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# Role of Computer Mapping in the Strategies of Water Conservation in Green Buildings as per IGBC guidelines- A Case study

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**Abstract:** Green buildings are sustainable or eco-friendly buildings. They conserve natural resources, reduce reliance on fossil fuels and minimize negative environmental impacts. Green building technologies with the help of computers can improve the quality of life for residents and mitigate the environmental and economic challenges associated with rapid urbanization and resource depletion. Conservation of water is a mandatory requirement of green buildings. The amount of water that is suitable for human consumption is only 0.3%. Many reports predict that by 2030, India's water demand will be double the supply. Groundwater, which constitutes 40% of the country's water supply, is depleting rapidly, with 54% of India's groundwater sources in decline. Different strategies are suggested to reduce the water requirements in buildings and landscaping the areas. The Indian Green Building Council (IGBC) claims that techniques including rain gardens, green roofing, rainwater harvesting, recycling, and the reuse of treated wastewater are employed to lower the portable water demand in green buildings. The study discusses the role of computer mapping in water management. The latest graphics processing and display functions are powerful tools and are used in several fields including water conservation. The study put forth that computer intelligence, automation and other characteristics can effectively improve soil and water conservation. The study emphasises the role of computer applications like mapping in water conservation methods followed in green buildings as per IGBC guidelines.

***Keywords:*** *Artificial Intelligence, Blockchain, Green building, Reinforcement, Water Conservation.*

## 1. Introduction

Rising demand for power, water supply and waste management are the most challenging problem our cities are facing today. Efficient and effective use of resources is necessary in supplementing the existing infrastructure. The current population of the world is approximately 8.1 billion with a growth rate of around 70 million people every year. UN reports shows that Global water demand for all uses, presently about 4,600 $km^3$ per year, will increase by 20% to 30% by 2050, up to 5,500 to 6,000 $km^3$ per year. Global water demand for agriculture will increase by 60% by 2025[3]. Worldwide 70% of the total water use is for agriculture purposes.

Studies shows that 12% of the world population drinks water from unsafe sources and more than 30% lives without any form of sanitation. 90% of sewage in developing countries is discharged into the water untreated. These activities contribute to water pollution. Every year 730 million tons of sewage and other effluents are discharged into the water. Industry discharges 300 to 400 megatons of waste into the water every year [6]. If this continues, all the fresh water resources will get exhausted and polluted which leads the world to water scarcity.

Indian Green Building council (IGBC) is a member driven committee including all stakeholders from construction industry like Architects, structural, interiors and MEP consultants, Landscape architects, project management consultants, facility management team, project team etc. IGBC provides services such as developing new Green building rating Programs, Certification services and Green building Training programs [16].

The IGBC Green New Buildings rating system addresses the most important national priorities, which include water conservation, handling waste, energy efficiency, reduced use of fossil fuels, lesser dependence on usage of virgin materials and health & well-being of occupants [8]. Green building which demands water conservation and prevention of water pollution can be a better construction strategy to be followed for the future construction. As per IGBC Guidelines, Water Efficient technologies followed in Green buildings are:

1. Roof/ Non roof Rain Water harvesting
2. Water Efficient Plumbing Fixtures
3. Landscape Design
4. Management of Irrigation
5. Waste Water Treatment and Reuse
6. Water Metering

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In the present scenario with large amount of water getting wasted and overused, huge volume of fresh water is getting drawn out from the existing sources causing depletion of water table in many areas. In this context, water efficient technologies can contribute an important part in conserving potable and non-potable water and in due course save the freshwater resources [4]. These methodologies help towards attaining sustainable development Goal -06 (Clear water and sanitation for all) adopted by all United Nations Member States in 2015.

## 2. Methodology

In this study a hypothetical Green Town ship Spring Valley City in 20.35-acre land is evaluated for its water efficiency and conservation strategies and its cost efficiency analysis is carried out comparing with the conventional township.

The project site, is located near to the state highway. Easily accessible from 25 m wide district road. The site has 3 bore wells, in that presently only one borewell is giving yield. There are two existing ponds in the site and storm water from the site naturally gets collected in these ponds. The proposed township, Spring Valley City consists of residential, commercial, Institutional, Office developments and a community centre in 20,35 acres land.

