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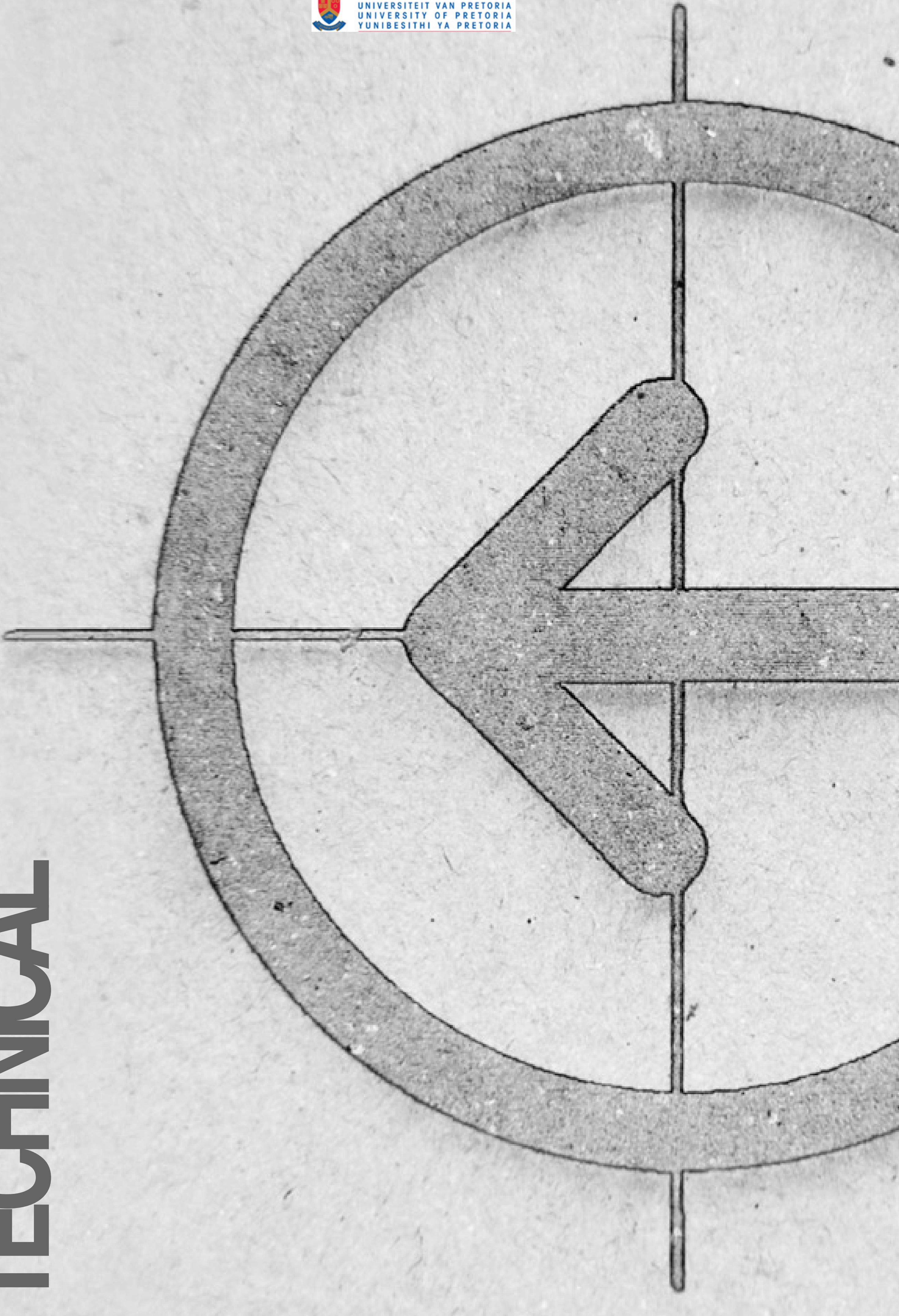

TECHNICAL

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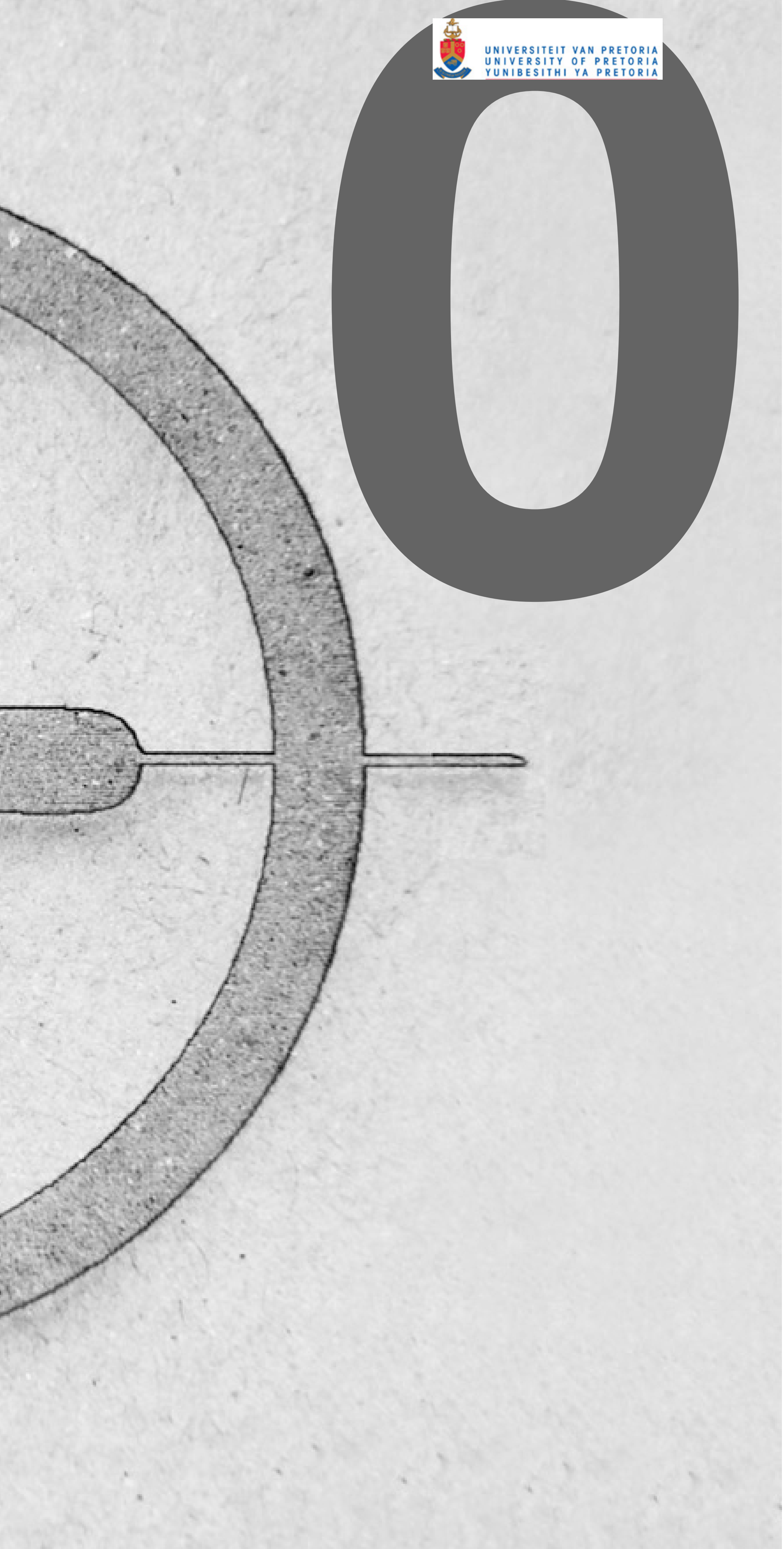

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CHAPTER 8 TECHNICAL

8.1 Construction

STRUCTURE

FRAME

Due to the required height and expected loads that will be imposed on the structure by the indoor agricultural activities the building requires a structure with high compressive strength.

