Chapter 6

Environmental Methodology

6

6.1 Methodology Flow Chart

During this study the following Methodology will be followed of as shown in Figure 6.1 It starts with Concept of the project, which shows the overall objective of the project, followed by Site study in terms of heat, wind and rain , then choosing the green roof company and determine its advantages, after that, calculation of excess construction loads analyzing, Finally find the financial cost of green roofs and design it using sketch up program.

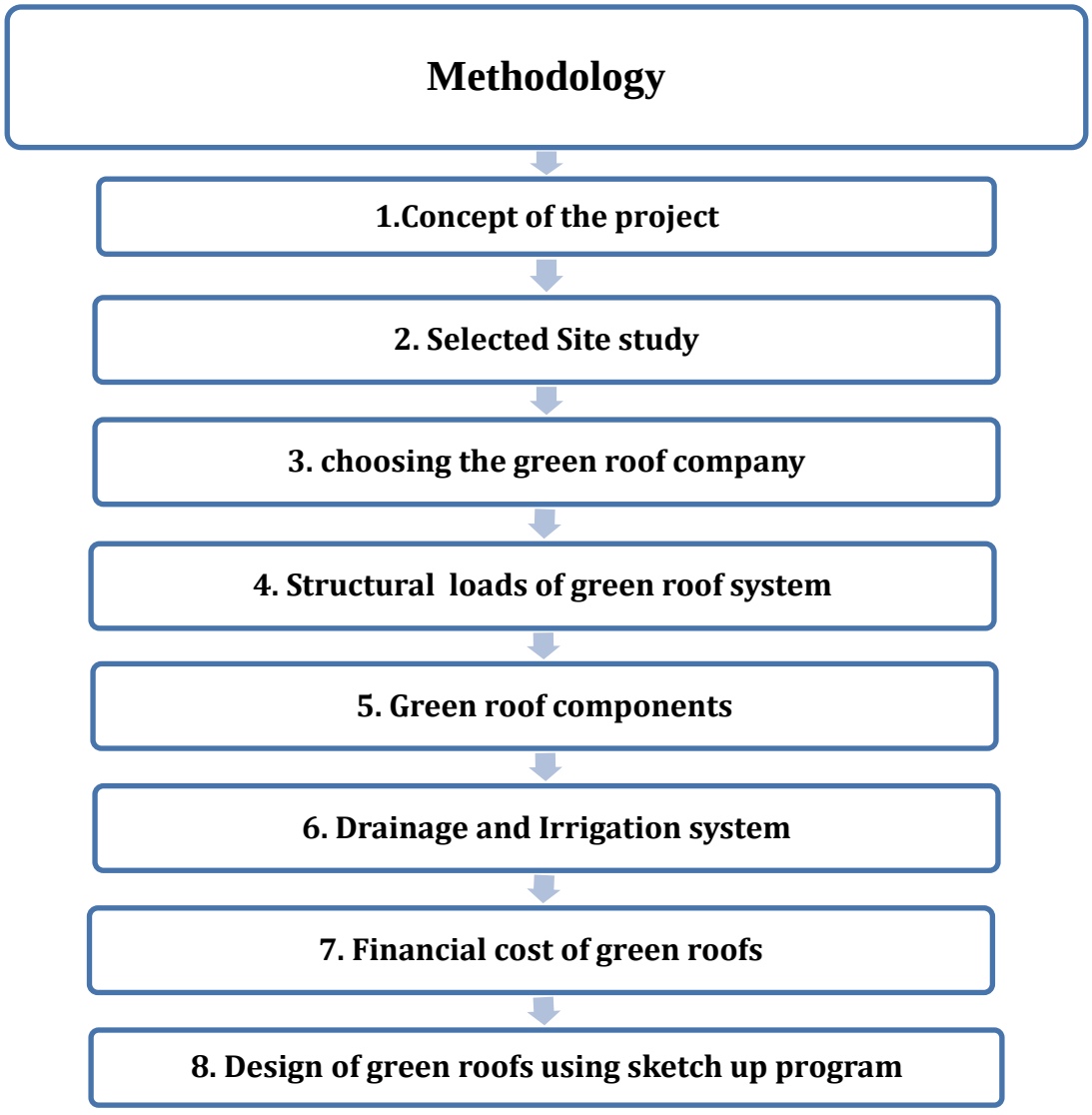

Figure 6.1 Methodology of environmental study .

6.2 Concept of the project

The objective of this project is to design a green roof system for a commercial-residential complex building to be an entertaining and environment place for the people who live in this building. Which have a total area of 9113 m^2, and consists of eight floors (two floor is basements) and have a background ,the background of the system is on slab roof (which is basement of garage) so we can apply the green roof system on the background too. As it shown in Figure 6.2 it is describe the area of the building Which will be used for green roof system

Figure 6.2 The desired area of the building for green roof system in brown colure

The design of the building dependent on an intensive green roof system with zero slope that make an equal distribution for the water on the floor, provided with drainage and irrigation system to prevent any leakage in the building.

6.3 Selected site study

6.3.1The importance of the site

The site of the building is located in the city of Hebron, specifically in the area of Ein Sara, which is known as the center of the city with high population area, located near the city's main street . In addition this area is considered to be poor in green spaces due to its urban location. The Figure 6.3 shown the site desired for the building

Figure 6.3.Site desired for the building

6.3.2 The movement of Sun ,Wind and Moisture

Hebron is exposed to the northeastern winds, which are very cold and dry winds. This is due to the low temperatures in the highlands. It is also exposed to the southwest winds, which are windy with rain and humidity. Because of its geographical location, the western wind blows on them and collides with warm currents. Those coming from the east meet with the winds coming from the west, reducing their moisture and making them more harmonious. They make the air moderate and dry, and the city blows dry wind like the five winds in the late spring.

The movement of the sun and wind are important factors in the analysis of the building and selecting plants on the surface. So that it can be divided into spaces suitable for climate and to meet the design requirements related to ventilation and natural lighting.

Sun: The movement and angles of the sun is one of the most important things to consider when directing and arranging buildings within the site, in order to avoid its direct radiation, especially in the summer, and here comes the role of solutions and environmental considerations that help us to avoid high temperatures. Table 6.1 Displays maximum temperature days each month for Ein Sara site. Also that Figure 6.4 for Ein Sara site displays how many days per month reach certain temperatures.

Table 6. 1. maximum temperature days each month[34].