The Residential development consists of 37 Presidential 3 BHK Villas, Ground +1floor structure considering High economy class customers and 144nos Luxury 2 BHK apartments ,2-Basements +Ground +17 floors structure considering middle economy class. Commercial development consists of food court in 2500 sqm area with 250 people seating capacity at a time with 6 kitchens. Office/Institutional building is situated in 6120 sqm area, Basement +Ground+ 3 floors structure. The top floor of building is considered for Institutional usage. The community centre is spread in 4300 sqm area with multiple sports courts, Library, Internet café, Necessity Store, Swimming Pool & a Party Hall with 300 people seating capacity.

Different sectors of Spring Valley Town ship are connected through well maintained Road network. Common amenities like Jogging, Track dispensary, Outdoor Gym, badminton court, Swimming Pool, Super market, Restaurants, Necessity store, Library, ATM etc; are planned inside the Town ship.

In this study, a proposal is given to make this project "Spring valley city" to be an ecofriendly town ship to streamline restoration and preservation of the natural resources. This is worked out by designing the water supply system, Rain water harvesting system and sewage management system considering the strategies that helps to reduce the fresh water requirements of the building following the IGBC Green Building requirements.

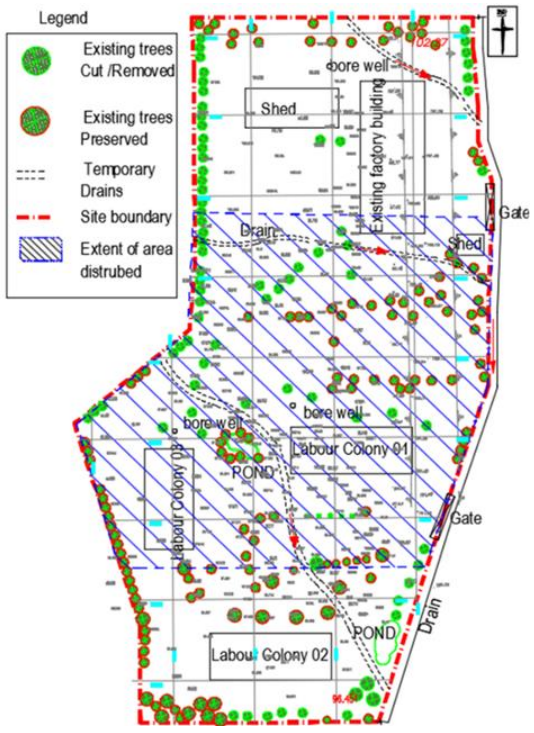


**Fig 1 :** Spring Valley City Town ship

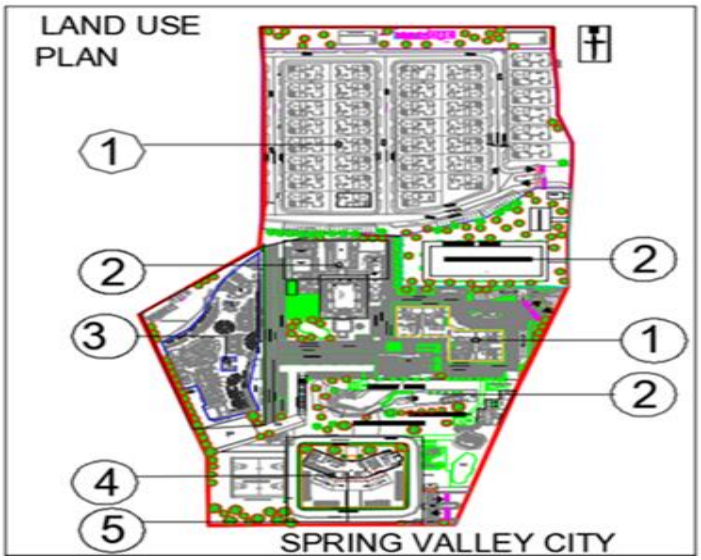


**Fig 2:** Spring Valley City Town ship- Existing Site plan

**1. RESIDENTIAL (VILLA DEVELOPMENT & HIGH-RISE APARTMENT)-** 37 Presidential 3 BHK Villas, Ground +1floor structure considering High economy class customers, 144nos Luxury 2 BHK apartments ,2-Basements +Ground +17 floors structure considering middle economy class.

