

DESIGN CRITERIA

Group 10

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Table of Contents

<i>List of Prioritized Needs</i>	3
<i>Technical Benchmarking</i>	6
<i>Reflection on Client Meeting</i>	7
<i>References</i>	8

List of Prioritized Needs

Need	Functional and non-functional requirements, constraints, and metrics
Simple and Easy Maintenance	The client requires simple and easy maintenance for the greenhouse. That is, the design must be simple, be easy to learn, and contain no unnecessary dependencies besides plant maintenance. The simplicity of the design largely caters to how user-friendly the greenhouse is, and the largest constraint to that factor is the hydroponics system. If the hydroponics design is too complex and isn't easy to access, there will be difficulties for whichever assistant is tasked with maintaining it. The greenhouse should generally be open and should not contain any fixed or locked plant beds. If all plants are located on top of movable structures within the greenhouse, then any sort of arrangement of plants can be made and all areas of the greenhouse will be accessible for maintenance. The greenhouse should also be able to fit at least 2 people inside at once for efficient access and completion of maintenance.
Modular and Expandable	The client requires the greenhouse units to be modular and expandable therefore the panes that make up the walls of the units must be easily replaceable/removeable. They (the panes) also cannot be made out of any sort of plastic material as requested by the client. The way in which the panes interlock must ensure that the structure is stable, but they also need to be easy to put together so that the client may be to build/modify the units themselves. As requested by the client, attaching numerous units together should not require professional aid and should not take an unreasonable amount of time to do. The greenhouse units will measure approximately 6ft x 6ft (L x W).
Hydroponics system	The client requires that the hydroponics system has easy maintenance and repairability. Such means that it is easy for them to understand the system so that no outside help is needed unless under extreme circumstances. The material in which the system is constructed must be non-corrosive and durable. The system must be of a non-pollutant nature because the client has stated that they put a focus on being all-natural.
Animal Resistant	The client requires the greenhouse to be resistant to animals that might break in and consume the crops. The animals that are commonly seen in that area and that may pose any harm to the

	<p>crops are mostly small mammals such as rodents, possums, racoons and beavers. The greenhouse can remain free of mice and voles as long as there are not any fissures between the walls and the ground where they could sneak in. Securing the entrance of the greenhouse at ground level to avoid racoons, possums or rabbits inside can be easily achieved, by installing lockable doors.</p>
Weather Resistant	<p>The client required the greenhouse to be resistant for any weather conditions in that location. Harsh weather occurs mostly during the winter with heavy snowfalls and strong wind currents. The greenhouse must withstand the largest amount of snow precipitation during the winter as well as the highest winds. According to the Average Weather Year-Round in Ottawa website, the highest level of snow can reach up to 314 mm (1.02 ft). Multiplying that by the snow density (12.48 lbs/ft³), gives a value of 12.7 lb/ft² of snow that the greenhouse must be able to hold. Two options that can hold up to 15 lb/ft² of snow are proposed. From the same website we find that the fastest wind speed can reach up to 11.9 kilometers (7.4 miles) per hour. The same two greenhouse options mentioned before can resist wind velocities way faster than the stronger winds in Ottawa.</p>
Non-plastic material	<p>Some materials that replace plastic for building a greenhouse are aluminum, glass, polycarbonate and galvanized steel, just to mention a few. We can compare the pros and cons. Wood is not very practical due to the amount of water that would be used in the greenhouse, the wood would eventually rot. Aluminium is not very strong but the solution to that is to double up for strength, however they provide good rigid form for glass or polycarbonate panels. Galvanized steel will require less framing members which means fewer shadows are cast. It is more beneficial for commercial growers. Lastly, glass has the highest quality but the most expensive. It is also expensive which makes it difficult to install and requires more man power. Polycarbonate is lightweight and easy to work with. It also costs less. It can take decades but may take decades or centuries to.</p>
Easy access	<p>The client wants a greenhouse with easy access. Hence the spacing of the frames need to be big so the door is big enough. It should also be built in the most convenient location on the property that gives it easier access to other buildings.</p>
Low cost	<p>The materials that the greenhouse should be built with have to be</p>