	Temp >40Cº (day)	**Temp >35Cº (day)**	**Temp >30Cº (day)**	**Temp >25Cº (day)**	**Temp >20Cº (day)**	**Temp >15Cº (day)**	**Temp >10Cº (day)**	**Temp >5Cº (day)**	**Frost day**
Jan	0	0	0	1.2	6.2	13.6	9.2	0.8	0.9
Feb	0	0	0.4	2.4	7.7	10.1	6.6	1	0.1
Mar	0	0.5	2.4	5.5	10.3	8.8	3.3	0.1	0.1
Apr	0.3	3	6.2	9.1	8.5	2.7	0.4	0	0
May	0.7	5.6	11.2	9.8	3.5	0.2	0	0	0
Jun	0.7	6.7	16.9	5.4	.3	0	0	0	0
Jul	0.4	13	16.3	1.3	0	0	0	0	0
Oug	0.5	13.5	16.2	1.1	0	0	0	0	0
Sep	0.1	5.1	20.4	4.4	0	0	0	0	0
Oct	0.1	2.5	10.2	14.7	3.1	0.5	0	0	0
Nov	0	0	2.7	10.4	12.3	3.9	.7	0	0
Dec	0	0	0.3	2.8	9.8	13.1	4.6	0.4	0.3

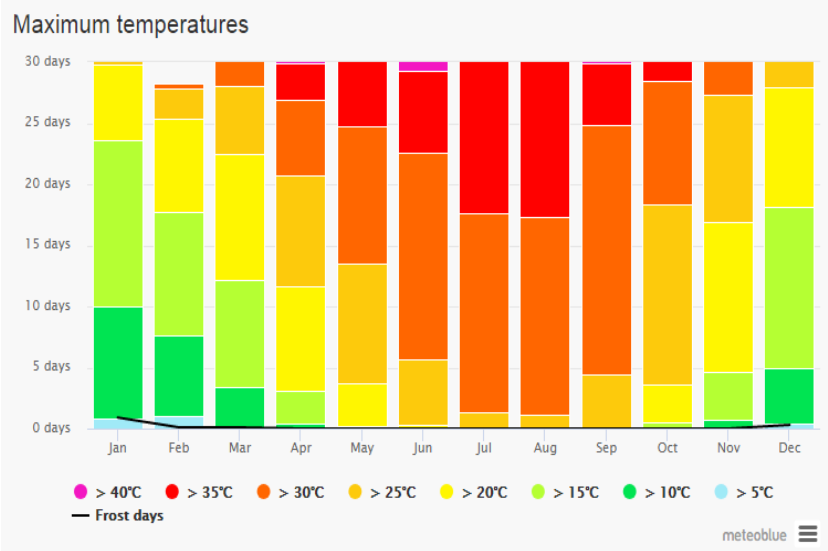

Figure 6.4 Maximum temperature days[34]

Wind: In the region the wind speed is about 3.27 km / h throughout the year. The direction of the wind changes during the day from the southern winds in the early hours of the morning to the winds of northwesterly evening, and the southern wind that starts from the shores of the Dead Sea.

:Pentaxian winds loaded with dust**.**

: Western winds and North West

: Cooled Eastern winds .

Figure 6. 5 Movement of wind in the selected location.

The Table.6.2 shows how many days within one month can be expected to reach certain wind speeds for Ein Sara. Strong winds from December to April, but calm winds from June to October.

Table 6.2: wind speed table for each month[34].

	Wind speed >5km/h (day)	**Wind speed >12km/h (day)**	**Wind speed >19km/h (day)**	**Wind speed >28km/h (day)**	**Wind speed >38km/h (day)**	**Wind speed >50km/h (day)**
Jan	12.3	11.4	5.3	1.6	0.4	0
Feb	8.2	11	5.4	3	0.5	0.2
Mar	4.3	14.5	9.2	2.5	0.5	0
Apr	2.3	12.7	12.7	2	0.2	0
May	0.6	8	20.5	2	0	0
Jun	0.1	2.8	23.9	3.3	0	0
Jul	0	3.3	24.9	2.8	0	0
Oug	0	3.6	26.6	0.8	0	0
Sep	0.5	8.4	20.2	0.9	0	0
Oct	3.3	16.9	10.5	0.4	0	0
Nov	11.2	13.3	4.4	1.1	0.1	0
Dec	15	10	4.4	1.3	0.3	0

Moisture: The climate of Hebron is affected by the climate of Palestine, which is known as dry and hot in summer, moderate and rain in winter. Despite the smallness of Hebron, its climate varies according to the terrain and the water bodies adjacent to and away from the desert. As for precipitation, rainfall rates vary depending on the geography of the area, as rainfall in Hebron ranges between (400-600 mm) annually.

The Figure.6.6 and Table 6.3 of the graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

Table 6.3: Number of sunny, partly cloudy, over cast and precipitation days[34].

	Sunny (day)	Partly cloudy (day)	Over cast (day)	Precipitation (days)	Precipitation (mm)
Jan	9.9	11.4	9.7	7.4	33
Feb	9	11.7	7.6	6.3	29
Mar	12	14.1	4.9	5	20
Apr	14.5	12.9	2.6	2.4	5
May	19.5	10.3	1.3	1.8	5
Jun	25.6	4.4	0	.5	1
Jul	24.6	6.4	0	.8	1
Oug	22	9	.1	.4	0
Sep	22.5	7.5	.1	.4	0
Oct	17.5	12.5	1	2	6
Nov	15.2	10.9	3.9	3.7	14
Dec	10.5	12.1	8.3	5	28

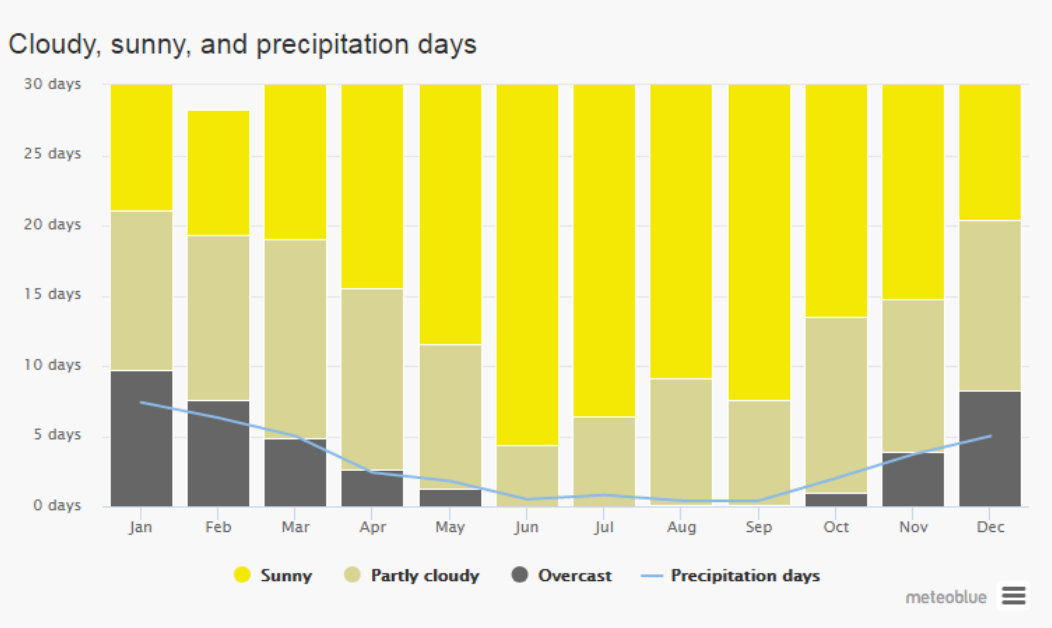

Figure 6.6 cloudy,sunny, and precipitation days[34].

