of the measures implemented.

* Points are not awarded for Offsite R.E installation

** 100 LPD solar hot water system will be equivalent to 1.5 kWp

Criterion 11
ENERGY METERING

Intent: To promote energy consumption monitoring through metering.

Maximum Points: 2

11.1 Appraisals:

11.1.1 Install a dedicated energy meter for each dwelling unit. **– Mandatory**

11.1.2 Install dedicated energy meters, each for outdoor spaces and indoor common area lighting. **– 1 point**

11.1.3 Install energy meter on renewable energy system to measure the energy generated (if installed*). **– 1 point**

11.2 Compliances:

11.2.1 Submit drawings indicating the location of various meters in the building.

11.2.2 Submit photograph of each meter installed in the building.

11.2.3 Submit technical specification sheets and purchase orders of metering system installed in the building.

* If the project is not installing renewables, then they shall lose points under criterion 10 and 1 point under this criterion.

SECTION III

Water Savings

Section Intent:

Whilst the models of affordable housing revolve around minimum area and cost considerations, provision of basic amenities such as adequate water supply and sanitation to the dwelling units becomes extremely crucial given the varied challenges encountered such as disparity in supply, deteriorating water quality and so on.

63 million Indians in rural areas live without access to clean water.[1] The census data of 2011 reveals that 47% of the households have the source of water within the premises and about 53.42% of the households still have to fetch water from a source located either nearby or away from the premises (500 meters or more in rural areas and 100 meters in urban areas).[2] This significantly impacts the sanitation and hygiene practices and the situation is even worse in areas which are drought prone or have perennial water shortage. World Bank estimates that 21% of contagious diseases in India are linked to unsafe water and the lack of hygiene practices.

In this background, supplying the required quantity of water as per NBC (National Building Code) of India 2016 becomes imperative as part of the rating system and over and above the section rewards efforts taken to reduce the building and landscape water demand, implement strategies for efficient use of water during construction, water harvesting and reuse. Lastly, the section mandates monitoring the water consumption at project level.

This section consists of four criteria as mentioned in the table below:

Table 3.1: Water savings criteria

Criterion Number	Criterion Name	Maximum Points
Part A : Construction phase		
Criterion 12	Efficient use of water during construction	2
Part B : Post Construction phase		
Criterion 13	Optimization of building and landscape water demand	9
Criterion 14	Water reuse	7
Criterion 15	Water metering	1
	Total Weightage	**19**

[1] Wild Water, State of the World's Water 2017, a new report by WaterAid, a global advocacy group on water and sanitation

[2] http://censusindia.gov.in/2011census/hlo/Data_sheet/India/HLO_Press_Release.pdf

Criterion **12**

EFFICIENT USE OF WATER DURING CONSTRUCTION

Intent: To minimize the requirement of potable water during construction by deploying effective construction management practices on site.

Maximum Points: 2

12.1 Appraisals :

12.1.1 Adopt strategies (at least 2 from the list below) to reduce the consumption of potable water during construction: **– 1 Point**

- Use of gunny bags/hessian cloth and ponding technique for curing.
- Use of additives to reduce water requirements during curing.
- Monitoring for leaks and water wastage.

12.1.2 Use of treated waste water/captured rain water in construction activities. **- 1 Point**

12.2 Compliance:

12.2.1 Submit narrative, along with date stamped contextual site photographs demonstrating the strategies implemented onsite to reduce the requirement of potable water during construction.

Criterion **13**

OPTIMIZATION OF BUILDING & LANDSCAPE WATER DEMAND

Intent: To reduce the overall water demand of the building through system optimization, which includes installation of water efficient systems such as low flush toilets equipped with dual flush functionality and water faucets with aerators. Additionally, this criterion emphasizes on reducing the landscape water demand through use of regionally appropriate, xerophyte (low water using native species of flora) plant species and efficient irrigation systems.

Maximum Points: 9

Non-applicability: All faucets, which are installed in spaces with water head height less than 5 meter or 17 feet, in a gravity fed system, are exempt from calculations in appraisal 13.1.1

13.1 Appraisals:

13.1.1 Reduce the total water requirement in the building by the following thresholds over the base case. **5 Points**

Table 3.2: Thresholds for building water reduction

Threshold for building water reduction	Points
20%	Mandatory
25%	1
35%	3
50%	5

Methodology for calculating, water consumption and water use reduction is as follows:

Water consumption = N×FR×U

Where,

- N = Total occupants
- FR = Flow rate of each type of fixtures (liters per flush/liters per minute)
- U = Number of uses of each type of fixtures (fixed)

Water use reduction (%) $= \frac{(A-B)}{A} \times 100$

Where,

- A = Annual Water Demand of Base case*
- B = Annual Water Demand of Design case

*(*In the base case, flow rates of conventional fixtures have been considered, and the same has been preset in the online calculator. Whereas in the design case, flow rates of the fixtures installed onsite must be fed.)*

13.1.2 Reduce the total landscape water requirement by the following thresholds over the base case. **4 Points**

Table 3.3: Thresholds for landscape water reduction

Threshold for landscape water reduction	Points
25%	1
35%	2
50%	4

Methodology for calculating landscape water requirement and reduction is as follows:

Landscape water requirement = $\frac{\text{(Plant factor X Evapotranspiration rate(mpd) X Canopy area (sq. m))}}{\text{Irrigation system efficiency}} \times 1000$

Where,

- Plant factor refers to water requirement of the plants.
- Evapotranspiration rate refers to the amount of water required by the plant for healthy growth and determines the rate at which the plant losses water through evaporation.
- Canopy area refers to the area covered by shrubs, grass covers, and trees in the plan view.
- Irrigation system efficiency refers to the ability of an irrigation system to deliver water to plants without any water loss.

Landscape water use reduction (%) $= \frac{(A-B)}{A} \times 100$

Where,

A = Annual landscape water demand of base case*

B = Annual landscape water demand of design case

(Base case would be 100% lawn area, whereas design case would be as done on site.)*

13.2 Compliances:

13.2.1 Submit calculation sheet demonstrating percentage savings through water efficient fixtures.

13.2.2 Submit purchase orders (reflecting full quantities) of the low-flow fixtures used in the project.

13.2.3 Submit specification details of the low-flow fixtures (make, model no, flow rates etc).

13.2.4 Submit calculation sheet demonstrating percentage savings through use of native species of flora and water efficient irrigation system.

13.2.5 Submit landscape plan indicating plant species and area covered under each species.

13.2.6 Submit manufacturer cut-sheets and purchase orders (reflecting full quantities) of the irrigation systems installed on site indicating the efficiency, in case different from the GRIHA recommended values.

13.2.7 Submit date stamped photographs of the landscaped area, installed irrigation system, installed low flow fixtures in the building.

Criterion 14
WATER REUSE

Intent: To ensure the availability of appropriate facilities for tertiary- level treatment of waste-water generated, artificial groundwater recharge and rainwater storage; and maximum utilization of treated and harvested water within the project site to reduce the overall dependence on fresh water supply from concerned authorities.

Maximum Points: 7

14.1 Appraisals:

14.1.1 Sewage treatment plant (STP) should be provided to treat 100% of the sewage water (grey water and black water combined)[1] generated on site. **– 2 points**

14.1.2 Re-use of treated water (from STP) and rainwater (from storage tanks) to meet the water requirement of the project as per the thresholds mentioned below. **– 5 Points**

Table 3.4: Thresholds for water reuse

Water reuse (% of the water demand)	Points
> 25%	1
>50%	3
> 75%	5

14.2 Compliances:

14.2.1 Submit water balance chart for the project.

14.2.2 Submit narrative on the sewage treatment along with block flow/process flow drawings, quantity of wastewater to be treated, and treatment efficiency of STP.

14.2.3 Submit drawing for dual plumbing system in case of treated water being re- used for flushing and landscaping purpose.

[1] Where:
Grey Water - Water that has been used for bathing, washing, laundry, dishwashing etc. but does not contain excreta.
Black Water - Combined domestic effluent including liquid and solid human body waste and the water discharged from the toilet usage.

Criterion 15

WATER METERING

Intent: To ensure that a monitoring mechanism is in place for supply of fresh water from concerned authority and at STP outlet line.