**2. RECREATIONAL & CULTURAL (CLUB HOUSE, OUTDOOR FITNESS AREA, JOGGING TRACK, PARK& OPEN SPACES)-** The community center is spread in 4300 sqm area with multiple sports courts, Library, Internet café, Necessity Store, Party Hall& swimming pool

**3. RETAIL (FOOD CORT, SUPER MARKET, PHARMACY ETC.)-** food court in 2500 sqm area with 250 people seating capacity at a time with 6 kitchens.

**4. OFFICES (G+2 STRUCTURE-OFFICE BLOCK)-** Office/Institutional building is situated in 6120 sqm area, Basement +Ground+ 3 floors structure.

**5. INSTITUTIONAL (1 FLOOR)** Top floor-office block

## 3. Results and Discussions

Water conservation refers to limiting water use and managing daily demand to improve water consumption. Water efficiency is the prudent use of fresh water, as well as the reduction of total water usage and wastewater generation. It also consists of enhanced procedures and technology that use less water to provide life services that are on par with or better than before.

In **Spring Valley City Township,** different methods adopted are;

1. Use of water efficient Plumbing Fixtures
2. Landscape Design
3. Management of Irrigation
4. Waste Water Treatment and Reuse
5. Rain water harvesting

### 3.1. Use of water efficient Plumbing Fixtures

Water efficient plumbing fixtures such as faucets, shower heads, and toilets flushes, sensor operated faucets etc. with low flow rates are proposed in residential and commercial buildings. Using low flow plumbing fixtures, which are made to run with less water, can save a significant amount of water.

Low flow fixtures are made with reducing water waste in mind. Approximately half the flow rate of a regular fixture is ejected by a low flow fixture on average. When we cumulatively apply that, we can approximate an annual water savings of one thousand liters. The table1 below shows Water Efficiency Rating Criteria for Sanitary-ware in India.

**Table 1:** Water Efficiency Rating Criteria for sanitary ware in India

| S.NO | PRODUCT | WATER CONSUMPTION /UNIT | Rating criteria | | |
|---|---|---|---|---|---|
| | | | 1 Star | 2 Stars | 3 Stars |
| **Part-I: Water Efficiency Rating Criteria for Sanitary Ware** | | | | | |
| I | Water closet /squatting pan | a) Full flush (Liters/flush) | Not more than 6 L per flush | Not more than 4.8 L per flush | Not more than 4 L per flush |

| | | | | | |
|---|---|---|---|---|---|
| | for flushing cistern and or flush valve | b) Reduced flush (Liters/ Flush) | Not more than 3 L per flush | Not more than 2.8 L per flush | Not more than 2 L per flush |
| ii | Urinal | Liters/Flush | Not more than 3 L per flush (inclusive of pre-flush and post flush, in case of sensor urinal) | Not more than 2 L per flush (inclusive of pre flush and post flush, in case of sensor urinal) | Not more than 1 L per flush (inclusive of pre flush and post flush, in case of sensor urinal) |
| **Part 2: Water Efficiency Rating Criteria for Sanitary Fitting in India** | | | | | |
| 1 | Metered Faucets for Basin Use | Litres/use | 1 | 0.8 | 0.6 |
| | Metered Faucets for Urinal-sensor or mechanical | Litres/use | 3 | 2 | 1 |
| 2 | Wash Basin/ Lavatory Faucets (Also applies to sensor faucets) | Litres/Min | 8 | 6 | 3 |
| 3 | Sink Faucets | Litres/Min | 8 | 6 | 4.5 |
| 4 | Over-head shower | Litres/Min | 10 | 8 | 6.8 |
| 5 | Handheld shower | Litres/Min | 8 | 6 | 4 |
| 6 | Handheld ablution | Litres/Min | 6 | 5 | 4 |

In this project Spring Valley City township, it is recommended to use plumbing fixtures with 2-star rating so as to maintain a flow rate minimum 15% less than baseline criteria. Thus, saving portable water usage and reducing the amount of waste water production.