6.4Reasons for choosing the green roof company

Germany is one of the most countries interested in green roofs, We have searched for several companies in Germany ,We have had difficulty communicating with companies and understanding their principals because of German language, until we found Zinco company ,Its website is written in English

ZinCo – one of the leading manufacturers – are pioneers and innovators in terms of extensive and intensive roof greening .We quickly contacted them and found a branch for company in the occupied Palestinian territories

This company had several advantages like:

1. its green roof system based on renewable raw materials, unique worldwide.
2. the aim of manufacturing the functional layers required for green roofing on a fully environmental basis
3. Looking towards that the protection mat, filter mat and drainage element will in future be based on bioplastics

Standards have been applied

The green roof layers have been chosen which contain characteristics that conform to the international specifications and are the most prominent international specifications that have been applied. First in properties of the Filter Sheet layer that the Effective opening width value It was taken according to (ASTM D-4751) Standard Test Methods for Determining Apparent Opening Size This test method shows the values in both SI units and inch-pound units. SI units is the technically correct name for the system of metric units known as the International System of Units.[35]

Secondly in the Properties of the Protection Material layer in Protection efficiency Have been adopted according to ISO 13428 describes an index test for the determination of the protection efficiency of a geosynthetic on a hard surface, exposed to the impact load of a hemispherical object The index test measures the change in thickness of a thin lead plate lying between the geosynthetic and a rigid support. As for the Static puncture it is according to ISO 12236 specifies a method for the determination of the puncture resistance by measuring the force required to push a flat-ended plunger through geosynthetics .[36]

Thirdly in the properties of the Root Barrier layer in Breaking strength and Tensile strength its standard according to (ASTM D751, Grab method) These test methods provide for this testing ensure the quality of Coated fabrics and rubber products made from coated fabrics.[35]

So it can be observed to international standard :

ASTM International Standards Worldwide

ASTM: International known as the American Society for Testing and Materials is a globally recognized leader in the development and delivery of international voluntary consensus standards. 12,000 ASTM standards are used

around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence.

ISO: The International Organization for Standardization is an international standard-setting body composed of representatives from various national standards organizations.

6.5Structural loads of green roof system

The loading of the green roof must be established before the survey is carried out to ensure capacity. Once the building's general loading capacity is known and any strong or weak loading points identified, the green roof can be designed to suit, or the capacity of the building can be adapted. Deeper substrate depths can be placed where loading capacity is higher i.e. above supporting columns. in Figure 6.6 its show cross section area for the green roof components of background garden and in Table6.4 show the structural loads of green roof for the background garden. While in Figure 6.7its show the cross section area of the green roof components for the roof and in Table.6.4 it is shown the structural loads of green roof for the roof garden.

1. **For background garden.**

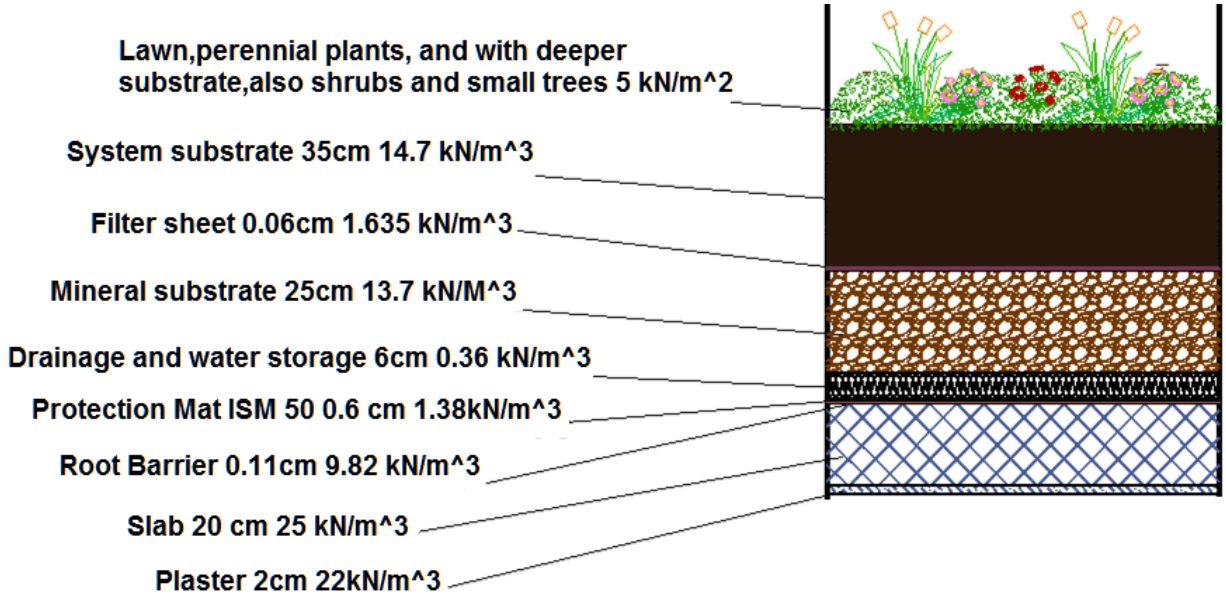

Figure.6.7.The cross section area for the green roof components of background garden of the building.

Table6.4 structural loads of green roof for the background garden

Layer name	Thickness (cm)	Density (Kn/m^3)
Planets	-	5
System substrate	35	14.7
Filter sheet	0.06	1.635
Mineral substrate	25	13.7
Drainage layer	6	0.36
Protection material	0.6	1.38
Root barrier	0.11	9.82
Slab	20	25
plaster	2	22

2. For roof garden.

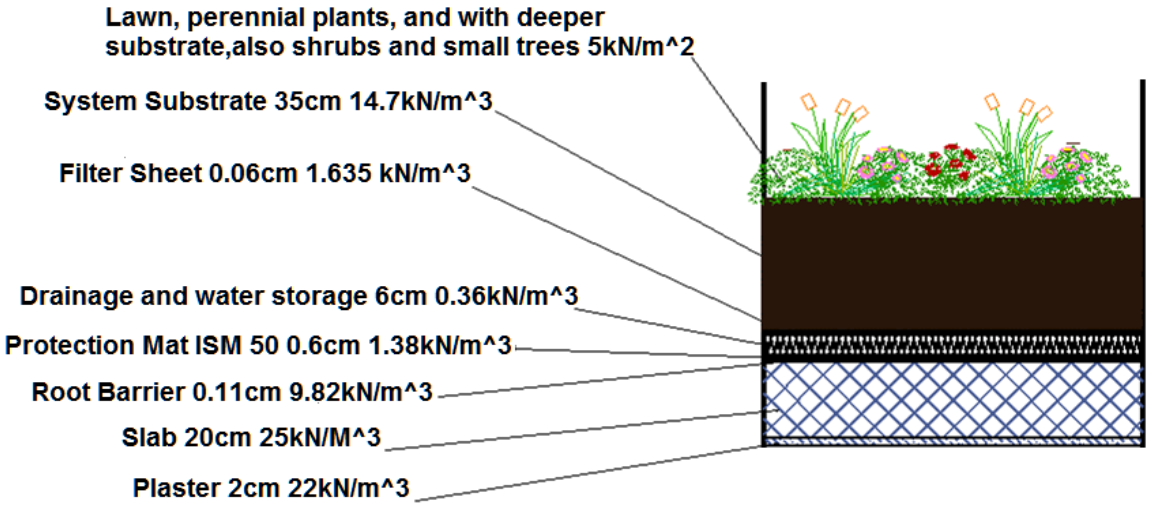

Figure.6.8 cross section area of the green roof components for the roof of the building.

Table.6.5 structural loads of green roof for the roof garden.