Maximum Point: 1

15.1 Appraisals:

15.1.1 Installation of water meters at the following locations: **- Mandatory**

- Fresh water inlet : municipal supply/bore well
- STP outlet (If installed)

15.1.2 Installation of sub water meters at each dwelling unit within the project site **– 1 Point**

15.2 Compliances:

15.2.1 Submit drawing earmarking location of installed water meters on site.

15.2.2 Submit purchase orders of water meters installed on site.

15.2.3 Submit date stamped photographs of installed water meters.

SECTION IV

Waste Management

Section Intent:

The country's rapid economic growth has resulted in a massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tonnes of municipal solid waste per annum[1]. Only 43 million tonnes (MT) of the waste is collected, out of which 11.9 MT is treated and 31 MT is dumped at landfill sites[2]. This implies that 75-80% of the municipal waste gets collected and only 22-28 % of this waste is processed and treated. Due to continual rapid economic growth, Indian cities are expected to only intensify their consumption patterns and it is estimated that the waste generation will increase to about 165 MT by 2030.

The key to efficient waste management is to ensure proper segregation of waste at source and further channelization through different streams of recycling and resource recovery. Thereafter, the reduced final residue should be deposited scientifically in sanitary landfills. The biodegradable component of India's solid waste is currently estimated at a little over 50 per cent. Installation of organic waste converters, biogas plants would further reduce the pressure on the landfills.

Therefore, segregating and managing waste from the initiation of construction to the operation of the building has become an integral part of the rating system. The section rewards efforts taken to reduce, reuse, segregate and recycle the waste generated on site during construction and operation.

This section consists of two criteria as mentioned in the table below:

Table 4.1: Waste management criteria

Criterion Number	Criterion Name	Maximum Points
Criterion 16	Construction waste management	1
Criterion 17	Post construction waste management	6
	Total Weightage	**7**

[1] Planning Commission Report. (2014). Reports of the task force on waste to energy (Vol-I) (in the context of Integrated MSW management). Retrieved from http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf

[2] http://pib.nic.in/newsite/PrintRelease.aspx?relid=138591

Criterion 16

CONSTRUCTION WASTE MANAGEMENT

Intent: To ensure segregation, safe storage, recycle, reuse and disposal of construction waste during construction.

Maximum Points: 1

16.1 Appraisals:

16.1.1 Develop and implement a construction waste management plan in compliance with the norms laid under Construction and Demolition Waste Management Rules, 2016. **– 1 point**

16.2 Compliances:

16.2.1 Submit narrative detailing the construction waste management procedure, reuse/ recycling measures adopted to manage construction waste.

16.2.2 Submit drawing showing locations of collection, segregation, storage and disposal of construction waste within the project site.

16.2.3 Submit date stamped photographs, with description, of the measures implemented.

Criterion **17**

POST CONSTRUCTION WASTE MANAGEMENT

Intent: To adopt and implement sustainable solid waste management strategies and provide appropriate infrastructure on site for collection, segregation, storage and disposal of solid waste during the operation phase; and to promote & provide infrastructure facilities for treatment of segregated organic/biodegradable waste on site.

Maximum Points: 6

Non-applicability:

If the total organic waste generation on site is less than 100 kg/day, then the project is exempt from appraisal 17.1.3.

17.1 Appraisals:

17.1.1 Adopt solid waste management plan in compliance with norms elaborated under Solid Waste Management Rules, 2016.

AND

Provide infrastructure for primary collection (door to door/chute system) & segregation (multi-colored bins) of solid waste.

AND

Provide designated secondary waste management areas within the project site for safe and hygienic storage of collected solid waste **– 3 Points**

17.1.2 Provide contractual tie-ups with CPCB (Central Pollution Control Board) authorized waste recyclers for safe recycling of recyclable wastes like metal, paper, plastic, glass, etc. **– 1 Point**

17.1.3 Provide infrastructure facilities for treating all the organic waste/biodegradable solid waste on site and converting it to resources such as manure, bio gas etc. **–2 Points**

Methodology for calculating waste quantity

The quantity of waste should be calculated by considering waste generation of 0.45 kg/ person/day.

The bio degradable waste component is:

Total solid waste generation (kg) = 0.45 × number of occupants

Total bio degradable waste generation (kg) = 0.55 × total solid waste generation

17.2 Compliances:

17.2.1 Submit a detailed narrative on strategies for primary & secondary solid waste collection, segregation, storage, disposal, and organic waste management.

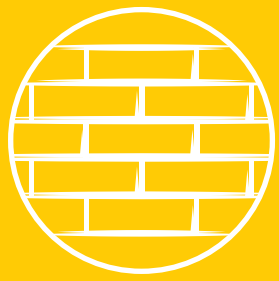
17.2.2 Submit drawing earmarking locations of primary & secondary solid waste storage facilities.

17.2.3 Submit document highlighting contractual tie-ups with CPCB authorized waste recyclers for collection of metal, plastic, paper, glass etc.

17.2.4 Submit date stamped photographs of implemented strategies under waste management plan for operation phase.

17.2.5 Submit detailed narrative on design, sizing and technology of the organic waste treatment strategy and highlighting method of reuse.

17.2.6 Submit purchase order of the installed organic waste treatment system.



SECTION V

Sustainable Building Materials

Section Intent:

The Indian construction sector has been growing at an average annual growth rate of 10% over the last decade, with its contribution to Gross Domestic Product (GDP) increasing from ₹1.5 trillion in 2001-02 to ₹4 trillion in 2011-12, equivalent to 8% of the nation's GDP.[1] By 2022, real estate and construction sector in India is also expected to generate 75 million jobs and emerge as the largest employer in the country.[2] Further, the construction sector was the fastest growing sector in terms of increase in absolute material consumption: between 1997 and 2007, material consumption grew by more than one billion tonnes. If such growth rates continue, the construction sector will surpass the agricultural sector before 2020 and become the highest material consuming sector in India.[3]

Considering the inadequacy of infrastructure in the country, the construction industry is expected to continue to grow at a fast pace in the coming decade. This growth shall put additional pressure on the extraction of already dwindling resources such as minerals, stones and sand. Manufacturing construction materials and products is a sub-industry that thrives under the construction industry. Extraction, manufacturing and transportation energy required towards availability of the material on site, comprise embodied energy.

Energy consumption by a building can thus be divided into direct energy, i.e. operational energy and indirect energy, i.e. the embodied energy. Energy expenditure for manufacturing building materials constitutes 20–25% of India's total energy demand and an estimated 30% of GHG emissions are contributed by the construction sector in India.[4] Considering the resource and energy consumption, re-thinking construction materials is the key to reducing the environmental impact of buildings. It is necessary to minimize the utilization of raw materials and optimize the embodied energy of building materials.

Some of the key strategies to achieve this goal comprise recycling building materials, minimizing the use of high embodied energy materials such as steel, utilizing local materials as much as possible and recycling and reusing industrial and construction waste for manufacturing. Building

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1 Report of the Working Group on Construction Sector for 12th Five Year Plan. Planning Commission. 2011. Government of India, New Delhi (as used in Material Consumption Patterns in India: A Baseline Study of the Automotive and Construction Sectors)

2 Real Estate. Indian Brand Equity Forum (IBEF). October 2017. www.ibef.org

3 Material Consumption Patterns in India: A Baseline Study of the Automotive and Construction Sectors. GIZ, TERI & DA. March 2016. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

4 Sustainability in human settlements: imminent material and energy challenges for buildings in India. M. Mani & B.V. Venkatarama Reddy. Journal of the Indian Institute of Science. 2012

technologies that follow these guiding principles could become sustainable and facilitate sharing the resources especially energy resources more efficiently, causing minimum damage to the environment.

This section consists of four criteria as mentioned in the table below:

Table 5.1 : Sustainable Building Materials Criteria

Criterion Number	Criterion Name	Maximum Points
Criterion 18	Reduction in environmental impact of construction	6
Criterion 19	Use of low-environmental impact materials in building interiors	5
Criterion 20	Use of recycled content in roads and pavements	4
Criterion 21	Low VOC paints, adhesives, sealants and composite wood products	2
Criterion 22	Zero ODP materials	Mandatory
	Total Weightage	**17**

Criterion **18**

REDUCTION IN ENVIRONMENTAL IMPACT OF CONSTRUCTION

Intent: To reduce the environmental impact of construction by utilizing environment friendly construction materials or technologies that use waste material or have recycled content or have low embodied energy.