### 3.2. Landscape Design

Design landscape should ensure minimum water consumption or landscape irrigation This can be achieved by reducing the turf area inside the project and by planting drought tolerant / native / adaptive species. Drought tolerant species are those species that do not require supplemental irrigation. Generally accepted time frame for temporary irrigation is 1 - 2 years. In this project Spring Valley City township, 48% of the total project site is dedicated for Landscape with approximate landscape area of 39000 sqm. The turf area for entire project is restricted to 23% of the total Landscape area. Local Shrubs like Chinese Hibiscus, Common lantana, Flame of woods, Olander, Flame lily etc. and Trees like Peepal, Scared tree, pongame oil tree, Mahua, Mangifera indica etc. are proposed in the landscape area. These Plants need less than 3 Liters of water per sqm for irrigation. And frequency of irrigation required is also less (2 twice in a week).

### 3.3. Management of Irrigation

Reducing the amount of water needed for irrigation by using strategies and systems for water-efficient management is the primary goal of irrigation management schemes. It is advised to employ a central shut-off valve, soil moisture sensors that are linked with the irrigation system, and based on the requirements for watering, turf and all forms of bedding areas need to be divided into separate zones. Drip irrigation is required for at least 75% of landscape planting beds in order to minimise evaporation. a time-based controller for the valves to guarantee plant health and limit evaporation loss, Device(s) for adjusting pressure to maintain ideal pressure in order to stop water loss and cut down on water use.

### 3.4. Waste water Treatment and Reuse

By properly disposing of the waste water produced on site, you can prevent contamination of the receiving streams. Utilise cleansed wastewater to lessen your reliance on potable water. On- site treatment of wastewater to avoid pollution of natural water streams. In this project Spring

Valley City Township, this is achieved by providing wastewater treatment infrastructure to treat 100% of the waste water generated within the project as shown in table 2. The treatment facility is at a sector level. Ensuring that the treated wastewater conforms to the quality standards required for respective application.

**Table 2:** Waste water Generation from Town ship

| **Building type** | **Villa development** | **High rise building** | **Office/institutional building** | **Club House** | **Food court** |
|---|---|---|---|---|---|
| No of Blocks | 37 | 144 | 1 | 1 | 1 |
| Site Area (Sqm) | 27231.5 | 18856.5 | 6121.4 | 8251 | 7589 |
| BUILT UP UNIT AREA(BUA)(Sqm) | 14951.33 | 41486.4 | 6937 | 4283 | 2567.5 |
| No of Floors | G+1 | 2B+G+17 | 2B+G+3 | G+1 | G |
| Terrace Area (Sqm) | 237.7/ villa | 1657 | 914.7 | 1581 | 2567.5 |
| Population as per NBC | 6 people/ Villa | 5 people/ apartment | 10 sqm/person | seating capacity of multipurpose hall | 5 sqm/person |
| Population | 222 | 720 | 694 | 300 | 514 |
| **WATER REQUIREMENT** | | | | | |
| Domestic water demand (lpcd) | 90 | 90 | 25 | 25 | 25 |
| Domestic water requirement (Cum) | 20 | 65 | 17 | 8 | 13 |
| Flush water demand (Recycled water) | 45 | 45 | 20 | 20 | 10 |
| Flush water requirement(cum) | 10 | 32 | 14 | 6 | 5 |
| **Total water requirement/day (cum)** | **30** | **97** | **31** | **14** | **18** |
| **sewage treatment** | | | | | |
| Volume of waste water /sewage generated per day | | | | 85% of water consumed | |
| Sewage generated-KLD | 25.5 | 82.6 | 26.5 | 11.5 | 15.3 |
| Total sewage generated at township | | | 161 | KLD | |
| STP-01 Capacity-KLD | | | 26.0 | | |
| STP-02 Capacity-KLD | | | 110.0 | | |
| STP-03 Capacity-KLD | | | 27.0 | | |
| Total capacity of STPs at Township | | | 163 | KLD | |
| **% of waste water treated at site** | | | **100%** | | |

In Spring valley City Town ship project, wastewater distribution infrastructure is so as to convey 100% of the treated wastewater for flushing use and for irrigating large turf /Landscape areas, Vegetable Garden, construction sites and other areas of non- potable uses within boundary of the project as shown in table 3.