Layer name	Thickness (cm)	Density (Kn/m^3)
Planets	-	5
System substrate	35	14.7
Filter sheet	0.06	1.635
Drainage layer	6	0.36
Protection material	0.6	1.38

Root barrier	0.11	9.82
Slab	20	25
plaster	2	22

6.6Green roof components

1. System Substrate

System Substrate "Roof Garden". Order No. 616101

High-quality recycled Substrate consisting of (crushed brick with selected mineral aggregates) and other components, such as sandy sample of the Substrate layer sample of the Substrate layer sample of the Substrate layer sample of the Substrate layer sample of the Substrate layer sample of the Substrate layer sample of the Substrate layer sample of the Substrate layer sample of the Substrate layer soil, enriched with substrate compost enriched with fiber materials. Particularly suitable for intensive green roofs with demanding perennials. Deeper thicknesses can support shrubs, bushes and trees. The vegetation can be established by planting plug plants. Its most prominent features are also excellent water retention, high air content – even at max, frost resistant and stable in structure and neutral ph. Table 6.6Displaysthe Chemical and Physical Properties of the Substrate layer. And all these components control by the University of Hohenheim (Germany).Intensive roof gardens require irrigation during dry periods. For optimal plant development the use of an appropriate slow release fertilizer is recommended in . Figure 6.9 shows the sample of the Substrate layer[37] .

Figure6.9.A sample of the Substrate layer[37].

Table 6.6.Chemical and Physical Properties of the Substrate layer[37].

Parameter	Value
Volume weight - dry - at max. water capacity	1000 g/l (+/- 100 g/l) 1500 g/l (+/- 100 g/l)
Maximum water capacity	50 Vol. %
Water permeability	0.3–30 mm/min
pH value	6.5–8.0
Salinity	< 2.0 g/l
Organic content	< 90 g/l
Compaction factor	1.3

2.Filter layer

Filter Sheet SF .Order No. 2101

Geotextile of thermally strengthened polypropylene, applicable for normal mechanical stress. Made of non-rotatable materials, resistant to all naturally occurring acids and alkalis. Its advantages are high water-passing ability, fast and easy installation, and are suitable for many applications. Table 6.7. appears Properties of the Filter Sheet layer[5]. In Figure 6.10 its show the sample of the Filter Sheet

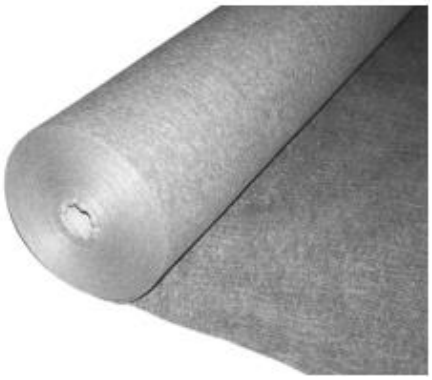

Figure6.10. A sample of the Filter Sheet layer[38] .

Table 6.7.Properties of the Filter Sheet layer [38].

Parameter	Value	Standard
Color	Grey	
Thickness	0.6 mm	
Weight	100 g/m²	
Static puncture	1100 N	
Maximum tensile strength	7.0 kN/m	
Flow rate Q under 4 inch (100 mm) water column:	70 l/(m²·s)	
Effective opening width, O95%	0.15 mm	(according to ASTM D-4751)
Dimensions:	2.00 m x 10.00 m	

3. Mineral Substrate

"Zincolit® Plus". Order No. 607102

High-quality recycled Substrate consisting of crushed brick, enriched with selected, non-flammable mineral aggregates; it is also frost resistant and stable in structure. Particularly suitable for sub-substrate for intensive green roofs with a total substrate depth of more than 350 mm or as infill of drainage layers. Fig 3.Displays a sample of the Mineral Substrate layer . in Figure 6.11 its show the sample of the Mineral substrate layer

Fig 6.11. A sample of the Mineral Substrate layer [39].

It is characterized by its high water permeability and high pore size. suitable for pumping and quality control of the University Hohenheim (Germany).For optimal plant development the use of an appropriate slow release fertilizer is recommended .Table 6.8 Displays Properties of the Mineral Substrate layer [39].

Table 6.8. Properties of the Mineral Substrate layer [6].

Parameter	Value
Volume weight - dry - at max. water capacity	 1020 g/l (+/- 100 g/l) 1300 g/l (+/- 100 g/l)
Maximum water capacity	28 vol. %
Water permeability mod.	60–400 mm/min
pH value (in CaCl2)	6.5–8.5
Salinity (water extract)	< 2.5 g/l
Compaction factor	1.1
Thickness	25cm

4. Drainage And water storage layer

Floradrain® FD 60 neo . Order No. 3062

High efficient recycled drainage and water storage element made of profiled plastic, suitable for intensive green roofs. Considered as Drainage and water storage element of thermoformed recycled polyolefin.it is Own a channel system for ventilation and drainage. applicable in combination with dam-up irrigation on 0° roofs. irrigated by diffusion and capillary action. In the end apply as permanent formwork e.g. under driveways and foundations. Fig 6.12 Displays a sample of the Drainage And water storage layer .and Table 6.9 Displays the Properties of the Drainage And water storage layer[40].

Figure 6.12. A sample of the Drainage And water storage layer [40].

Table 6.9. Properties of the Drainage And water storage layer[40].

Parameter	Value
Material	Polyolefin, mainly PE
Color	Black
Height	60 mm
Weight	2.2 kg/m²

Water retention capacity with infill	13 l/m²
Filling volume	27 l/m²
Compressive strength (at 10 % compression) *without filling*	40 kN/m²
In-plane Water Flow Rate - roof slope 1 %: -roof slope 2 %: -roof slope 3 %:	 1.1 l/(s·m) 1.6 l/(s·m) 2.0 l/(s·m)
Net dimensions:	1.00 m x 2.25 m
Amount per pallet	450 m² (net)

5.Protection Material

Protection Mat ISM 50 . Order No. 2050

Synthetic recycled fiber material , highly resistant to mechanical stress; for use as protection layer under intensive green roofs, walkways and driveways, etc. High-quality, extremely stable fiber material of polyester/polypropylene, bottom sided fiber impregnation using acrylic compounds. In Figure 6.13. Displays A sample of the Protection Material layer .

Figure 6.13. A sample of the Protection Material layer[41] .

It is also High quality for sound insulation, non-rotting synthetic fiber material as water and nutrient storage with proven protective effect according to European Standard EN ISO 13428, bottom sided fiber bonding using acrylic dispersions, thickness 6 mm, weight 850 g/m², penetration forces according to Standards EN ISO 12236 > 3500 N, delivery and installation according to manufacturer´s instructions as a Protection layer

against mechanical impact on top of the water proofing. Table 6.10.Displaysthe Properties of the Protection Material layer[41].

Table 6.10. Properties of the Protection Material layer[41].