Maximum points : 6

The project may choose any one alternative from appraisals 18.1.1, 18.1.2, and 18.1.3 (Refer Appendix Table 3A and 4A)

Alternative 1 – Utilization of BIS recommended waste materials in building structure

18.1 Appraisals :

18.1.1 Minimum 15% replacement of sand, aggregate or Ordinary Portland Cement (OPC) with any BIS recommended waste by weight of sand, aggregate or OPC respectively used in structural concrete. **–2 Points**

18.1.2 More than 25% replacement of sand, aggregate or Ordinary Portland Cement (OPC) with any BIS recommended waste by weight of sand, aggregates or OPC respectively used in structural concrete. **–4 Points**

18.1.3 Minimum 40% composition of building blocks/bricks by any BIS recommended waste by volume, for 100% load bearing and non-load bearing masonry walls. **–2 Points**

18.2 Compliances:

18.2.1 Submit documentation (calculations, manufacturer's cut-sheets & purchase orders – reflecting full quantities) demonstrating 15% (or higher) replacement of Sand, Aggregate or Ordinary Portland Cement (OPC) in structural concrete by BIS recommended waste materials.

18.2.2 Submit documentation (calculations, manufacturer's cut-sheets & purchase orders – reflecting full quantities) demonstrating that BIS recommended waste material constitutes at least 40% of all walls.

18.2.3 Submit date stamped photographs with description of the measures implemented.

Alternative 2 – Use of recycled materials in building structure

18.1 Appraisals: (Contd.)

18.1.1 Utilization of minimum 2.5% recycled content in structural framework. **–2 Points**

18.1.2 Utilization of more than 5% recycled content in structural framework. **–4 Points**

18.1.3 Utilization of minimum 40% recycled content in infill panels. **–2 Points**

18.2 Compliances:

18.2.1 Submit documentation (calculations, manufactures cut-sheets & purchase orders –reflecting percentage of recycled content) demonstrating the percentage of utilization of recycled content in structural framework and infill panels.

18.2.2 Submit photographs, with description, of the measures implemented

Alternative 3 – Embodied energy calculation

18.1 Appraisals: (Contd.)

18.1.1 Demonstrate reduction in combined embodied energy of structure and walls by at least 10% below the base case. **–2 Points**

18.1.2 Demonstrate reduction in combined embodied energy of structure and walls by at least 20% below the base case. **–4 Points**

18.1.3 Demonstrate reduction in combined embodied energy of structure and walls by at least 30% below the base case. **–6 Points**

Base Case: *RCC structure with burnt clay brick masonry. The live load, equipment load and spans in the design and the base case should be same. The total length of masonry walls in design and base case should be same.*

18.2 Compliances: (Contd.)

18.2.1 Submit calculations demonstrating reduction in embodied energy.

18.2.2 Submit manufacturer cut-sheets or technical test report of the low-energy materials used in building structure and walls.

18.2.3 Submit drawings highlighting the use of low embodied energy materials in the relevant floor plans.

18.2.4 Submit purchase orders (reflecting full quantity) and relevant sections of the BOQ highlighting the low-energy materials used.

18.2.5 Submit date stamped photographs with description, of the measures implemented.

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Criterion 19

USE OF LOW-ENVIRONMENTAL IMPACT MATERIALS IN BUILDING INTERIORS

Intent: To promote installation of low environmental impact materials in the building interiors and reduce the usage of virgin material.

Maximum Points : 5

19.1 Appraisals:

19.1.1 Demonstrate that at least 25% of all materials used for building interiors* meet the GRIHA requirement of low-impact material*. **– 1 point**

19.1.2 Demonstrate that at least 50% of all materials used for building interiors*meet the GRIHA requirement of low-impact material*. **–3 Points**

19.1.3 Demonstrate that at least 70% of all materials used for building interiors* meet the GRIHA requirement of low-impact material*. **–5 Points**

Following materials will be considered as low-environmental impact:

- Stones from India
- Composite wood based products
- FSC Chain of Custody certified products
- Manufactured products with at least 5% recycled content
- Products with EPD (cradle to gate) analysed and published as per ISO 14025 / ISO 21930
- Products with water footprint (cradle to gate) analysed and published as per ISO 14046

19.2 Compliances

19.2.1 Provide manufacturer cut-sheets/ 3rd party test certificates highlighting specifications of low environmental impact finishes/products used in the building interiors.

19.2.2 Provide drawings demarcating (by highlighting with clear dimensions) the use of aforementioned finishes/products in the interior layouts/plans.

19.2.3 Submit purchase orders (reflecting full quantities) and relevant sections of the BOQ for the low environmental impact materials used.

19.2.4 Submit date stamped photographs, with description, of the measures implemented.

* Materials used for building interiors shall comprise of flooring/dado/doors and windows (panels & frames)/ in-built furniture/false ceilings and panelling, as applicable to the project.

Criterion **20**

USE OF RECYCLED CONTENT IN ROADS AND PAVEMENTS

Intent: To substitute raw materials in infrastructure construction with wastes, in order to reduce the pressure on mining for virgin materials as well as landfills required for their disposal by utilizing them in the construction of bituminous roads and pavements.

Maximum Points : 4

20.1 Appraisals:

20.1.1 Utilization of minimum 8% recycled waste (as per CRRI/IRC recommendations) in road construction by volume of materials for 100% of the bituminous roads on site. **–2 Points**

20.1.2 Utilization of minimum 10% recycled waste in construction of pavements by volume of materials for 100% of all material used in the pavements on site. **–2 Points**

20.2 Compliances:

20.2.1 Submit technical specifications/brochures along with tender documents and purchase order to demonstrate that the roads have at least 8% waste content as per the clause.

20.2.2 Submit technical specifications/brochures along with tender documents and purchase order to demonstrate that the pavement construction have at least 10% waste content as per the clause.

20.2.3 Submit date stamped photographs, with description, of the measures implemented

Criterion **21**

LOW VOC PAINTS, ADHESIVES, SEALANTS AND COMPOSITE WOOD PRODUCTS

Intent: To promote use of low-VOC and lead-free interior paints; low-VOC adhesives and sealants; composite wood product without urea-formaldehyde in order to maintain good indoor air quality for the occupants.

Maximum Points : 2

21.1 Appraisals:

21.1.1 Ensure that all interior paints are low-VOC and lead-free (Appendix, Table 5A), all adhesives and sealants used are low-VOC (Appendix, Table 6A, 7A) and such interior composite wood products are used which do not have urea-formaldehyde as a bonding resin. **–2 Points**

21.2 Compliances:

21.2.1 Submit technical specification sheets for the following:

- Low-VOC and lead-free paints being used in building interiors
- Low-VOC adhesives, sealants used in building interiors
- Composite wood products used in building interiors

21.2.2 Submit purchase orders (reflecting full quantities) for the above materials.

Criterion 22
ZERO ODP MATERIALS

Intent: To lower the greenhouse effect and ensure use of low ozone depleting potential (ODP) materials in building insulation, HVAC & refrigeration equipment and fire fighting systems.

22.1 Appraisals:

22.1.1 Ensure that all the insulation used in the building should be CFCs and HCFCs free. **Mandatory**

22.1.2 Ensure that the fire suppression systems and fire extinguishers installed in the building should be Halon free. **Mandatory**

22.1.3 Ensure that all refrigerants used in HVAC system to be free from CFC and HCFC. **Mandatory**

22.2 Compliance:

22.2.1 Submit specification sheets & purchase orders (reflecting full quantities) highlighting that the insulation, fire fighting systems and refrigerants comply with Appraisal 22.1.1 – 21.1.3

SECTION VI

Social Aspects

Section Intent:

The notion of sustainability refers to the social implications along with the environmental and economic side. Affordable Housing projects have potential social impacts on the local community during the construction as well as the operational phase. Additionally, the construction sector in India is considered to be the second largest employer and contributor to economic activity, after agriculture sector.[1] Inspite of the statutory protections, poor working conditions and lack of effective social protection are evident among workers of the construction sector, making them quite vulnerable. Furthermore, the quality of life of the occupants of the affordable housing projects could be enhanced by strengthening the social aspect of the project. Hence, it is critical that the safety and sanitation of the workers as well as the liveability of the building occupants is considered while constructing green buildings.