As a large percentage of the building's external envelope is to be glazed (to allow light transmittance) a structural framing system is allowing the flexibility to use non-load bearing glazed infill.

Steel frame is chosen as the primary structure over concrete as this material will allow for easier construction of proposed "angled" facades using prefabricated steel member and that can be assembled on site.

That fact that steel can be recycled whereas concrete can only be re-used also plays a part in the decision.

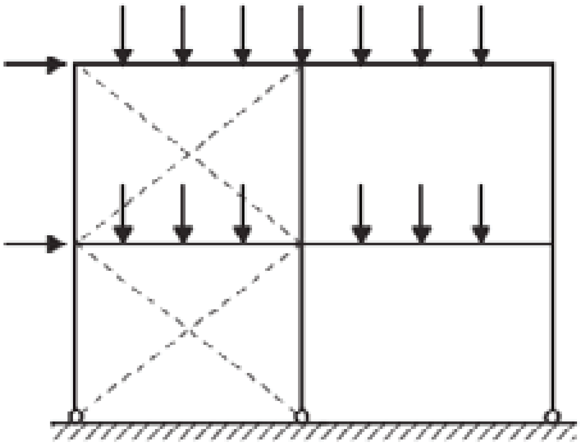


Figure 129: Braced steel frame with pinned connections.

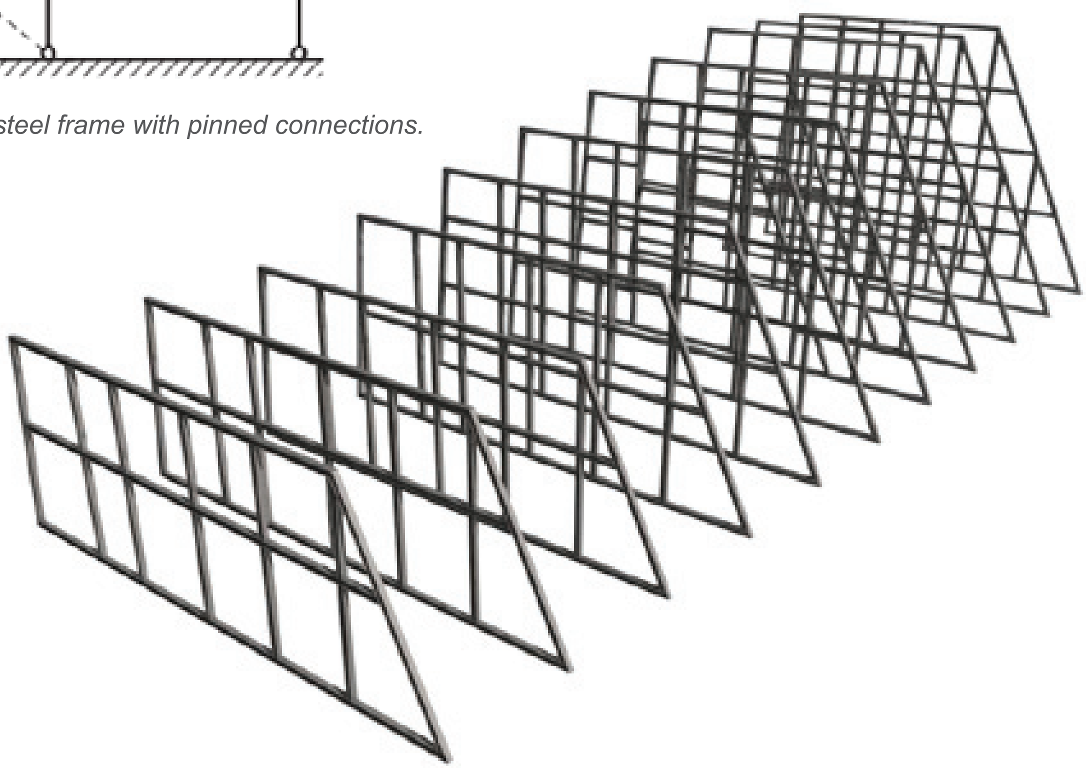


Figure 128: Main structural steel members spaced at 6.5m interfals.