	<p>at a low cost but appropriate for the clients requirements. For example, the watering system is going to cost more, and for it to be safe for children it must be supported with good material, and also the material should be weather friendly. All of these requirements are going to affect the cost.</p>
Safety for children	<p>One of the needs is to be children-safe, which means making an object safe for children—designed to prevent children from injuring themselves or doing damage. The first thing is that there must not be any lower panes of glass. Plastic would not be an ideal manufacturing material, because it is not weather-friendly, but plexiglass is ideal manufacturing materia. A second thing might be putting a barrier between the pathway and the plants. This barrier could be like a plastic curtain with a zipper to prevent the children from falling directly on the plants.</p>

Technical Benchmarking

Specifications (down) Greenhouse Name (right)	Wayfair	Delightful Yard	Reno
Simple and Easy Maintenance (5)	Yes	Yes, "maintenance free"	Yes. However, has the least amount of space, less people will be able to enter at a time
Modular and Expandable (4)	Not likely. Based on the design, there may be room to disassemble and expand	No	No
Hydroponics System (4)	Watering system	No	No
Animal Resistant (3)	Yes	Yes	Yes
Weather Resistant (3)	Can hold up to 15 lb/ft ² of snow, wind resistance of 52 mph, mounting/anchor system	Can hold up to 15 lb/ft ² of snow, wind resistance of 56 mph	Yes
Non-Plastic Material (3)	Polycarbonate	Polycarbonate	Polycarbonate
Low Cost (2)	\$903.99	\$1299.00	\$1143
Safe for Children (2)	0.16mm panes with large surface area	0.7mm panes, small surface area, with diagonal supports	Diagonal supports
Easy Access (for 5'0 to 5'5") (1)	6.17' W x 8.17' D x 6.25' H	6' W x 7' H x 8' D	6.2-ft D x 6.3-ft W x 6.6-ft H, might be crowded

Reflection on Client Meeting

After the client meeting, many new considerations and concerns were addressed. Originally in our greenhouse design, we did not consider the fact that many locations may need to be assisted. The grow wall and the clients home became new additions to the design process, and required a shift in thinking. We needed to be able to consider the constraints on each location and make the appropriate changes to the greenhouse design. Ultimately, we decided to make a general design for the greenhouse consisting of identical size and structure similar to connecting parts in an Ikea set. Additionally, we did not consider children's safety in the first draft; we weren't aware that a greenhouse would be situated at a school location. As such, we needed to consider what parts of the greenhouse could cause injury or could be easily breakable. Animal resistance was also another feature that wasn't taken into account at first. However, not much needs to be changed for this feature. We just need to ensure that our design is structurally intact, has no soft materials at the exterior, and needs to have only a few, select openings from which people can enter (no small openings for squirrels or other small animals to enter). In conclusion, the client meeting was very valuable to our design process as we were able to gather an idea of what specific metrics and design features would benefit or constrain the client and users of the greenhouse.

References

Technical Benchmarking Resources:

Wayfair 6.17' W x 8.17' D Heavy Duty Greenhouse

<https://www.wayfair.ca/outdoor/pdp/julys-song-617-w-x-817-d-heavy-duty-greenhouse-bl-ys1004.html>

Hybrid polycarbonate greenhouse 6 x 8 ft grey frame

https://delightfulyard.com/products/hybrid-polycarbonate-greenhouse-6-x-8-ft-grey-frame-palram-canopia?currency=CAD&variant=40665818202261&utm_medium=cpc&utm_source=google&utm_campaign=Google%20Shopping#specifications

Reno outsunny 6.2-ft L x 6.3-ft W x 6.6-ft H greenhouse

https://www.renopot.com/en/outsunny-62-ft-l-x-63-ft-w-x-66-ft-h-greenhouse-845-058-330928760?viewStore=76050&cm_mmc=organic_search_-google_-gmb_-instore&utm_medium=organic_search&utm_source=google&utm_campaign=gmb&utm_content=instore

Climate and Average Weather year round in Ottawa

<https://weatherspark.com/s/23201/3/Average-Winter-Weather-in-Ottawa-Canada>

Snow density

<https://www.sciencelearn.org.nz/resources/1391-snow-and-ice-density>

Mammals of Ottawa's greenbelt (location of the farm)

https://www.inaturalist.org/check_lists/10672-Ottawa-Greenbelt-Check-List?iconic_taxon=40151