This section mandates the provision of safe & hygienic living and working conditions for the construction workers; universal accessibility for the building occupants; encouraging walkability to basic services; and enhancing environmental awareness amongst the building occupants.

Table 6.1: Social Aspects Criteria

Criterion Number	Criterion Name	Maximum Points
Criterion 23	Facilities for construction workers	1
Criterion 24	Universal Accessibility	2
Criterion 25	Proximity of transport & basic services	10
Criterion 26	Environmental Awareness	2
Criterion 27	Tobacco Smoke Control	Mandatory
Criterion 28	Water Quality	Mandatory
Criterion 29	Provision of Access to Clean Sources of Cooking Fuel	1
	Total Weightage	**16**

[1] https://www2.deloitte.com/content/dam/Deloitte/in/Documents/IMO/in-imo-infrastructure_and_construction_sectors_building_the_nation-noexp.pdf)

Criterion 23

FACILITIES FOR CONSTRUCTION WORKERS

Intent: To ensure safe, healthy and hygienic working and living conditions for construction workers of the project.

Maximum points : 1

Non-applicability: If no families are allowed to work and live at construction sites, then appraisal 23.1.3 is not applicable.

231 Appraisals:

23.1.1 Ensure compliance with NBC (2016) safety norms for providing the necessary safety equipment and measures for construction workers. **Mandatory**

23.1.1 Ensure provisions for drinking water, hygienic working & living conditions and sanitation facilities for the workers. **Mandatory**

23.1.2 Provide a crèche facility for children of construction workers. **–1 Point**

23.2 Compliances:

23.2.1 Submit relevant sections of tender document showing that the conditions mentioned in Appraisal 22.1.1, 22.1.2 and 22.1.3 (if applicable) are required to be implemented by the contractor during construction on site.

23.2.2 Submit test reports demonstrating that the drinking water provided to workers meets the relevant BIS drinking water norms.

23.2.3 Submit narrative on provision of crèche facility for children of construction workers.

23.2.4 Submit date stamped photographs, with description, of the measures implemented.

Criterion 24
UNIVERSAL ACCESSIBILITY

Intent: To promote adoption of measures in the project to make it universally accessible.

Maximum points: 2

24.1 Appraisals:

24.1.1 Compliance with Harmonised Guidelines and Space standards for Barrier Free Built Environment for Persons with Disability and Elderly persons. –**2 Points**

24.2 Compliances:

24.2.1 Submit drawings demonstrating that the project incorporates design measures for Universal Accessibility as recommended in Harmonised Guidelines and Space standards for Barrier Free Built Environment for Persons with Disability and Elderly person.

24.2.2 Submit photographs, with description, of the measures implemented.

24.2.3 Submit narrative elaborating measures adopted in the project.

Criterion 25

PROXIMITY TO TRANSPORT AND BASIC SERVICES

Intent: To reduce the carbon footprint of building occupants.

Maximum points: 10

25.1 Appraisals:

25.1.1 The walking distance of transportation facilities ((formal & informal)*) shall be less than 500 m from the main entrance of the project. **– 1 Point**

* Formal – Bus stand, MRTS, ISBT, Railway stations;
Informal – Auto stands, rickshaw stands, e-vehicle stands

25.1.2 The average distance of basic services from the main entrance of the project shall be lesser than the following thresholds. **–5 Points**

Table 6.2: Thresholds for average distance of basic services from the main entrance of project

Thresholds	Points
< base case**	1
25% < base case	3
50% < base case	5

** The base case has been defined in the online calculator.

25.1.3 Provision of designated area within project boundary for setting up of informal market with the following necessary infrastructure facilities. **–4 Points**

Table 6.3: Point distribution for provision of facilities within project

Facilities	Points
Covered space for market	1
Waste Management Scheme	1
Availability of Drinking Water	1
Toilet Facility	1

25.2 Compliances:

25.2.1 Submit documentation (narrative and satellite images) highlighting the distances to the closest transportation facilities and/or basic services around the site.

25.2.2 Submit narrative describing the informal market space and the infrastructure facilities provided along with it.

25.2.3 Submit site layout plan demarcating location for informal market space, toilet, waste management facility, and drinking water facility as provided.

25.2.4 Submit date stamped photographs, with description, of the measures implemented.

25.2.5 Perform calculations in the calculators made available on the online panel to demonstrate compliance.

Criterion 26
ENVIRONMENTAL AWARENESS

Intent: To create awareness about sustainability and environment amongst building occupants and visitors.

Maximum points: 2

26.1 Appraisals:

26.1.1. Adopt measures to create environmental awareness amongst the building occupants and visitors. **(1 Point for each measure)**

26.2 Compliances:

26.2.1 Submit narrative highlighting strategies implemented in the project to create environmental awareness.

26.2.2 Submit date stamped photographs, with description, of the measures implemented.

Criterion 27
TOBACCO SMOKE CONTROL

Intent: To facilitate effective implementation of tobacco control laws and to put in place strategies such as prohibiting smoking in the common areas for better occupant health.

26.1 Appraisals:

27.1.1 Adopt measures to ensure zero exposure of non-smoking occupants to tobacco smoke.

Mandatory

26.2 Compliances:

27.2.1 Submit narrative highlighting strategies implemented to ensure compliance with 26.1.1.

27.2.2 Submit date stamped photographs, with description, of the measures implemented.

Criterion 28
WATER QUALITY

Intent: To ensure that the quality of water available for use during operational phase of the building meets the relevant national standards.

28.1 Appraisals:

28.1.1 To ensure quality of water from all sources (ground water and municipal water) conforms to IS Standard [IS 10 500 – 1991] (Table 8 A). **Mandatory**

28.2 Compliances:

28.2.1 Submit report/ certificate from local municipal authority or from NABL accredited laboratory for the quality of potable water.

28.2.2 Submit quality checking frequency and sampling plan for potable water.

Criterion **29**

PROVISION OF ACCESS TO CLEAN SOURCES OF COOKING FUEL

Intent:To promote the usage of clean sources of cooking fuel advocated by *Pradhan Mantri Ujjwala Yojana (PMUY)* by facilitating provision of infrastructure for PNG or LPG connections.

Maximum Point: 1

29.1 Appraisals:

29.1.1. To ensure provision of necessary infrastructure for safe access to clean sources of cooking fuel (PNG, LPG, etc.). – **1 Point**

29.2 Compliances:

29.2.1 Submit narrative highlighting facilities provided to building occupants for availing clean sources of cooking fuel.

29.2.2 Submit date stamped photographs, with description, of the measures implemented.

Criterion 30

BONUS POINTS

Intent: To reward additional measures adopted by the project which have not been covered in the previous 29 criteria.

Maximum points: 4

30.1 Appraisal:

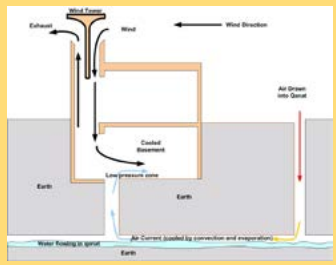
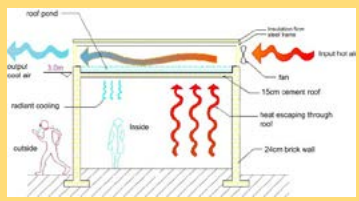
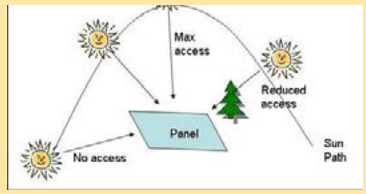
30.1.1 Adopt strategies, independent of the previous 29 criteria, to make the project more sustainable.