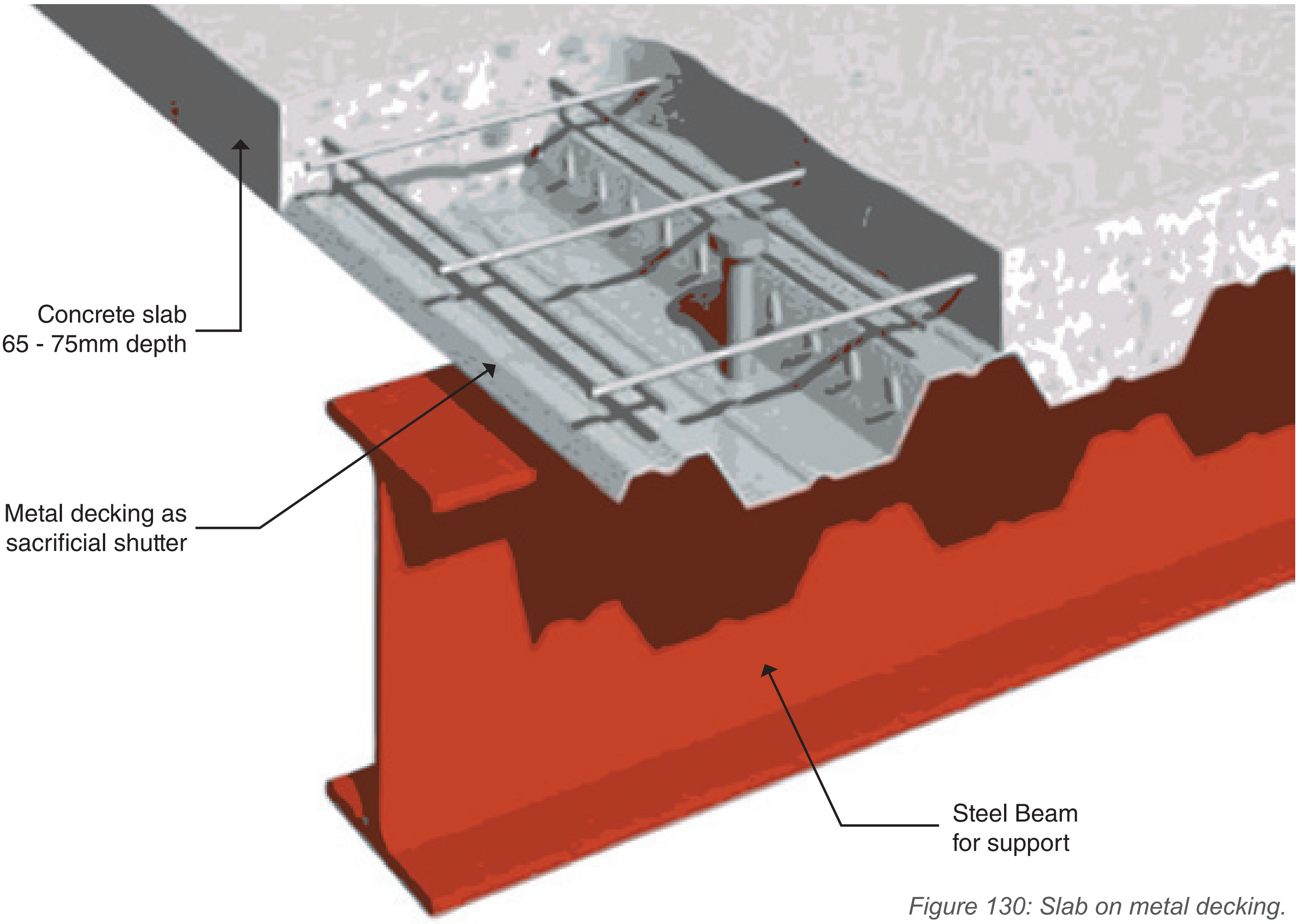


Figure 130: Slab on metal decking.

SLABS

Due to the "ramped" nature of a large percentage of surfaces in the building a cast in-situ slab system is chosen over a pre-fabricated floor or roof construction. Metal decking is used a sacrificial shutter, thereby making use of the steel frame for support and further reducing the use of concrete.

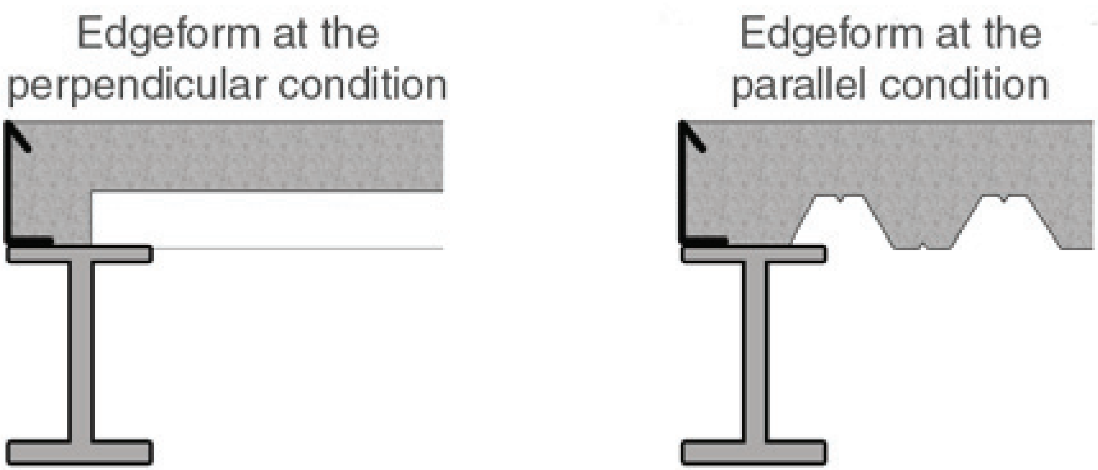


Figure 131: Slab on metal decking edge details.

GREEN ROOF

The roof is required to accommodate a large amount of outdoor agriculture. An intensive green roof construction is proposed to give adequate soil depth for consumable fauna.

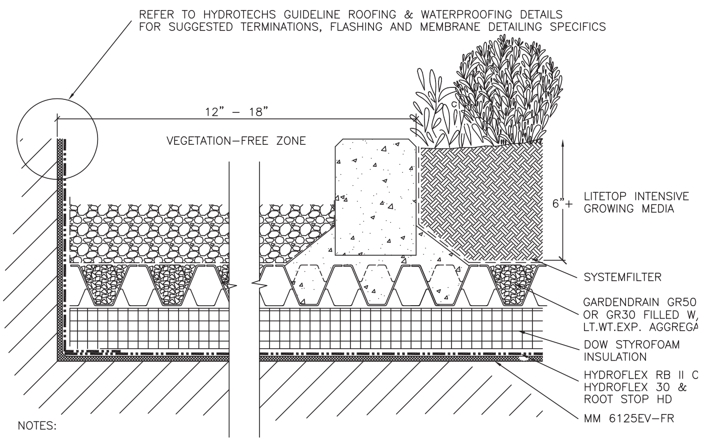


Figure 133: Green roof edge detail.