Parameter	Value	Standard
Color	grey mottled	
Thickness	6 mm	
Weight	850 g/m²	
Water retention capacity	4 l/m²	
Protection efficiency according to EN ISO 13428	Residual thickness ≥ 40 %	Protection efficiency according to EN ISO 13428
Static puncture	> 3500 N	ISO 12236
Strength class	5	
Improves footstep sound insulation (with concrete slabs in gravel bedding):	(delta L w,R=25 dB)	
Dimensions	2.00 m x 25.00 m	

6. Root Barrier

WSB 100-PO Order No. 1084

Recyclable polyolefin, applicable as root protection on extensive and especially on intensive green roofs ,hot air weld able layer , Resistant to bitumen, microorganisms, but not resistant to bamboo. .flexible at low temperatures and excellent weld able sheet, superb weather-profess, resistant for short time for oil, made of flexible polyolefin (FPO), with polyester weft-inserted reinforcement, root proof FLL tested according to the German FLL method of 2002.Figure.6.14.Displays A Sample of the Root Barrier layer .And Table 6.11. Display Properties of the Root Barrier layer[42] .

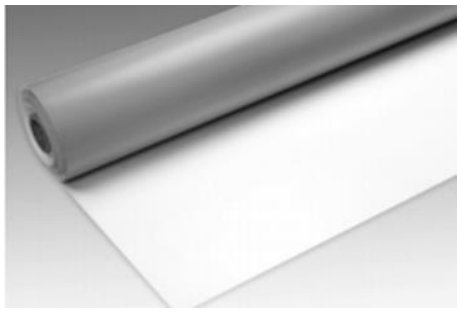

Figure 6.14. A Sample of the Root Barrier layer[42].

Table 6.11 Properties of the Root Barrier layer[42] .

Parameter	Value	Standard
Thickness	1.1 mm	
Weight	1.1 kg/m²	
Breaking strength	1.500 N	(ASTM D751, Grab method)
Tensile strength	> 20 %	(ASTM D751, Grab method)
Water vapor permeability of air layer thickness	sd = 280 m	
Dimensions	2.44 m x 30.50 m	
Accessories:	EDP No. 1192 (inside/outside corner): EDP No. 1195 (Unsupported flashing):	
roll size	0.60 m x 15.00 m	
weight per roll	9 kg	

6.7 Green roofs Installation

6.7.1Main steps of green roofs installation

1. At the beginning, the surface is prepared with Waterproofing coating , to avoid the possibility of water leakage and be humid. Secondly, Installing the Root Barrier layer above the water proofing dyeing, the layer are to be hot air welded root proof. The root barrier has to be taken above the Growing Media along edges and at roof penetrations. Cut the root barrier in situ at roof penetrations. Thirdly ,Install the Protection Material above root barrier. The protection material has to be taken above the Growing Media along edges and at roof penetrations. Cut the protection material in situ at roof penetrations. Consider the roof is completely covered. As in the Figure 6.15.

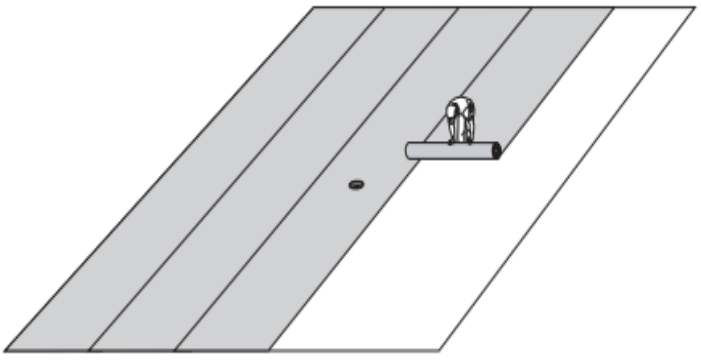

Figure 6.15: Installing water proofing, root barrier ,and protection material layers[43] .

2. Install drain access boxes: Position drain access boxes bringing its height to cultivated plants . As in the Figure 6.16.Adding sidewall elements as required, excess water flows through small holes and spills over the edges to be carried off the roof. A gap between the high-water level of the plates and the top of the drainage layer assures proper soil drainage at all times. All the drainage boxes are Connected together to form a network and eventually the water will be drained from the final channel. Since drainage layer are lightweight and easy to install, they have become the most popular drainage system for green roofs.

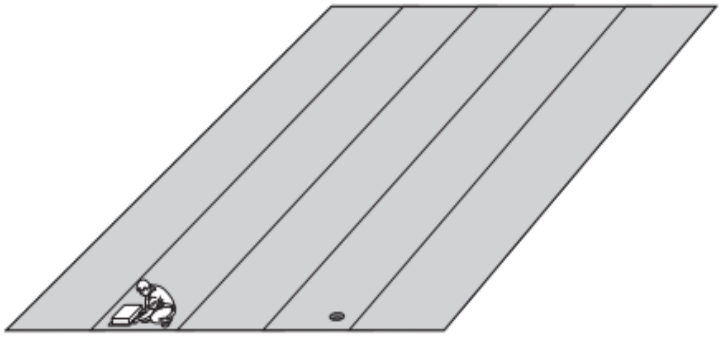

Figure 6.16: Installing drain access boxes, [43].

3. Lay drainage layer: Lay drainage layer (Fig 6.17) in a staggered pattern. layer of plastic plates can be easily cut with a circular saw, or half-sheets can be purchased to speed installation. The plates should tit tightly but are not overlapped. The thickness available to match drainage and water storage requirements is60 mm .

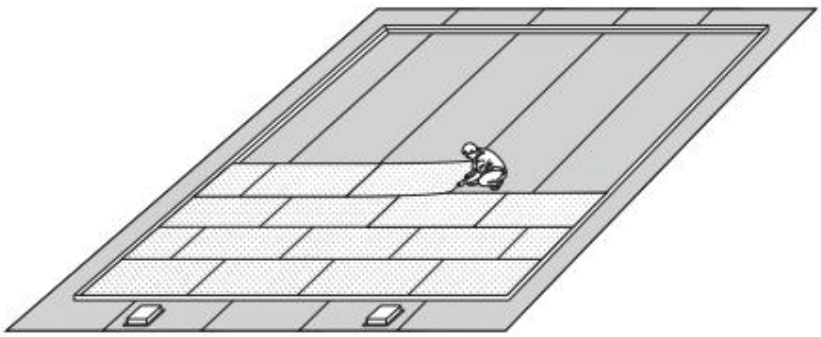

Figure 6.17:Installing drainage layer [43]

4. Spread gravel perimeter/mineral substrate : Spread well-washed gravel (Figure 6.18) screened to (95mm) minimum particle size. Whenever possible, the gravel should be dispensed from super sacks suspended from cranes to minimize the potential for damage .

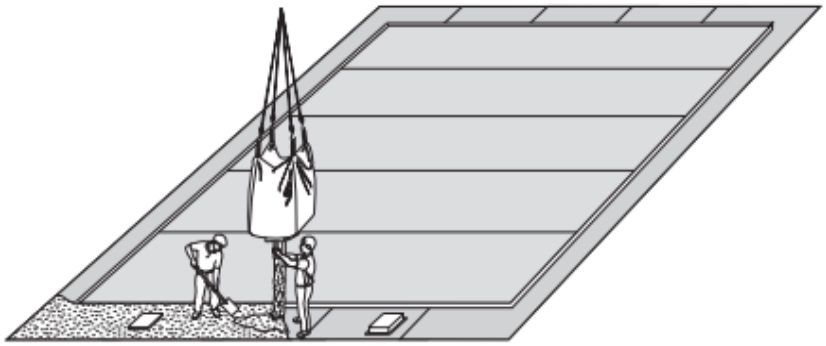

Figure 6.18: Spreading gravel perimeter [43]

5. Lay separation fabric/filter sheet : Separation fabric (Figure 6.19) is engineered to retain soil without clogging while allowing plant roots to easily penetrate to reach water in the drain plates. Unroll Separation Fabric over the drain plates, overlapping adjacent sheets at least six inches (152 mm) .