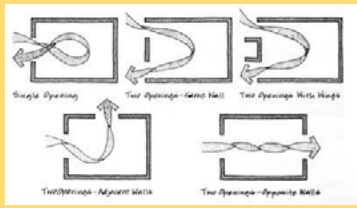
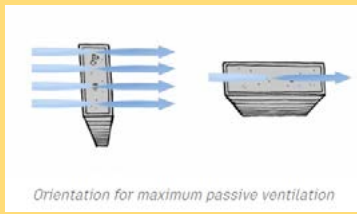
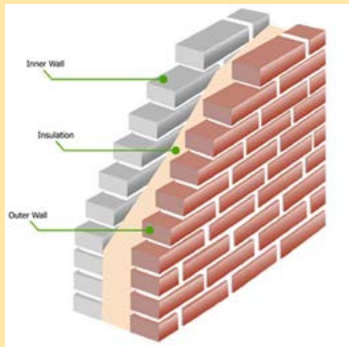
30.2 Compliance:

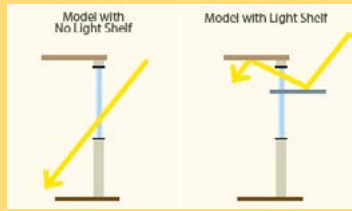
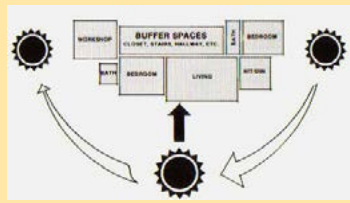
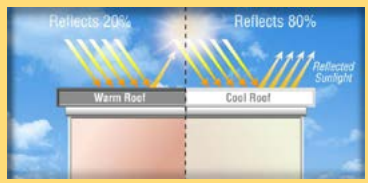
30.2.1 Submit date stamped photographs, with description, of the measures implemented.

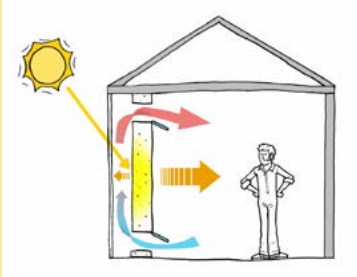
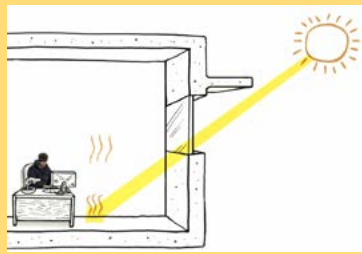
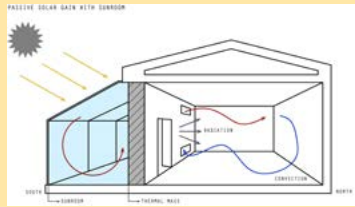
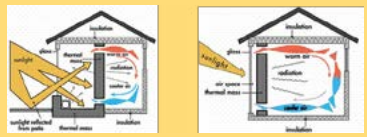
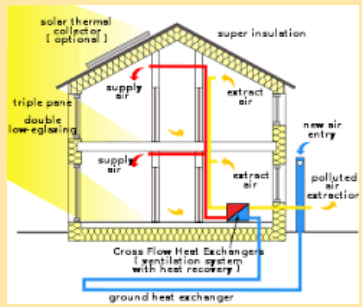
APPENDIX

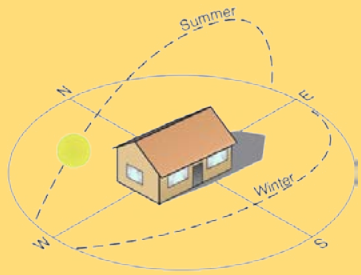
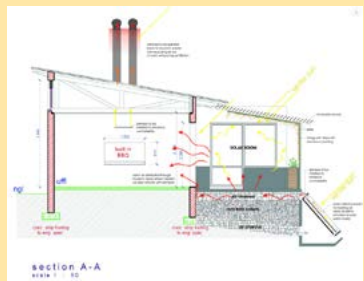
Table 1 A : List of Passive Design Measures

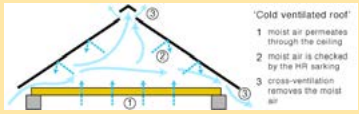
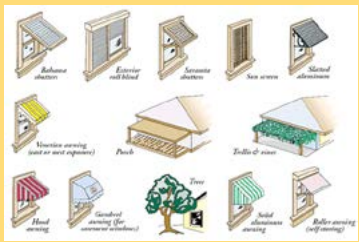
Sr. No.	Strategy	Definition			Image
1.	Wind tower	In a wind tower, the hot air enters the tower through the openings in the tower, gets cooled, becomes heavier and sinks down. The inlet and outlet of rooms induce cool air movement. In the presence of wind, air is cooled more effectively and flows faster down the tower and into the living area. After a whole day of air exchanges, the tower becomes warm in the evenings. During the night, cooler ambient air comes in contact with the bottom of the tower through the rooms. The tower wall absorbs heat during daytime and releases it at night, warming the cool night air in the tower.			 Wind Tower
	Cold	**Composite**	**Warm and Humid**	Moderate	**Hot and Dry**
2.	Courtyard	Due to incident solar radiation in a courtyard, the air gets warmer and rises. Cool air from the ground level flows through the louvered openings of rooms surrounding a courtyard, thus producing air flows. At night, the warm roof surfaces gets cooled by convection and radiation. If this heat exchange reduces roof surface temperature to wet bulb temperature of air, condensation of atmosphere moisture occurs on the roof and the gain due to condensation limits further cooling. If the roof surfaces are sloped towards the internal courtyard, the cooled air sinks into the court and enters the living space through low-level openings, gets warmed up, and then leaves the room through high-level openings.			 Courtyard
	Cold -	**Composite**	**Warm and Humid**	**Moderate**	**Hot and Dry**
3.	Roof pond for evaporative cooling	A roof pond uses a store of water above the roof to mediate internal temperatures, usually in hot desert environments. At night, the insulation is removed and the exposed water loses significant amount of heat by radiation to the night sky. Early in the morning, the insulating panels are replaced to protect the water from the heat of the day and solar radiation.			 Roof Pond
	Cold	**Composite**	Warm and Humid	Moderate	**Hot and Dry**
4.	Reduced solar access	Solar access can be described as the ability of the sun to penetrate a building or be utilized by a solar collector on the surface of that building between 9 a.m. and 3 p.m. The protection of solar access requires locating buildings and trees where their shadows will not obstruct more than 10 percent of the sunlight available to the solar PV/thermal system.			 Reduced Solar Access
	Cold	**Composite**	Warm and Humid	Moderate	**Hot and Dry**

5.	Site planning / Building envelope design to increase cross ventilation and reduce heat gain	Wind ventilation is a kind of passive ventilation that uses the force of the wind to pull air through the building. Cross ventilation can be enhaced by placing windows or vents on opposite sides of the building, to aim or funnel breeze through the interiors. The direction , speed, amount of wind, the potential passage of air through vents, chimneys and other feneratration affects ventilation. By orienting the building so that its shorter axis aligns with prevailing winds will provide the most wind ventilation, while orienting it perpendicular to prevailing winds will provide the least passive ventilation. There are some rules of thumb for two scenarios in which windows are facing the direction of the prevailing wind: - For spaces with windows on only one side, natural ventilation will not reach farther than two times the floor to ceiling height into the building. - For spaces with windows on opposite sides, the natural ventilation effectiveness limit will be less than five times the floor to ceiling height into the building.			 Cross Ventilation  Orientation for maximum ventilation.
	Cold	**Composite**	**Warm and Humid**	**Moderate**	Hot and Dry
6.	Cavity wall/ thermal mass to reduce heat gain/loss	A cavity wall is a wall formed by an inner skin and an outer skin of masonry (sometimes referred to as 'leaves'), connected by ties, but separated by a cavity. The cavity could utilise air or insulation material. The heat gets stored in the cavity, which acts as a thermal barrier, bouncing it back into the room and holding it for longer.			 Cavity wall
	Cold	**Composite**	**Warm and Humid**	**Moderate**	**Hot and Dry**
7.	Dense vegetation cover to moderate micro-climate	Planted areas in a city tend to reduce daytime maximum temperatures, reducing radiant exchange at the ground surface. Vegetation could be used to provide shading from the harsh sun in adverse seasons.			 Dense vegetation
	Cold	**Composite**	Warm and Humid	**Moderate**	**Hot and Dry**