**Table33:** waste water Reuse

| . **% WASTE WATER REUSE** | |
|---|---|
| Efficiency of STP | 90% |

| | | | | | |
|---|---|---|---|---|---|
| VOLUME OF STP TREATED WATER AVAILABALE PER DAY | | | 144.9 | cum | |
| | Villa development | High raised building | Office/ institutional building | Clubhouse | Food court |
| Flush Water Requirement (Cum) | 10.0 | 32.4 | 12.2 | 6 | 5.135 |
| Total Flush Water Requirement | | | 65.8 | Cum | |
| Landscape Area Available | 9163.7 | 5604.3 | 7273.5 | 7758.4 | 9213.1 |
| Total Available Landscape Area | 9.6 | Acre | | | |
| Landscape water demand (Liters/Sqm) | 3 | 3 | 3 | 3 | 3 |
| Landscape Water Requirement - KLD | 34.4 | 21.0 | 27.3 | 29.1 | 34.5 |
| Total Landscape Water Requirement at Town Ship | | | 146.3 | Cum | |
| STP Treated Water Available of Landscape Watering | | | 79.1 | Cum | |
| **% OF TREATED STP WATER REUSED AT SITE** | | | **100%** | | |

### 3.5. Rain water Harvesting

By collecting rainfall efficiently, rainwater harvesting at the site raises the groundwater table and lowers the demand for municipal water. Table 4 shows the rainwater harvesting or storage system for the Spring Valley City Town Ship project, which aims to collect at least 100% of the runoff from the roof and non-roof impermeable regions. The harvesting system should be able to collect enough rainwater to last at least one day during the average rainfall event for the previous five years.

**Table:4**: Rain water Harvesting details

| **BUILDING TYPE** | **VILLA** | **HIGH RISE BUILDING** | **OFFICE/ INSTITUTIONAL BUILDING** | **CLUB HOUSE** | **FOOD COURT** |
|---|---|---|---|---|---|
| TERRACE AREA (sqm) | 237.7/ villa | 1657 | 914.7 | 1581 | 2567.5 |
| **RAIN WATER HARVESTING DETAILS** | | | | | |
| The harvesting system designed should have harvesting capacity of at least 1 day's normal rainfall* occurred in the last 5 years.in meter | | | | | 0.031 |
| Terrace Area (sqm) | 237.7/ villa | 1657 | 914.7 | 1581 | 2567.5 |
| Run-off Coefficient for Terrace | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| **Capacity of rain water tank (CUM)** | **6.91/villa** | **48.2** | **26.6** | **46.0** | **74.6** |
| Non-terrace impervious catchments (driveway and podium area) | 5904.00 | 4173.3 | 3510.3 | 715.0 | 990.0 |
| Run-off Coefficient for Non-Terrace Impervious area | | | | | 0.50 |
| Storm water generated (CUM) | 90.33 | 63.85 | 53.71 | 10.94 | 15.15 |
| Pervious landscape area | 9163.70 | 5604.3 | 7273.5 | 7758.4 | 9213.1 |
| Run-off Coefficient for pervious landscape area | | | | | 0.20 |
| Storm water generated (CUM) | 56.08 | 34.30 | 44.51 | 47.48 | 56.38 |
| Total volume storm water generated at site | | | 472.74 | CUM | |
| Depth of rain water recharging pond | | | 0.60 | M | |
| Volume of recharging pond 1 | | | 108.90 | CUM | |
| Volume of recharging pond 2 | | | 302.16 | CUM | |
| **Total storage capacity of recharge ponds** | | | **411.06** | **CUM** | |
| **Volume of to be recharge through recharge pits (CUM)** | | | **61.68** | **CUM** | |
| Size of Recharge pit | | | 0.9mdiaX3.5 depth | | |
| Surface area of Recharge pit | | | 9.90 | Sq.m | |

| | | | |
|---|---|---|---|
| Percolation capacity | 25.00 | mm/hr/sq.m | |
| No. of recharge pits required | 10.38 | | |
| | 11.00 | NOS | |
| **% OF RAIN WATER HARVESTED AT SITE** | **100%** | | |


**Fig 3:** Spring Valley City Location of Sewage water collection Tanks


**Fig 4:** Spring Valley City Location of Rain Treatment plants (STP)

The total amount of water delivered to the site, the actual amount of water used for all site end uses, and the total amount of water leaving the site are all compared on a water balance chart. Water balance chart shows zero discharge from township.