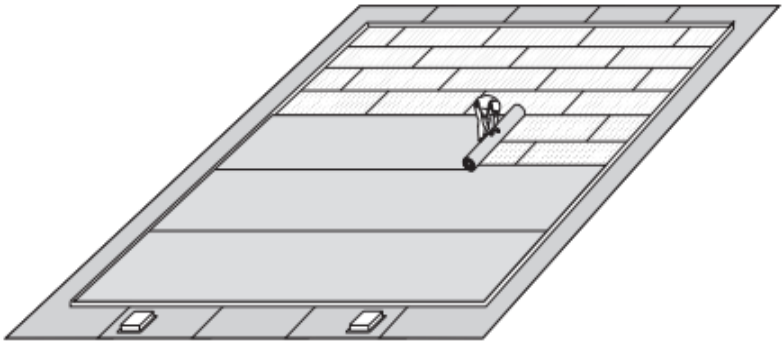

Figure 6.19: Laying separation fabric [43]

6. Spread soil: For intensive roofs, spread intensive green roof is soil as needed to obtain the required system thickness. Where possible, the media should be dispensed from super sacks suspended from cranes to minimize the potential for damage(Figure 6.20).

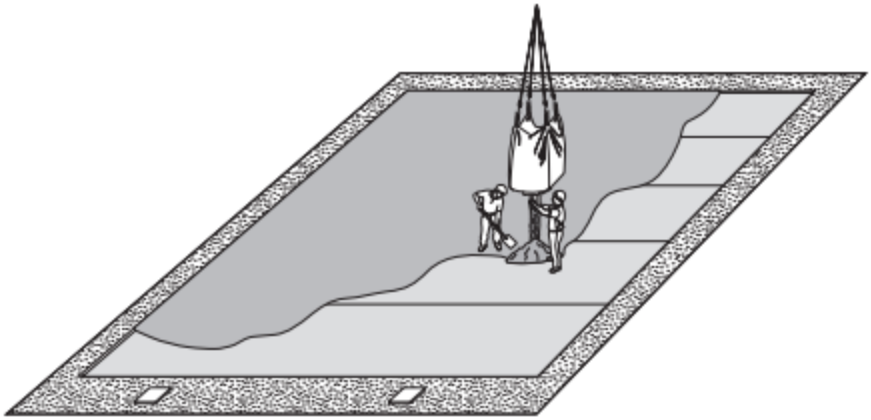

Figure 6.20: Spreading soil [43]

7. Plant: Insert green roof plants (Figure 6.21) in a random pattern. Irrigation should be during dry periods for the first two years during extended dry periods for the first two years[43].

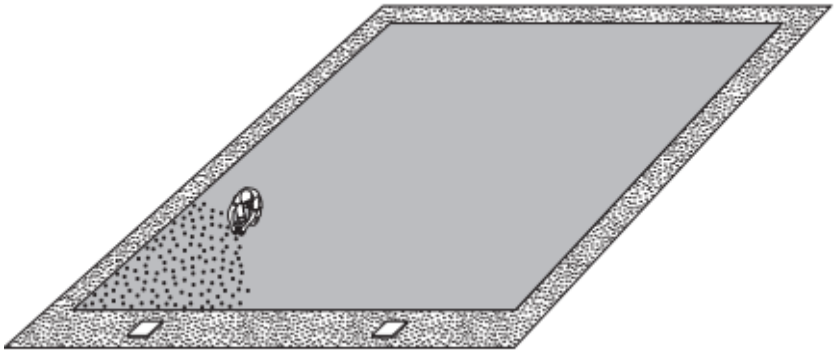

Figure 6.21: Planting [43]

6.7.2Sections of green roofs

1. System build up for Green Roof .

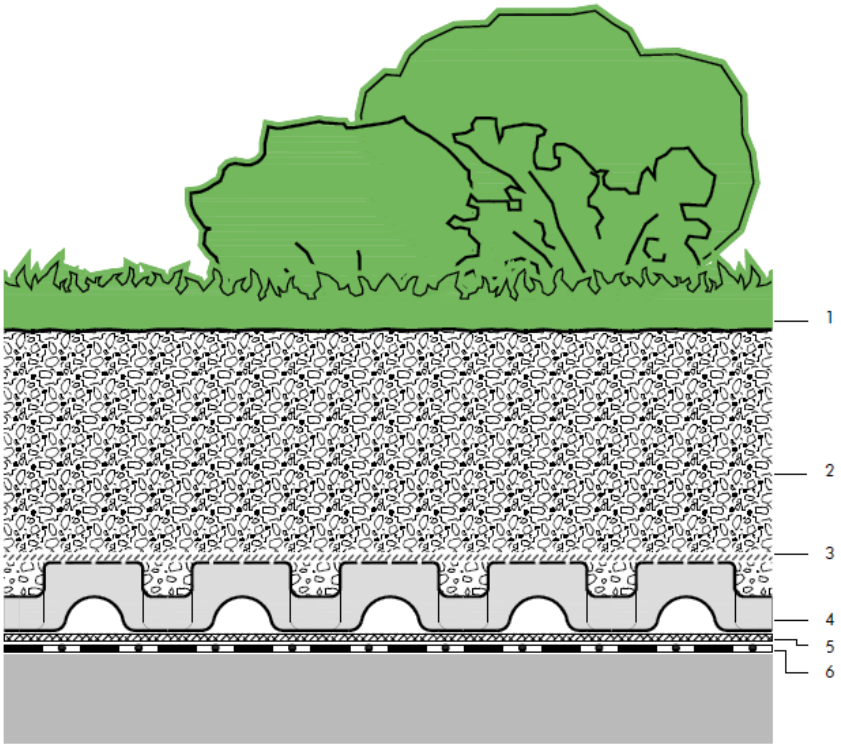

Figure.6.22, 1. Lawn, perennials, shrubs and trees.2. System Substrate.3 .Filter Sheet .4 Drainage Element . 5 .Protection Material . 6 .Roof construction with root-resistantwaterproofing.

2. Wall connection for Roof Garden.

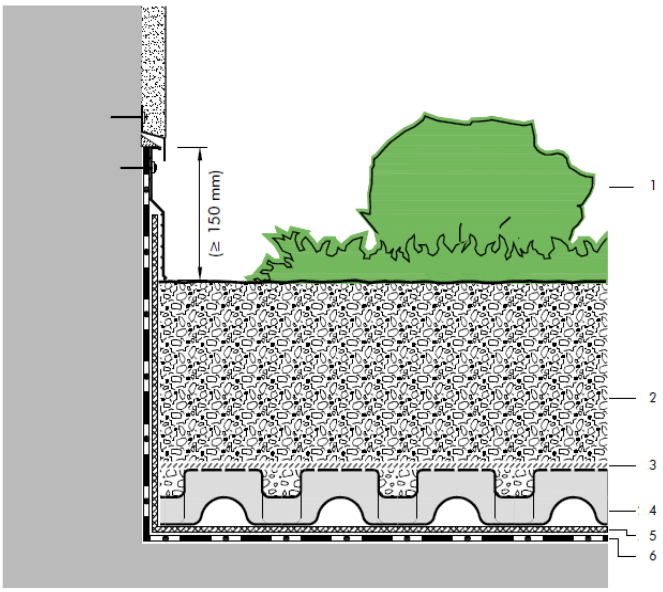

Figure6.23.1. Lawn, perennials, shrubs and trees.2 .System Substrate .3.Filter Sheet .4. Drainage Element .5.Protection.6.Roof construction with root-resistant and waterproofing.