8.	Design according to site slope/ topography	Topography refers to the slope and level of the land. From a design point of view, a sloping site will be more challenging. The contour locations and spacing of contours are crucial to siting of the building. It is preferable to design buildings along with the contours, integrating it into the design to reduce unnecessary cutting and filling of soil.			 Slope
	Cold	**Composite**	Warm and Humid	**Moderate**	**Hot and Dry**
9.	Light shelf	Light shelves usually refer to horizontal surfaces mounted inside a building. These interior light shelves divide windows between the viewable portion and the part that lets in additional natural light, bouncing it upward and reflecting it off the ceiling to aid in deeper penetration of daylight in the interior space.			 Light shelf
	Cold	**Composite**	**Warm and Humid**	**Moderate**	**Hot and Dry**
10.	Internal distribution of spaces to be carried out such that buffer spaces like store rooms, staircases, toilets etc. are located on the unfavourable facades	The service areas, staricases, lifts etc. may be placed along the unfavourable orientation according to the climate, location of the project. This will ensure buffer spaces between the harsh sunlight and regularly occupied spcaces.			 Buffer Spaces
	Cold	**Composite**	**Warm and Humid**	**Moderate**	**Hot and Dry**
11.	Cool roof in the form of vegetated roof/terrace garden/roof pond	Cool roofs are roofs covered with a reflective coating with high emissivity properties. These effectively reflect sun's energy away from the roof surface. This quality helps in reducing the cooling load of the HVAC system. Cool roofs can help cool buildings, cities, and the planet by reducing the percentage of sunlight converted to heat by the building surface. Green roofs are living vegetative systems located on rooftops. Their benefits include cooling the building through shading and insulation, reducing peak storm runoff, and potential of growing food. A cool roof uses highly reflective building material, regardless of the color.			 Cool Roof
	Cold	**Composite**	**Warm and Humid**	**Moderate**	**Hot and Dry**

12.	Trombe wall	A trombe wall is a system for indirect solar heat gain, consisting of a dark colored wall of high thermal mass facing the sun, with glazing spaced in front to leave a small air space. The glazing traps solar radiation like a small greenhouse.			 Trombe wall
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry
13.	Direct solar gain in room	Direct gain is a passive heating technique which enables admittance of sunlight into the living spaces, directly through openings or glazed windows, to heat the walls and floors and thereby the air inside. The requirements of a direct gain system are glazed windows and thermal storage. The glazed windows are generally located facing south to receive maximum sunlight during winter (in northern hemisphere). They are generally double glazed, with insulating curtains, to reduce heat loss during night time.			 Direct Solar Gain
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry
14.	Solarium/sun space	Sunspaces are referred as "isolated gain" passive solar systems because the sunlight is collected in an area which can be closed off from the rest of the house. During the day, the doors or windows between the sunspace and the house can be opened to circulate collected heat and kept closed at night to allow for the temperature drop.			 Sun Space
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry
15.	Solar wall/ thermal mass	SolarWall systems are building integrated and consist of perforated metal heating panels mounted onto the building's sun facing wall.			 Thermal mass
	Cold	Composite	**Warm and Humid**	Moderate	**Hot and Dry**
16.	Maximum openings positioned in order to bring in more heat	The position of the home, with regard to the sun, can be one of the most important factors in maximizing the use of the sun. In the northern hemisphere, the sun is mostly towards the south, which means that whichever wall is facing south will receive the most sunlight.			 Increase heat gain
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry

17.	Air lock to prevent heat loss	Heat loss occurs in a building when heat escapes from inside the building to outside, typically through the roof, walls, windows and floor. An airlock between two entities reduces the amount of air infiltration and heat loss.			 Air locks
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry
18.	Glass covered atrium/ central space	Resistance to the elements is the primary focus of the atrium enclosure. Several components can make up the skin of the atrium. They are the walls, roof and any sloping surfaces that act to keep water and wind out of the interior space and control the amount and quality of daylight penetrating the space. It is generally covered with a transparent material, allows light inside and enclose large gathering halls or a transition space. It also helps in keeping the space warm during daytime.			 Glass covered atrium
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry
19.	Orientation of the building	The ideal orientation for solar glazing is within 5 degrees of true south. Glazing oriented to within 15 degrees of true south will perform almost as well. The glazing orientation up to 30 degrees off - although less effective – will still provide substantial level of solar contribution.			 Orientation
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry
20.	Rock bed	Rock beds are a means of enlarging the thermal mass of the building and thereby increasing the ability to store energy. Air is drawn from the sunspace and through bed of rocks. Heat is given off to the rocks and air is re-circulated to sun space to collect more heat. At night when heat is needed, air from the occupied space is drawn through the rock bed, where it picks up heat and distributes it back to the occupied space. The rock bed can be located under a concrete slab, which gets heated by bed.			 Rock Bed
	Cold	Composite	Warm and Humid	Moderate	Hot and Dry

21.	Light coloured external surface to reflect solar radiation	To reduce heat transmission,light coloured external surfaces can be used to reduce heat transmission to the interiors in addition to the cooling loads. The studies show that temperatures were reduced by 4 °C (M.Taleb, 2014) when it is used alongside painting in grey or darker colours. Cooler colours will additionally produce more infrared radiation than others. The coating of the light colours is dependent on both the climate and the type of material that is used. Considering these parameters can lead to energy being saved, especially at peak times.			 Light coloured surface
	Cold	**Composite**	**Warm and Humid**	**Moderate**	**Hot and Dry**
22.	High ceiling/ ventilated roof	The hot air rises and escapes through the ventilators, letting cooler air to take its place. Higher ceilings induce the aforementioned effect to a higher extent.			 Ventilated Roof
	Cold	**Composite**	**Warm and Humid**	Moderate	
23.	Window shading throughout the year	Exterior shades catch the sun and reflect some of it away from the window. Some exterior shades are partially transparent, so some of the incident radiation passes through them to the window. The rest is absorbed by the shade material. Heat absorbed by the exterior shade is largely carried away from the window by radiation and air borne convection currents. Overhang is a crucial element in passive solar design because it blocks the sun's heat energy when it is not desired. Because the sun travels different paths across the sky in the winter (low) and summer (high) time, an overhang can be constructed to obstruct, and utilize the heat energy from the sun. The shading devices could be horizontal, vertical, inclined according to the altitude of the sun.			 Windows Shaded
	Cold	Composite	**Warm and Humid**	**Moderate**	**Hot and Dry**
24.	Shaded veranda	Well-designed sun control and shading devices, either as part of a building or separately placed from a building facade, can reduce heat gain and cooling requirements. Addtionally, they can also improve the natural lighting quality of building interiors. The design of effective shading devices will depend on the solar orientation of a particular building facade.			 Shaded Veranda
	Cold	**Composite**	**Warm and Humid**	Moderate	**Hot and Dry**