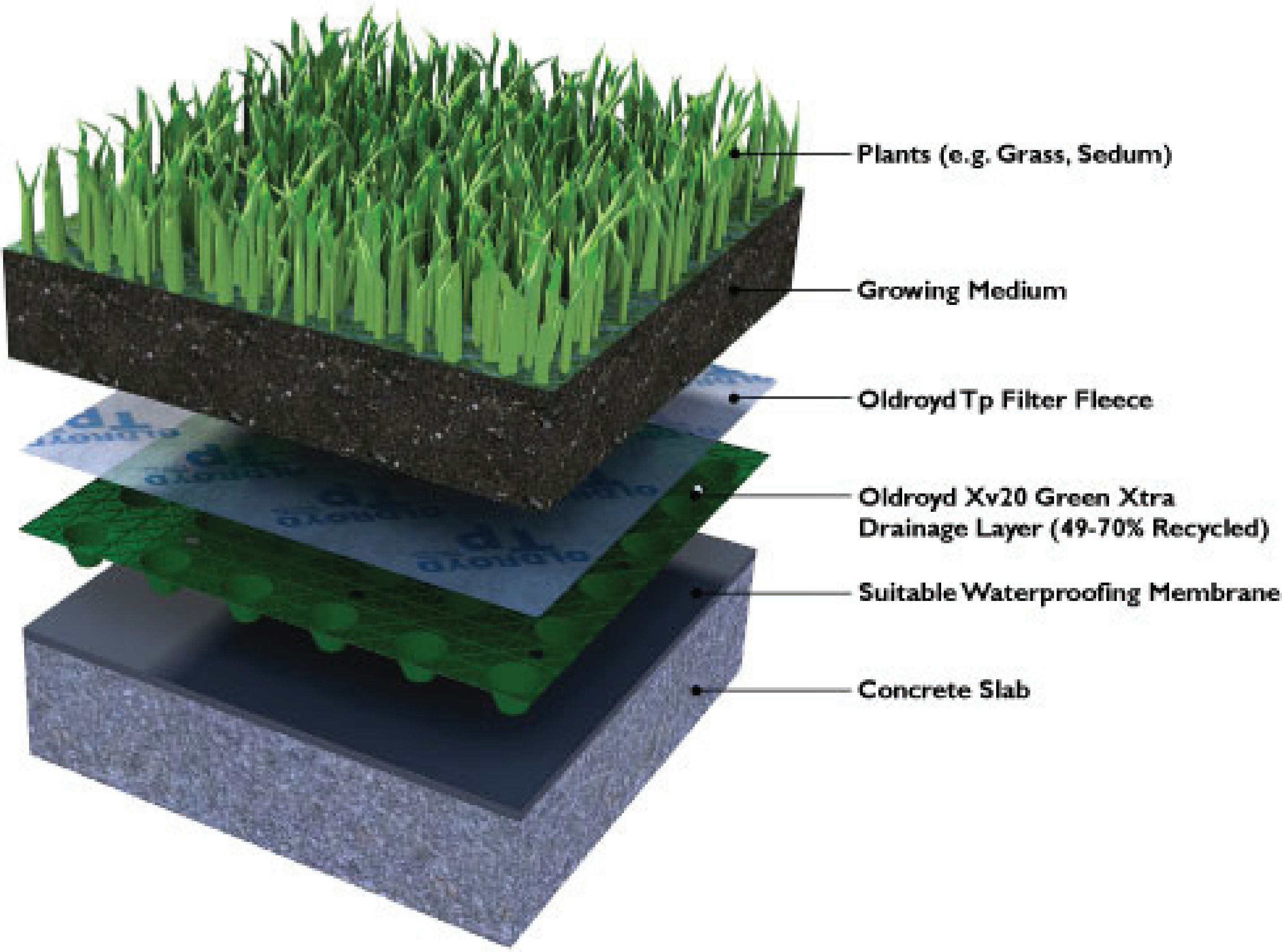


Figure 132: Exploded view of green roof construction.

SUBSTRUCTURE

Due to the expected ground conditions in an area bordering on a river bank a deep foundation system would be preferable for a multistory construction.

Piling was considered to transfer building loads down to a stable soil condition, however it is thought that due to the proposed basement construction adequate depth will be achieved.

The basement is constructed to withstand both the imposed soil pressure and heave caused by water

table.

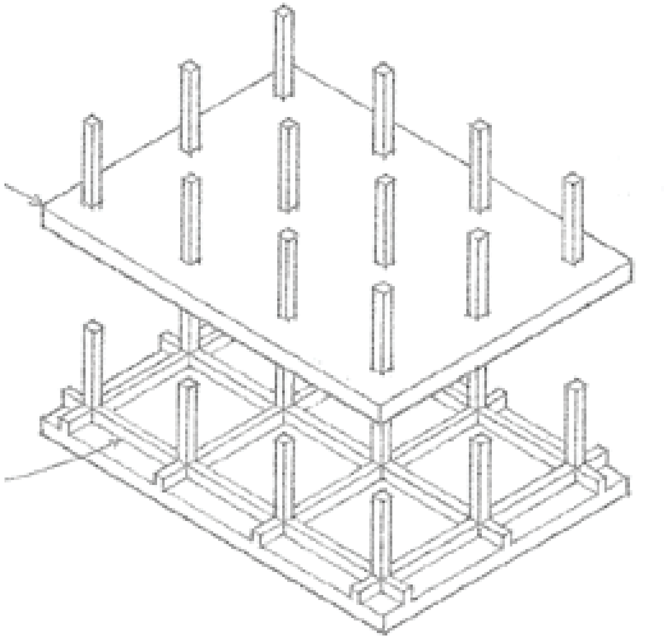


Figure 134: Basement concrete beam and post construction.

ENVELOPE

CURTAIN GLAZING

North and South facing facades are covered with glazed curtain walls to allow for maximum natural light into the growing areas.

These curtain walls can be supported by the proposed steel frame using spider connectors to give a flush glazing finish.

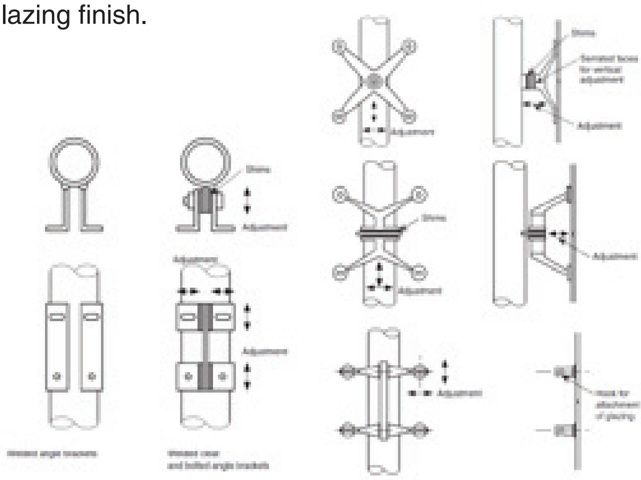
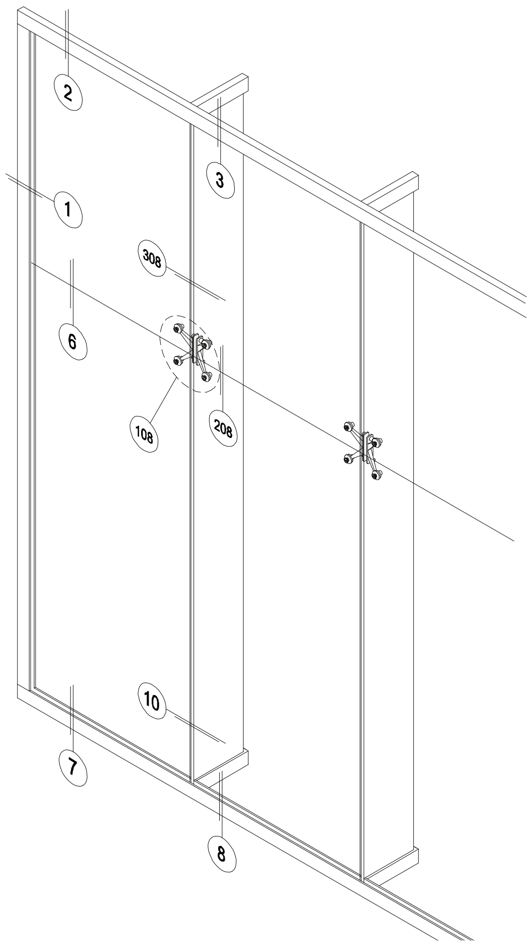


Figure 135: Curtain wall glazing connection details



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LIVING WALL

West facing facades are covered with a living green wall system, together with the green roof this system helps to mitigate the heat island effect.

Planting used on this wall will have to be heat tollerant as the western facade is expected to recieve high levels of direct late afternoon sun.