3. Roof outlet with inspection chamberfor Roof Garden.

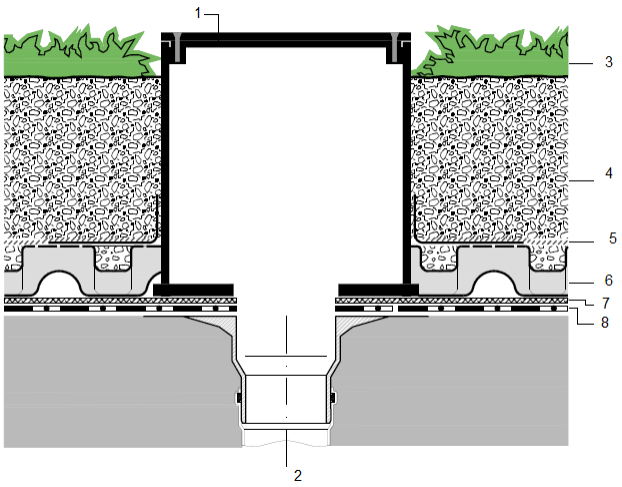

Figure.6.24 1. Inspection Chamber /drainage box.2. Roof outlet.3. Lawn, perennials, shrubs and small trees.4. System Substrate .5. Filter Sheet .6. Drainage Element .7. Protection, Material .8. Roof construction with root-resistant waterproofing.

4. Foundation for supporting structures / roof shelter .

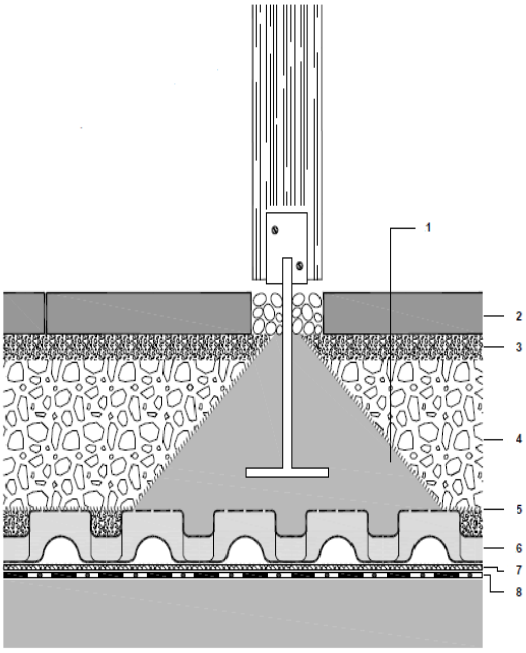

Figure.6.25, 1.Concrete foundation for supporting structures.2 .Concrete paving slab.3 .Stone chippings, height (30 - 50 mm).4. Gravel base layer.5. Filter Sheet .6. Drainage Element 7.Protection Material .8. Roof construction with root-resistant waterproofing.

5. Root ball anchorage

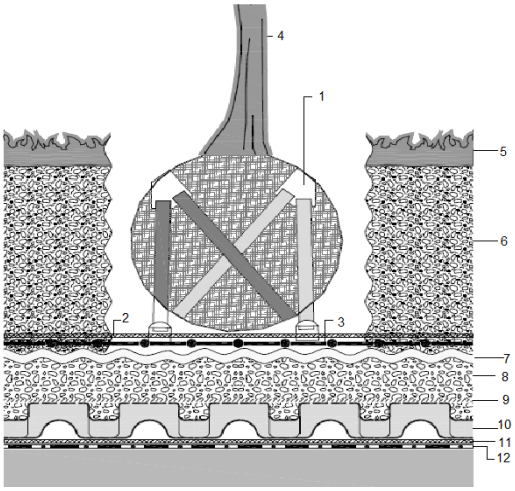

Figure.6.26, 1. Root ball anchorage.2. Biodegradable fiber ,e.g. coco-material (optional) .3 .Reinforcement steel mesh.4. Tree.5. Lawn.6. System Substrate.7. Drainage pipes.8. mineral substrate.9. Filter Sheet .10. Drainage Element, filled with mineral substrate11. Protection Material .12. Roof construction with root-resistant waterproofing.

6.8Drainage and irrigation system

The drainage system of the project dependent on drainage network, consists of drainage boxes (inspection champer) and a collection of pipes. The inspection champer inserted at the height of the substrate Surrounded with a gravel soil to protect and drain the roof outlet in intensive green roof system asin Figure 6.27. And the drainage pipes installed through the slab connected with each other to flow the water for the final discharge passing through a filter before pumping by the drain pump to the reservoir . Drainage box have an upper filter layer to drain excessive of the surface water, and a sides filter connected to the drainage layer to drain the water infiltration, at the end of drainage box there is Dam_up element to control the exit of water working as a valve for the roof outlet.

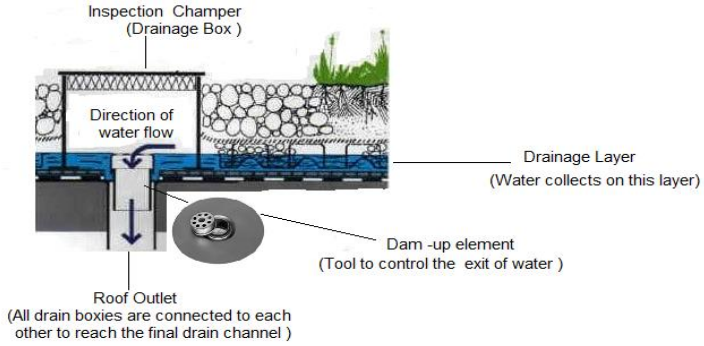

Figure 6.27 drainage system of green roof.

The irrigation system principle depend on soil moisture sensor ,indicates the humidity percent in the soil, send the signs to water level controller ,its work principle on the percent of the humidity if there is increasing in the humidity percent from the allowable range in the soil ,the controller send a signal to the drain pump to work and drain the excessive water to the tank. And if there is reducing in the percent of humidity from the allowable range the controller send a signal for the pump to work and irrigate the roof garden by the same water of the tank. in Figure 6.28 it is show the drainage and irrigation system of green roof.