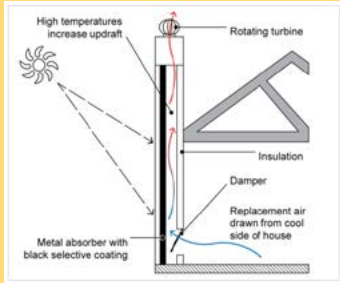
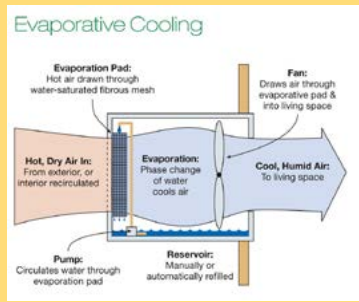
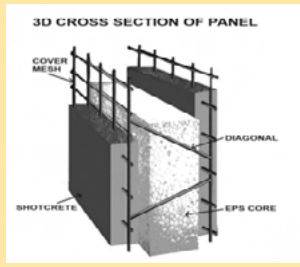
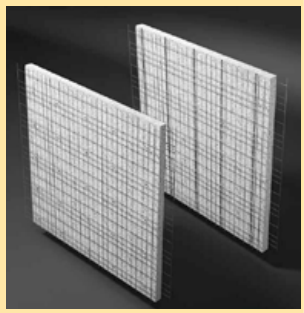
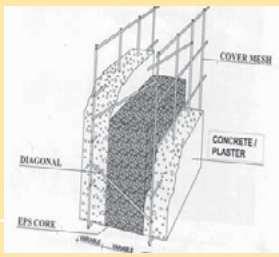
25.	Solar chimney	A solar chimney is a type of passive solar heating and cooling system that can be used to regulate the temperature of a building as well as for providing ventilation. Solar chimneys enhance stack ventilation by providing additional height and well-designed air passages that increase the air pressure differential. Warmed by solar radiation, chimneys heat the rising air and increase the difference in temperature between incoming and out-flowing air. The increase in natural convection from these measures enhances the draw of air through the building.			 Solar Chimney
	Cold	Composite	**Warm and Humid**	Moderate	**Hot and Dry**
26.	Minimize area of roof light	The size of the skylight impacts the solar heat gain, conduction gains and losses. Typically 3–5% skylight to roof area ratio is used for roof windows/skylights and 1–2% is sufficient for some high performing tubular skylights. Skylight manufacturers may further reduce their products' solar heat gain coefficient (SHGC) and increase their thermal insulation (reduce their U-value) through the use of shafts, tubes, ceiling diffusers and supplementary blinds or integral shades.			 Roof Light
	Cold	Composite	**Warm and Humid**	**Moderate**	**Hot and Dry**
27.	Passive evaporative cooling structure	Evaporative cooling is a passive cooling technique in which outdoor air is cooled by evaporating water before it is introduced in the building. The heat of air is used to evaporate water, thus cooling the air, which in turn cools the living space in the building. It is a low energy passive system. There are basically two methods of evaporative cooling: Direct and Indirect Evaporative cooling. In a direct evaporative cooler, a blower forces air through a permeable and water-soaked pad. As the air passes through the pad, it is filtered and cooled as well as humidified. On the other hand, an indirect type evaporative cooler carries a secondary heat exchanger that prevents humidity levels from being increased in the airstream that enters the home.			
	Cold	**Composite**	Warm and Humid	Moderate	**Hot and Dry**

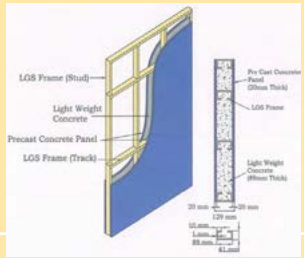
Table 2 A: Soil fertility test parameters

Nutrients	**Rating***			**Recommended Test****
	Low	**Medium**	**High**	
Organic Carbon	<0.5	0.5-0.75	>0.75	Colorimetric method; Datta et al
Available nitrogen alkaline kMnO4-N (kg/ha)	<280	281-560	>560	Kjeldahl apparatus
Available phosphorus Olsen's P (kg/ha)	<10	11-25	>25	Olsen method
Available potassium Ammonium Acetate-K (kg/ha)	<120	121-280	>280	Ammonium acetate extraction method
* Subject to minor variation as per local conditions.				
**Tests to be performed at ICAR (Indian Council of Agricultural Research)-accredited laboratory				

Table 3 A : BMTPC 8+8 technologies for faster and affordable construction

S.No.	Type	Technologies	Description		Possible approach for attempting criterion 18
1	Formwork Systems	Formwork for Monolithic Concrete Construction	All walls, floors, slabs, columns, beams, stairs, together with door and window openings are cast in-situ monolithically using appropriate grade of concrete in one operation by using specially designed, easy to handle modular formwork made up of Aluminium/Plastic/Aluminium-Plastic Composite.		Alternative 1 & 3
2		Modular Tunnelform	Tunnel formwork is a mechanized system for cellular structures. It is based on two half shells which are placed together to form a room or cell. Several cells make an apartment. With tunnel forms, walls and slab are cast in a single day.		Alternative 1 & 3
3		Sismo Building Technology	Sismo Building Technology is an insulating shuttering kit for whole building based on a three-dimensional lattice made of galvanized steel wire. The lattice is filled with materials of different nature to serve as formwork. Description of the components is as follows: 3D lattice (2.2 mm Ø galvanized steel wire) Infill panels (EPS, rock wool, mineral board) Structural filler (concrete) Finishing (plastering, natural stone, panelling etc.)		Alternative 2 & 3
4	Precast Sandwich Panel Systems	Advanced Building System – EMMEDUE	It consists of panels of expanded polystyrene (EPS) insulation core encased in shortcrete and steel reinforcement, which is cast on-site.		Alternative 2 & 3

S.No.	Type	Technologies	Description		Possible approach for attempting criterion 18
5	Precast Sandwich Panel Systems	Rapid Panels	The Rapid Panel is a prefabricated assembly of high-strength steel wire forming a panel with a core of expanded polystyrene (EPS). The basic unit of the Rapid Panel is the zig-zag truss. Structure is made of concrete columns and beams (M20).		Alternative 2 & 3
6		Reinforced EPS Core Panel System	It is a factory-made system based on expanded polystyrene panels (corrugated) reinforced with double mesh of galvanized cold steel wires, interconnected to each other. In this technique, a core of undulated polystyrene is covered with interconnected zinc coated welded wire mesh on both sided reinforcement and shortcrete concrete.		Alternative 2 & 3
7		QuickBuild 3D Panels	It consists of a welded wire space frame integrated with a polystyrene insulation coreSteel trusses that are pierced through the polystyrene core and welded to the outer layer sheets of galvanized steel mesh to form a rigid panel		Alternative 2 & 3
8		Concrewall Panel System	It is an industrial system for the construction of structural walls of reinforced concrete for building in single panel up to G+3. The system is composed of a factory produced panel of undulated (wave shape) polystyrene covered on both sides by an electro-welded zinc coated square mesh of galvanized steel.		Alternative 2 & 3
9		Glass Fibre Reinforced Gypsum (GFRG) Panel System	Also Branded as Rapidwall, it is a building panel product, made of calcined gypsum, plaster, reinforced with glass fibers. GFRG panels, suitably filled with plain reinforced concrete possesses substantial strength to act not only as load bearing elements but also as shear wall, capable of resisting lateral loads due to earthquake and wind.		Alternative 2 & 3

S.No.	Type	Technologies	Description		Possible approach for attempting criterion 18
10	Light Gauge Steel Structural Systems	Light Gauge Steel Framed Structure (LGSFS)	It is developed through a cold-formed process without the use of heat. This process enables steel manufacturers to produce light-weight but high tensile steel sheets.		Alternative 2 & 3
11		Light Gauge Steel Framed Structure with Infill Concrete Panels (LGSFS-ICP)	It is a technology using factory made Light Gauge Steel Framed Structure (LGSFS), light weight concrete and precast panels. Precast Concrete Panels are used as facing sheets for construction of walls. Self-compacting concrete of M20 grade is used.		Alternative 2 & 3
12	Steel Structural Systems	Factory Made Fast Track Building System	Factory Made Fast Track Modular Building System comprises of prefabricated steel structure with different walling components. About 70 percent of the work is done in the factory with minimal usage of concrete, which enables system to deliver the building within a few days of work at site. The steel modules are pre-fitted with flooring, ceiling tiles, electrical and plumbing fittings.		Alternative 2 & 3
13		Speed Floor System	The Speed Floor System is a suspended concrete flooring system using a roll formed steel joist as an integral part of the final concrete and steel composite floor. It is essentially a hybrid concrete/steel tee-beam in one direction and an integrated continuous one-way slab in other direction. It is suitable for use in all types of construction.		Alternative 1, 2 & 3
14	Precast Concrete Construction Systems	Waffle-Crete Building System	It consists of large, structural, ribbed panels of reinforced precast concrete, bolted together. The casting can be done in casting yard, which reduces the construction time. The building after construction can be shifted from one place to another as the structure is joined using bolt connections.		Alternative 3

S.No.	Type	Technologies	Description		Possible approach for attempting criterion 18
15	Precast Concrete Construction Systems	Precast Large Concrete Panel System	This technology is suitable for construction of high rise buildings resisting seismic and wind induced lateral loads along with gravity loads. These elements are cast in a controlled factory condition.		Alternative 3
16		Industrialized 3-S system using cellular light weight concrete slabs & precast columns	It is based on factory mass manufactured structural prefab components conforming to provisions of relevant Indian Standards. Joints are filled with 1:5 Cement Mortar and separate screed concrete of minimum 40 mm thick – grade M20 is put in the entire area of slab before flooring / water proofing.		Alternative 1, 2 & 3