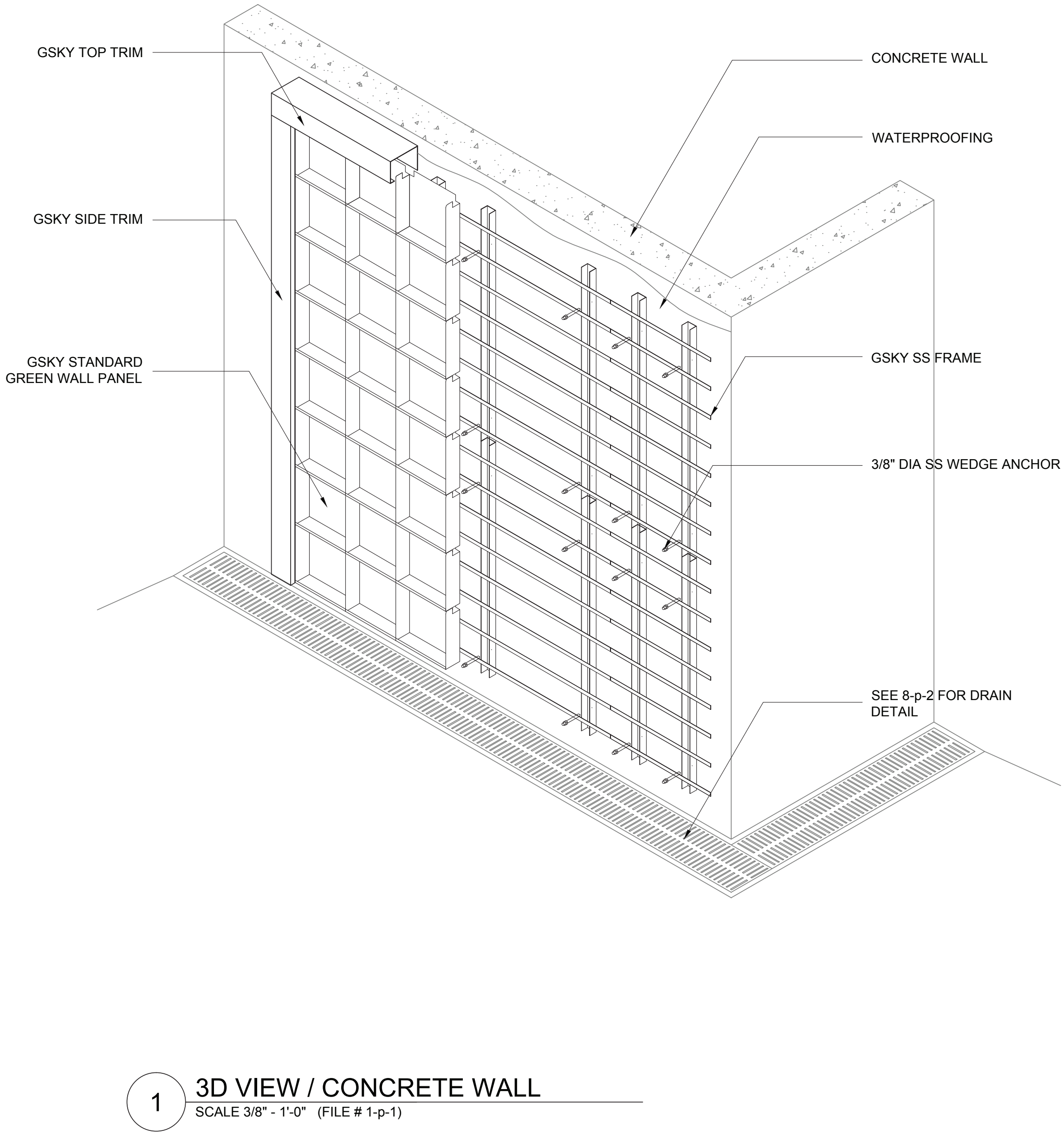
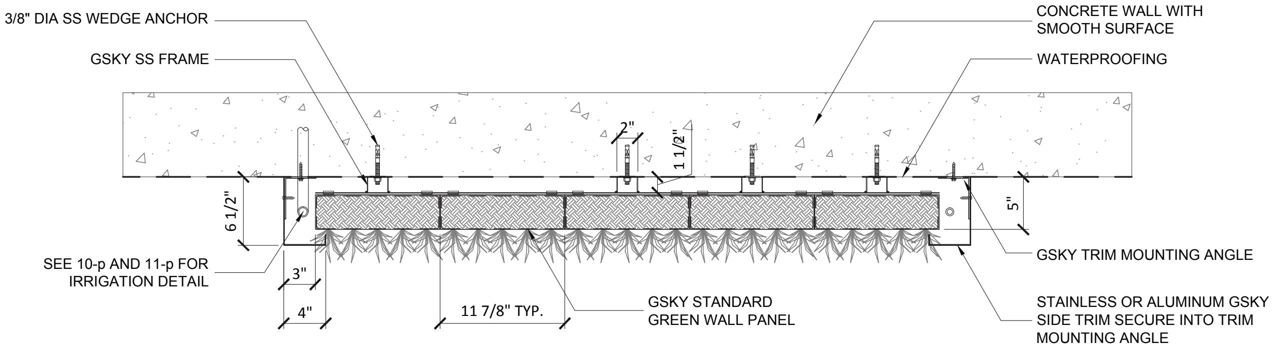
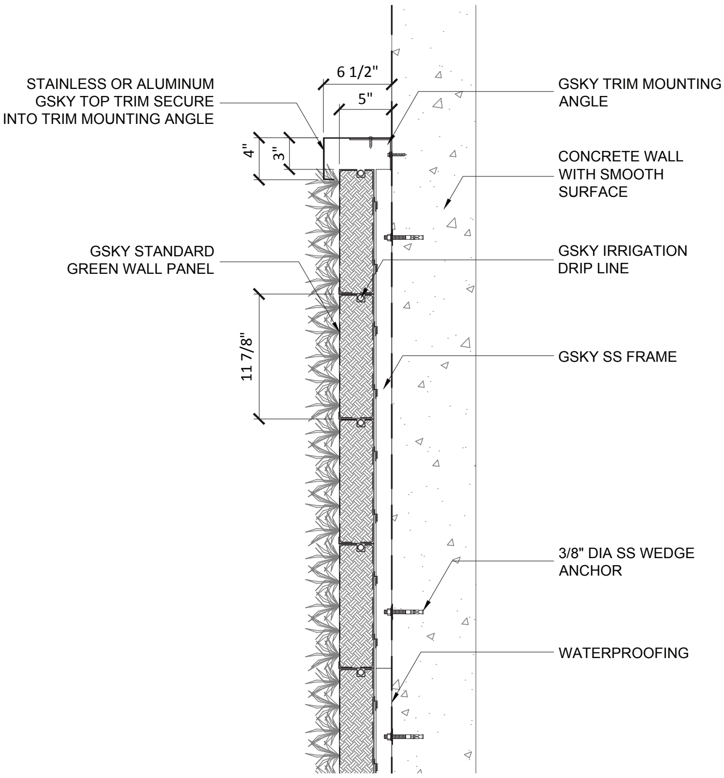
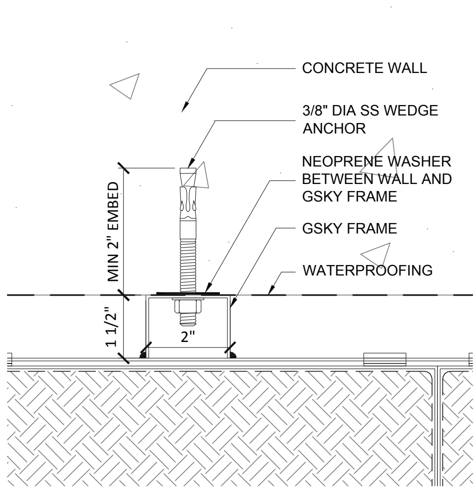


Figure 136: Living wall assembly drawing.