## 4. Cost Savings Through Water Efficiency

Green Buildings encourages water usage in a self-sustainable manner through 3 R's-Reduce-Recycle-Reuse. Water conservation in townships can be accomplished through the installation of on-site sewage treatment plants, sensor-operated fixtures, efficient plumbing fixtures, water recycling by using treated water for landscaping and other uses, and automated water metres to measure water usage during water audits.. Water savings using Rain water harvesting, STP treated water for non-portable water uses for Spring valley City Town ship project is explained below in table 5

**Table:1** Cost efficiency through Water conservation

| **Cost efficiency through Water conservation** | | | |
|---|---|---|---|
| **Total water requirement/day (cum)** | **186** | **KLD** | |
| Total available landscape area | 39013.0 | SQM | |
| Landscape water demand (Liters/sqm) | 3 | | |
| Landscape water requirement -KLD | 117.0 | KLD | |
| **Total water requirement/year (cum) for township** | **86100** | **KL** | |
| **Tanker water cost for 6000 Liters** | **500** | **Rs** | |
| **Total cost for water/yr** | **₹ 71,74,997.2** | **Rs** | |
| **15% Reduction in water consumption by using highly water efficient fixtures is considered for Green town ship** | | | |

| | | | |
|---|---|---|---|
| **Total water requirement/year (cum) for township** | **73185** | **KL** | |
| **Total terrace rain water tank storage for township** | **195.36** | **KLD** | |
| Construction cost of rain water tank (66/-/cum) | **₹ 12,893.5** | **Rs** | |
| **Considering 60 rainy days /year Total Rain water harvested/year** | **11721.37** | **KL** | |
| **Sewage generated-KLD** | **85% of water consumed** | | |
| Total sewage generated at township | 158.3 | | |
| STP-01 Capacity-KLD | 26.0 | KLD | |
| STP-02 Capacity-KLD | 110.0 | | |
| STP-03 Capacity-KLD | 25.0 | | |
| Total capacity of STPs at Township | 161.0 | KLD | |
| **Construction cost of STP (66000/-/KLD)** | **₹ 1,06,26,000.0** | **Rs** | |
| **Total quantity of treated waste water available/year** | **52888.50** | **KL** | |
| **Water to be bought from outside/year** | **8575.10** | **KL** | |
| **Total cost for water/year** | **₹ 7,14,591.5** | **Rs** | |
| **Saving in water charges /year** | **₹ 64,60,405.6** | | |
| **No. of years required to break even the initial cost** | **1.65** | | |

This study shows that with 15% reduction in water consumption using low flow fixtures,100% Rain water harvesting, 100% reuse of STP treated water for Flushing and Landscape irrigation in Green Town ship, the Spring Valley town ship can be water sustainable in 3 years and the Initial construction cost of STP and Rain water harvesting systems can be recovered in 2 years.

## 5. Conclusions

Water conservation is necessary to guarantee that there will be adequate water for the coming year and for future generations. Water is a vital resource for life on Earth. Sustainable water resource management at every sector has to be implemented for this purpose. Retaining the existing sources of freshwater and avoiding the water pollution is most essential for avoiding crisis of water in future.

Green buildings that prioritizes environmental responsibility, resource efficiency, occupant health, and sustainable development offers solutions to mitigate water scarcity, promote waste reduction and recycling, and create healthier and more productive spaces. Green buildings, certified by organizations like IGBC, can achieve water savings of 50-80% compared to conventional buildings.

Green development with environmental protection aligns with the United Nations Sustainable Development Goals (SDGs). Sustainable cities and communities, affordable and clean energy, and clean water and sanitation are among the key SDGs that are relevant to the building industry.

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