Table 4A: Inorganic industrial/mine solid wastes in India

Type of Solid Waste	Solid waste generation (x10^6 tonnes/year)
Fly ash	112
Coal mine wastes	60
Lime stone wastes	18
Construction waste	15
Blast furnace slag	11
Iron ore tailings	11
Copper mine tailings	4
Marble dust	6
Red mud, lime sludge, phospho-gypsum, zinc tailings, kiln dust, gold mine tailings etc	20
Inorganic industrial/mine solid wastes (total)	257

Source: Solid wastes generation in India and their recycling potential in building materials by Asokan Pappu, Mohini Saxena, Shyam R. Asolekar, Regional Research Laboratory (CSIR), Habib Ganj Naka, Bhopal–462026, India CESE, Indian Institute of Technology, Bombay-400076, India

Table 5A:VOC of interior and exterior coating

Interior Coatings	
Coating Type	VOC weight in grams / litre of product minus water
Non flat	<150
Flat	<50
Exterior Coatings	
Coating Type	VOC weight in grams / litre of product minus water
Non flat	<100
Flat	<200
Anti-corrosive	
Gloss/semi gloss/flat	<250

Table 6A: Limits for low-VOC content in adhesives in interior applications

Architectural adhesive application	VOC content limit(g of VOC/litre)
Wood Flooring	100
Industrial/rubber flooring	60
Ceramic tile	65
Structural glazing	100
Multi-purpose construction	70
Sub-floor	50
Wall boards/panel	50
PVC welding	285
Adhesive primer for plastic	250
Structural wood member	140
Sub-specific use metal to metal	30
Wood	30
Fibre glass	80
Plastic foams/porous materials (except wood)	50

Table 7A: Limits for low-VOC content in interior sealants

Sealant Application	VOC content limit(grams of VOC per litre)
Architectural/roadways	250
Single-ply roo material installation/repair	450
Others	420
Sealant Primer applications architectural non-porous	250
Sealant Primer applications architectural porous	775
Other sealant primer applications architectural	750

Table 8A Test Characteristics For Drinking Water (Clause 3.1)

Sr No. (1)	Substances or Characteristics (2)	Requirement (Desirable limit) (3)	Undesirable effect outside the desirable limit (4)	Permissible limit in the absence of absolute solution (5)	Methods of test (Ref to IS) (6)	Remarks (7)
Essential characteristics						
	Colour, Hazen units, Max	5	Above 5, consumer acceptance decreases	25	3025 (Part 4) :1983	Extended to 25 only if toxic substances are not suspected, in absence of alternate sources
	Odour	Unobjection-able	-	-	3025 (Part 5) :1983	a) Test cold and when heated b) Test at several dilutions
	Taste	Agreeable	-	-	3025 (Part 7and 8) : 1984	Test to be conducted only after safety has been established
	Turbidity, NTU, Max	5	Above 5, consumer acceptance decreases	10	3025 (Part 10) : 1984	-
	pH value	6.5 to 8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation	3025 (Part 11) : 1984	-
	Total hardness (as CaCO3) mg/l, Max	300	Encrustation in water supply structure and adverse effects on domestic use	600	3025 (Part 21) :1983	-
	Iron (as Fe) mg/l, Max	0.3	Beyond this limit taste/ appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria	1.0	32 of 3025 : 1964	-
	Chloride (as Cl) mg/l, Max	250	Beyond this limit, test, corrosion and palatability are affected	1000	3025 (Part 32) :1988	-
	Residual, free chlorine, mg/l, Min	0.2	-	-	3025 (Part 26) : 1986	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be Min 0.5 mg/l.

Table 8A Contd...

Sr No. (1)	Substances or Characteristics (2)	Requirement (Desirable limit) (3)	Undesirable effect outside the desirable limit (4)	Permissible limit in the absence of absolute solution (5)	Methods of test (Ref to IS) (6)	Remarks (7)
	Fluoride (as F) mg/l, Max	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5	23 of 3025 : 1964	-
Desirable Characteristics						
	Dissolved solids mg/l, Max	500	Beyond this palatability decreases and may cause gastro intestinal irritation	2 000	3025 (Part 16) : 1984	-
	Calcium (as Ca) mg/l, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200	3025 (Part 40) : 1991	-
	Magnesium (as Mg), mg/l, Max	30	Encrustation to water supply structure and adverse effects on domestic use	100	16, 33, 34 of IS 3025 : 1964	-
	Copper (as Cu) mg/l, Max	0.05	Astringent taste, discoloration and corrosion of pipes, fitting and utensils will be caused beyond this	1.5	36 of 3025 : 1964	-
	Manganese (as Mn) mg/l, Max	0.1	Beyond this limit taste/ appearance are affected, has adverse effect on domestic uses and water supply structures	0.3	35 of 3025 : 1964	-
	Sulphate (as SO4) mg/l, Max	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400 (see col 7)	3025 (Part 24) : 1986	May be extended up to 400 provided (as Mg) does not exceed 30

Table 8A Contd...

Sr No. (1)	Substances or Characteristics (2)	Requirement (Desirable limit) (3)	Undesirable effect outside the desirable limit (4)	Permissible limit in the absence of absolute solution (5)	Methods of test (Ref to IS) (6)	Remarks (7)
	Nitrate (as NO2) mg/l, Max	45	Beyond this methaemoglobinemia takes place	100	3025 (Part 34) : 1988	-
	Phenolic compounds (as C6H5OH) mg/l, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002	54 of 3025 : 1964	-
	Mercury (as Hg) mg/l, Max	0.001	Beyond this, the water becomes toxic	No relaxation	(see Note) Mercury ion analyser	To be tested when pollution is suspected
	Cadmium (as Cd), mg/l, Max	0.01	Beyond this, the water becomes toxic	No relaxation	(see Note)	To be tested when pollution is suspected
	Selenium (as Se), mg/l, Max	0.01	Beyond this, the water becomes toxic	No relaxation	28 of 3025 : 1964	To be tested when pollution is suspected
	Arsenic (as As), mg/l, Max	0.05	Beyond this, the water becomes toxic	No relaxation	3025 (Part 37) : 1988	To be tested when pollution is suspected
	Cyanide (as CN), mg/l, Max	0.05	Beyond this, the water becomes toxic	No relaxation	3025 (Part 27) : 1986	To be tested when pollution is suspected
	Lead (as Pb), mg/l, Max	0.05	Beyond this, the water becomes toxic	No relaxation	(see Note)	To be tested when pollution/ plumbosolvency is suspected
	Zinc (as Zn), mg/l, Max	5	Beyond this limit it can cause astringent taste and an opalescence in water	15	39 of 3025 : 1964	To be tested when pollution is suspected
	Anionic detergents (as MBAS) mg/l, Max	0.2	Beyond this limit it can cause a light froth in water	1.0	Methylene-blue extraction method	To be tested when pollution is suspected

Table 8A Contd...

Sr No. (1)	Substances or Characteristics (2)	Requirement (Desirable limit) (3)	Undesirable effect outside the desirable limit (4)	Permissible limit in the absence of absolute solution (5)	Methods of test (Ref to IS) (6)	Remarks (7)
	Chromium (as Cr6+) mg/l, Max	0.05	May be carcinogenic above this limit	No relaxation	38 of 3025 : 1964	To be tested when pollution is suspected
	Polynuclear aromatic hydrocarbons (as PAH) g/l, Max	-	May be carcinogenic	-	-	-
	Mineral oil mg/l,Max	0.01	Beyond this limit undesirable taste and odour after chlorination take place	0.03	Gas chromatographic method	To be tested when pollution is suspected
	Pesticides mg/l, Max	Absent	Toxic	0.001	-	-
	Radioactive materials: a) Alpha emitters Bq/l, Max b) Beta emitters pci/l, Max	 - -	 - -	 0.1 1	58 of 3025 : 1964 - -	 - -
	Alkalinity mg/l, Max	200	Beyond this limit taste becomes unpleasant	600	13 of 3025 : 1964	-
	Aluminium (as Al), mg/l, Max	0.03	Cumulative effect is reported to cause dementia	0.2	31 of 3025 : 1964	-
	Boron, mg/l, Max	1	-	5	29 of 3025 : 1964	-

Note — Atomic absorption spectrophotometric method may be used.

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