2 PLAN DETAIL / CONCRETE WALL
SCALE 3/4" - 1'-0" (FILE # 1-p-2)





4 FASTENER DETAIL / CONCRETE WALL
SCALE 3" - 1'-0" (FILE # 1-p-4)

3 SECTION DETAIL / CONCRETE WALL
SCALE 3/4" - 1'-0" (FILE # 1-p-3)

Figure 137: Living wall construction details.

8.2 Technology

BASIC HYDROPONIC SYSTEMS

Six basic types of hydroponic systems will be used in the indoor agriculture areas; Wick, Water Culture, Ebb and Flow (Flood & Drain), Drip (recovery or non-recovery), N.F.T. (Nutrient Film Technique) and Aeroponic.

Each one of these systems have specific features that make them ideal for specific crops or climatic conditions. The methods range from fully passive to mechanised systems, the use of all these systems allows for the research of yields given by different levels of natural and artificial resources.

DEEP WATER CULTURE

The water culture system is the simplest of all active hydroponic systems. The platform that holds the plants is usually made of Styrofoam and floats directly on the nutrient solution. An air pump supplies air to the air stone that bubbles the nutrient solution and supplies oxygen to the roots of the plants, keeping the plants roots from drowning. Effort should be made to keep light from getting to the nutrient solution.

Wherever there is light and nutrients, algae will grow. Algae eat the nutrients you are trying to feed to your plants, and when pieces of algae die they attract fungus gnats. Fungus gnats lead to many other problems.

Water culture is the system of choice for growing leaf lettuce, which are fast growing water loving plants, making them an ideal choice for this type of hydroponic system. Very few plants other than lettuce will do well in this type of system.

Since there are no drip or spray emitters to clog, it is also a good choice for organic hydroponics growing systems. This system is well suited for volcanic lava chips media, or else a mixture of one part vermiculite to 5 parts expanded clay pellets.

The biggest draw back of this kind of system is that it doesn't work well with large plants or with long-term plants.

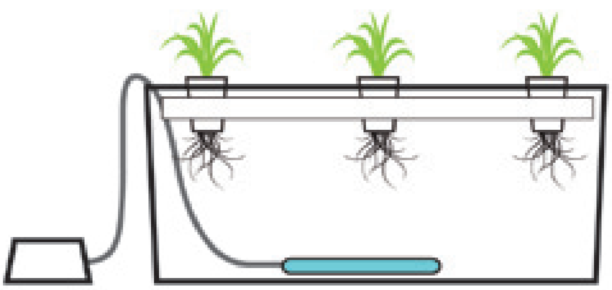


Figure 138: Deep water culture.

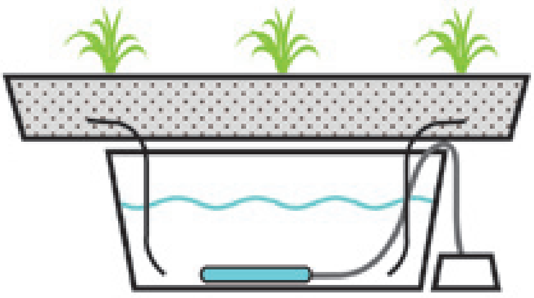


Figure 139: Wick System.

WICK SYSTEM

This is a passive system, which means there are no moving parts. In wick hydroponic growing systems, the plants are again in their own container, separate from the nutrient reservoir. Pieces of absorbent material (usually nylon rope) are buried partially in each plant container. The other end of the rope is allowed to dangle in the nutrient solution. The absorbent material pulls the nutrient solution from the reservoir up into the growing medium.

This system can use a variety of growing medium. Perlite, Vermiculite, Pro-Mix and Coconut Fibre are among the most popular.

The biggest draw back of this system is that plants that are large or use large amounts of water may use up the nutrient solution faster than the wick(s) can supply it.

EBB & FLOW - (FLOOD AND DRAIN)

In the flood and drain method, the plants sit in their own container separate from the nutrient reservoir. The Ebb and Flow system works by temporarily flooding the grow tray with nutrient solution and then draining the solution back into the reservoir. This action is normally done with a submerged pump that is connected to a timer.

When the timer turns the pump on nutrient solution is pumped into the grow tray. When the timer shuts the pump off the nutrient solution flows back into the reservoir. The Timer is set to come on several times a day, depending on the size and type of plants, temperature and humidity and the type of growing medium used.

The Ebb & Flow is a versatile system that can be used with a variety of growing mediums. The entire grow tray can be filled with Grow Rocks, gravel or granular Rockwool. Individual pots filled with growing medium can be used, this makes it easier to move plants around or even move them in or out of the system.

The main disadvantage of this type of system is that with some types of growing medium (Gravel, Growrocks, Perlite), there is a vulnerability to power outages as well as pump and timer failures. The roots can dry out quickly when the watering cycles are interrupted. This problem can be relieved somewhat by using growing media that retains more water (Rockwool, Vermiculite, coconut fibre or a good soilless mix like Pro-mix or Faffard's).

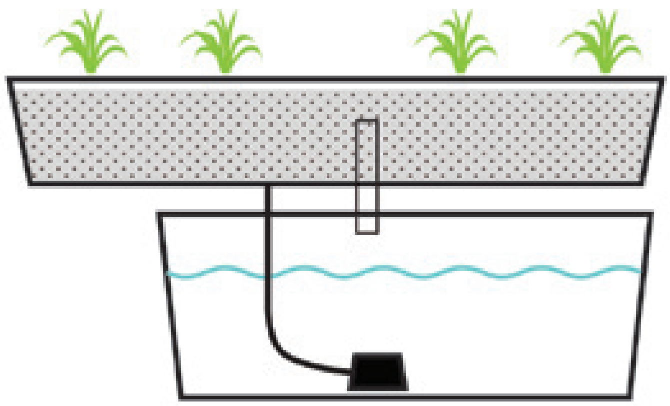


Figure 140: EBB & Flow System.

DRIP SYSTEMS

RECOVERY / NON-RECOVERY

Drip systems are probably the most widely used type of hydroponic system in the world. Operation is simple, a timer controls a submersed pump. The timer turns the pump on and nutrient solution is dripped onto the base of each plant by a small drip line. In a Recovery Drip System the excess nutrient solution that runs off is collected back in the reservoir for re-use. The Non-Recovery System does not collect the run off.

A recovery system uses nutrient solution a bit more efficiently, as excess solution is reused, this also allows for the use of a more inexpensive timer because a recovery system doesn't require precise control of the watering cycles. The non-recovery system needs to have a more precise timer so that watering cycles can be adjusted to insure that the plants get enough nutrient solution and the runoff is kept to a minimum.

The non-recovery system requires less maintenance due to the fact that the excess nutrient solution isn't recycled back into the reservoir, so the nutrient strength and pH of the reservoir will not vary. This means that you can fill the reservoir with pH adjusted nutrient solution and then forget it until you need to mix more. A recovery system can have large shifts in the pH and nutrient strength levels that require periodic checking and adjusting.