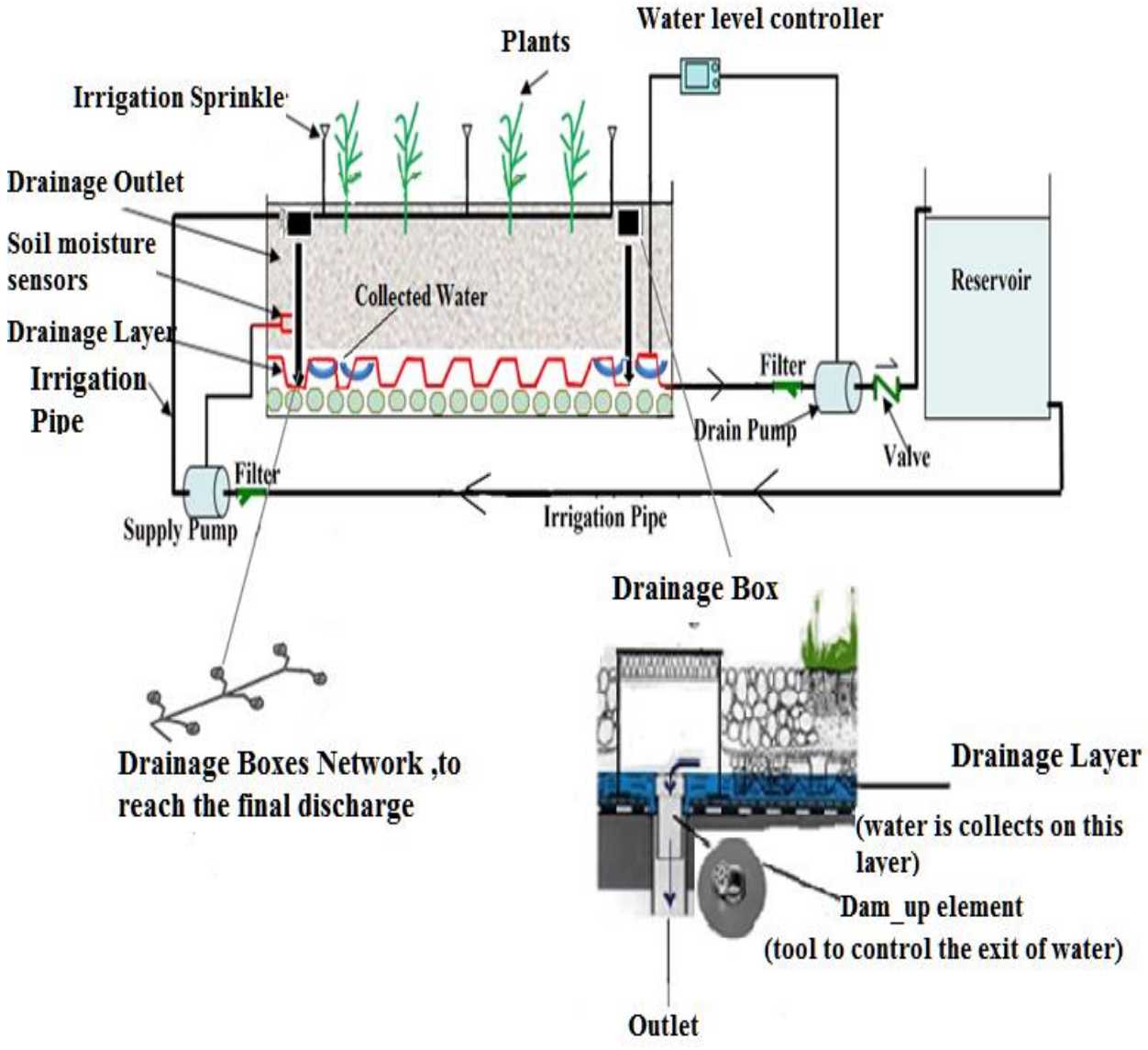

Figure 6.28 drainage and irrigation system of green roof

6.9Planting

The appropriate origin environment for the growth of selected plants has been taken into consideration ,plants that grow in temperate, Mediterranean, almost moderate humidity were selected in accordance with the climate of Palestine especially Hebron.n the system of green roofing we need plants that are permanent greens this was taken into consideration only fruit trees were excluded that their leaves are falling due to need to their nutritional values .when choosing a plant type you can note that most selected plants are small size type to reduce the load on the building, most of the plants were chosen with flowers had beautiful colors to give an aesthetic view to the building.

1. Bougainvillea, Paper Flower

Figure6.29 Bougainvillea, Paper Flower

Table 6.12 Properties of Bougainvillea, Paper Flower

Origin	Mediterranean
Vigour	fairly fast
Humidity	semi humid
Type	Climbers, evergreen , semi evergreen
Height	10 m-25 m Spread : 4 m-10 m
Irrigation	Medium
Flowers Colour	red, purple, pink, white
Period	April – June

2.Treasure Flower

Figure6.30 Treasure Flower

Table 6.13 Properties of Treasure Flower

Origin	Mediterranean,
Vigour	normal growth
Humidity	semi-humid
Irrigation	medium
Type	Perennial , evergreen
Height	0.3 m
FLOWER Colour	yellow
Period	March - June

3.Jacquemontia

Figure6.31 jacquemontia

Table 6.14 Properties of jacquemontia

Origin	Mediterranean,
Vigour	fast growing
Humidity	semi-humid
Irrigation	medium
Type	Climbers , evergreen
Height	2 m
FLOWER Colour	blue
Period for flower	January - December

4.Pink Jasmine

Figure6.32 Pink Jasmine

Table 6.15 Properties of Pink Jasmine

Origin	sub-Mediterranean, Mediterranean
Vigour	fairly fast growing
Humidity	semi humid
Irrigation	high
Type	climbers , evergreen
Height	3 m-6 m
FLOWER Colour	white, pink
Period for flower	February - August

5.Crape Myrtle

Figure6.33 Crape Myrtle

Table 6.16 Properties of Crape Myrtle

Origin	Mediterranean
Vigour	fast growing
Humidity	semi-arid, semi humid
Irrigation	Medium
Type	Shrub
Height	5 m-10 m
FLOWER Colour	Pink
Period	July – September

6.Lantana, Shrub Verbena

Figure6.34 Lantana, Shrub Verbena

Table 6.17 Properties of Lantana, Shrub Verbena

Origin	Mediterranean
Vigour	normal growth
Humidity	semi-arid, semi humid
Irrigation	Medium
Type	Shrub, evergreen
Height	1 m-1.8 m
FLOWER Colour	orange, red, yellow, pink
Period for flower	May – October

7.Grape Vine, enab

Figure6.35 enab

Table 6.18 Properties of enab

Origin	sub-Mediterranean, Mediterranean
Vigour	fast growing
Humidity	semi-arid, semi humid
Irrigation	Medium
Height	0.5 m-1.5 m
Type	Climbers , deciduous
FLOWER Colour	light green
Period	May – June

6.10Financial cost of green roofs

The cost of the green roofs was calculated based on the prices of the company ZinCo after it was visited, which has a branch in the city of Ramlah located in the occupied Palestinian,kknowing that the area of 1442 is the area of the back garden in addition to the area of green surface, the number of drainage boxes were estimated because of the lack of expansion of its characteristics in the project.

Table 6.19 Financial cost of green roofs

	Component	**Unit**	**Price**	**Total area**	**price**
1.	Filter layer	1m2	0.106	1442	152.85
2.	Drainage And water storage layer	1m2	0.825	1442	1189.65
3.	Protection Material layer	1m2	0.246	1442	354.72
4.	Root Barrier	$1m^2$	0.233	1442	335.99
Total layer prices = 2033.21ILS					
1.	Drainage boxes	Pcs (Unit)	162	Assume 10 boxes	1620
2.	Head System	-	3500		3500
3.	Accompaniment / guidance / supervision	Work hours	300		300
4.	Root ball anchorage	Pcs (Unit)	200	Assume 50ball anchorage	10000
Total prices = 17453.21 ILS					