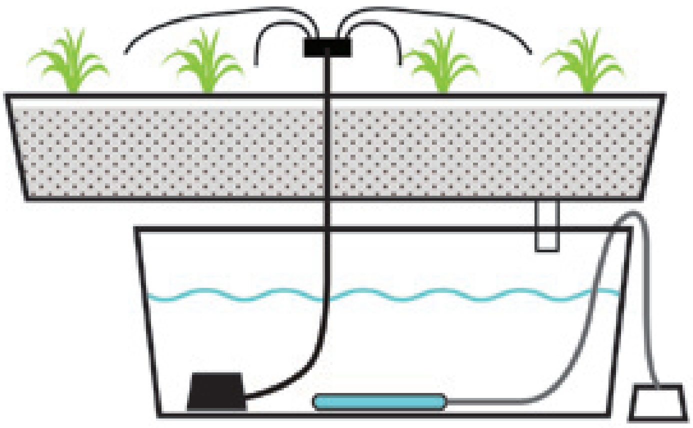


Figure 141: Drip System.

N.F.T.

(NUTRIENT FILM TECHNIQUE)

This is the kind of hydroponic system most people think of when they think about hydroponics. N.F.T. systems have a constant flow of nutrient solution so no timer required for the submersible pump. The nutrient solution is pumped into the growing tray (usually a tube) and flows over the roots of the plants, and then drains back into the reservoir.

There is usually no growing medium used other than air, which saves the expense of replacing the growing medium after every crop. Normally the plant is supported in a small plastic basket with the roots dangling into the nutrient solution.

N.F.T. systems are very susceptible to power outages and pump failures. The roots dry out very rapidly when the flow of nutrient solution is interrupted.

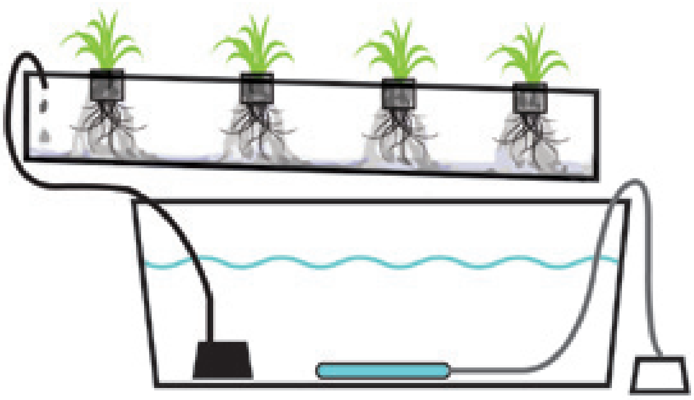


Figure 142: Nutrient Film Technique.

AEROPONIC

As you can see, there really is no growing medium in this method. The plants roots hang down into the container and grow mostly in air, except for the few that grow long enough to make it into the nutrient solution in the bottom.

The pump used is a high-pressure pump, and the spray emitters are made specially to deliver a very fine, highly oxygenated spray.

It is often very hard to assemble individual parts into a well-working system, and the individual parts can be expensive as well. Also, the fine-spray emitters will

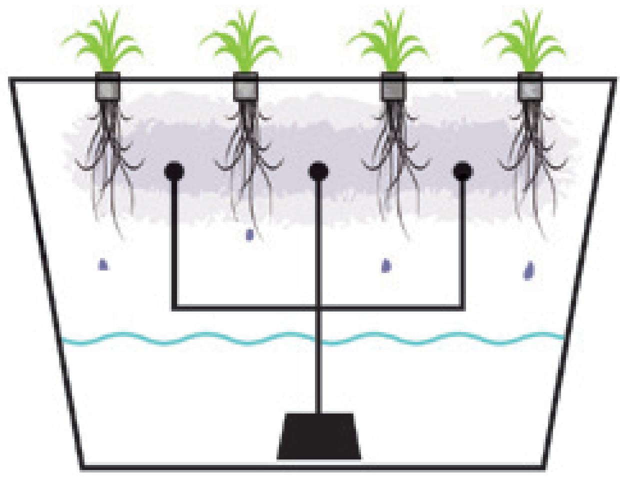


Figure 143: Aeroponics.

instantly clog if you try to use anything except high quality hydroponic fertilizers (no organics).

Of all the hydroponics growing systems, this is the most difficult to master and the most temperamental. Ph changes and nutrient imbalances occur more quickly because of the increased absorption rates and high levels of oxygenation. Furthermore, with no grow media to protect the roots, the plants react negatively to these changes much more quickly.

The aeroponic system is probably the most high-tech type of hydroponic gardening. Like the N.F.T. system above the growing medium is primarily air. The roots hang in the air and are misted with nutrient solution. The mistings are usually done every few minutes. Because the roots are exposed to the air like the N.F.T. system, the roots will dry out rapidly if the misting cycles are interrupted.

A timer controls the nutrient pump much like other types of hydroponic systems, except the aeroponic system needs a short cycle timer that runs the pump for a few seconds every couple of minutes.

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8.3 Services

Carbon dioxide (CO_2) and light are essential for plant growth. As the sun rises in the morning to provide light, the plants begin to produce food energy (photosynthesis). The level of CO_2 drops in the greenhouse as it is used by the plants. Ventilation replenishes the CO_2 in the greenhouse. Because CO_2 and light complement each other, electric lighting combined with CO_2 injection are used to increase yields of vegetable and flowering crops. Bottled CO_2, dry ice, and combustion of sulfur-free fuels can be used as CO_2 sources. Commercial greenhouses use such methods.

LIGHTING

Plants utilizes certain colour wavelengths of light to manufacture energy through photosynthesis. This energy is then used by the plant as fuel for growth. Major photosynthesis activity takes place when the red and blue wavelengths are present. All plants have different light intensity requirements, ranging from a far corner of a room to brilliant sunshine.
Growing hydroponic vegetables indoors requires the use of at least some artificial lights, in order to fruit, vegetables require high light levels to develop vast amounts of energy.

VENTILATION

Air movement by ventilation alone may not be adequate in the middle of the summer; the air temperature may need to be lowered with evaporative cooling. Also, the light intensity may be too great for the plants. During the summer, evaporative cooling, shade cloth, or paint may be necessary. Shade materials include roll-up screens of wood or aluminium, vinyl netting, and paint.
Small package evaporative coolers have a fan and evaporative pad in one box to evaporate water, which cools air and increases humidity. Heat is removed from the air to change water from liquid to a vapour. Moist, cooler air enters the greenhouse while heated air passes out through roof vents or exhaust louvres. The evaporative cooler works best when the humidity of the outside air is low. The system can be used without water evaporation to provide the ventilation of the greenhouse. Size the evaporative cooler capacity at 1.0 to 1.5 times the volume of the greenhouse. An alternative system, used in commercial greenhouses, places the pads on the air inlets at one end of the greenhouse and uses the exhaust fans at the other end of the greenhouse to pull the air through the house.

ENERGY

Growing indoors requires a lot of energy on a continuous basis. Growing lights and water pumps require continual electrical supply and heat and humidity management.
A Biogas Reactor can be used to supply a combined heat-and-power system.

WATER

A water supply is essential. Hand watering is acceptable for most greenhouse crops if someone is available when the task needs to be done; however, for commercial use an automated system is preferred. A variety of automatic watering systems is available to help to do the task over short periods of time. Time clocks or mechanical evaporation sensors can be used to control automatic watering systems. Mist sprays can be used to create humidity or to moisten seedlings. Watering kits can be obtained to water plants in flats, benches, or pots.

COMPUTER CONTROL SYSTEMS

The Computer Control System has two main functions with regards to the aquaponics system. The first is to allow efficient control and maintenance of the system which reduces energy use and both simplifies and minimizes the labour involved in the system while providing optimal conditions for the growth of The Plants and fish. The second goal of the Control System is to collect operational data from both automatic sources (sensors/actuators) and manual input sources (growth speeds, complex chemical analysis).

* The final presentation will include a detailed section illustrating the integrated solution of the above services.

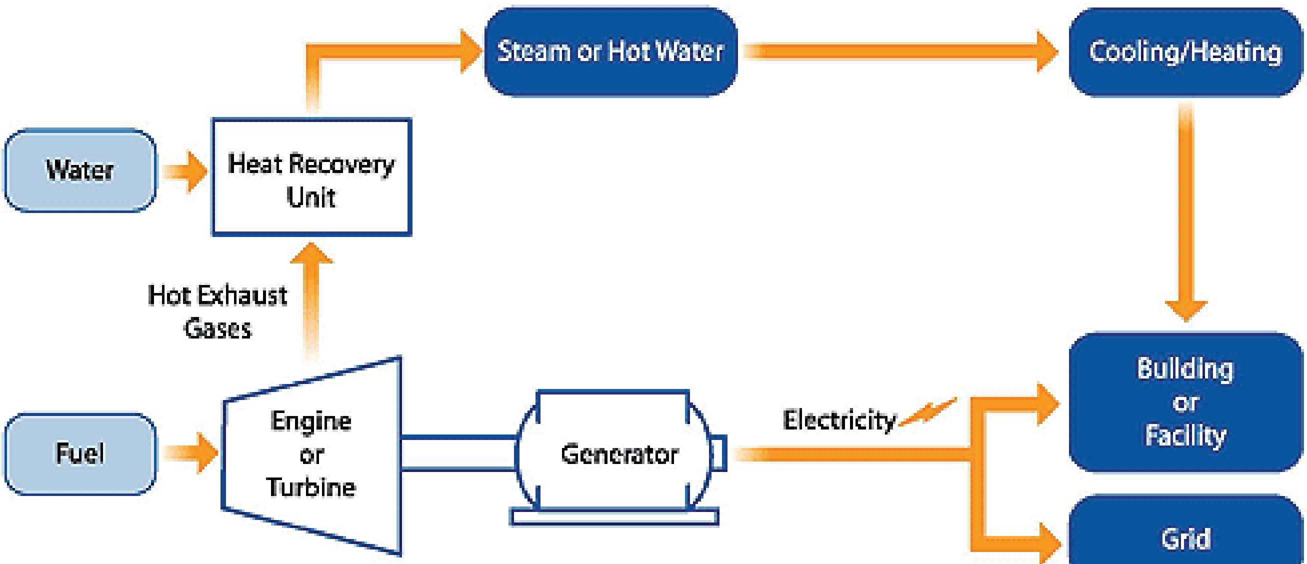

Figure 144: Fuel generated by biogas reactor used for power, heating and cooling systems.

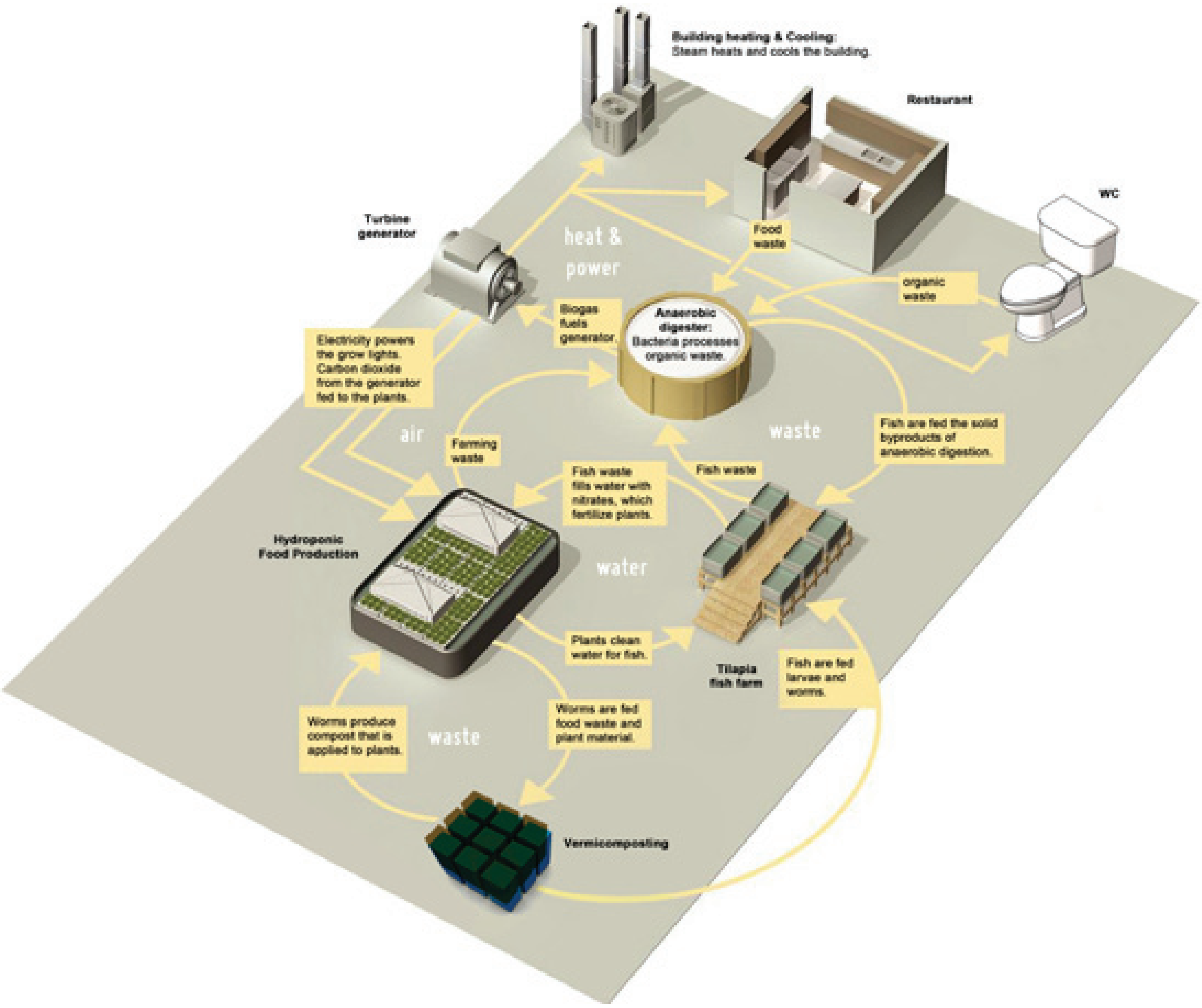

Figure 145: Anaerobic digester as key component to a zero-waste system.