UBC Botanical Garden
Conceptual Redevelopment

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University of British Columbia

CIVL 445

November 28, 2013

Letter of Transmittal

UBC Botanical Gardens
6804 SW Marine Drive
Vancouver, BC, V6T 1Z4

APEX Design Services
CIVL445 – Team 14
Civil and Mechanical Engineering Building
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November 28, 2013

RE: UBC Botanical Garden Conceptual Redevelopment

In response to the call for concept development for the UBC Botanical Gardens, APEX is pleased to submit the attached report summarizing our analysis and recommendations.

The report begins with project background, scope and the identification of areas for improvement in the Garden. A mission statement for the concept is formed, and development components are targeted to best meet our goals. The components are expanded upon individually and ranked respective to each other and our mission statement. The report contains simple calculations necessary for conceptual design, and some preliminary cost estimates.

Thank you for the opportunity to take on this interesting project. For any further information or clarification please contact the undersigned. **Total Number of Submitted Pages: 40**

Sincerely,

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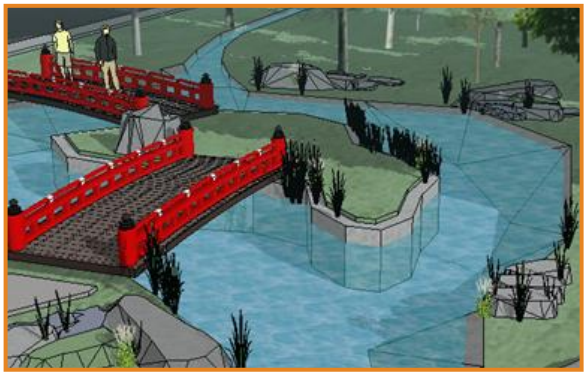

ubcbotanicalgarden
& centre for plant research
AT THE UNIVERSITY OF BRITISH COLUMBIA

UBC Botanical Garden

Conceptual Redevelopment

CIVL445 – Team 14

To provide multi-functional development concepts that enhance and display the Garden's collection while promoting education, public awareness and revenue generation.

Executive Summary

The UBC Botanical Garden, located on the south-west side of the UBC Vancouver campus, holds a nationally recognized collection of plants for research and display. It is in the Gardens' interest to attract more visitors and researchers to the 30 hectare green space, and APEX has been contacted to develop a concept for the revitalization of this historic Vancouver site.

Our Mission Statement for this project:

> *APEX will provide multi-functional development concepts that enhance and display the Garden's collection while promoting education, public awareness and revenue generation.*

The proposed development is concentrated to the north-west corner of the Gardens near the entrance. The following components are proposed for the development:

- Multi-purpose Learning Center is proposed to support the Gardens' research and academic efforts, while providing revenue opportunities through publicly offered courses and seminars, as well as the Gardens' first on-site cafe. The Learning Center will also incorporate a laboratory and classroom for students and faculty. Estimated $5.1M.

- Stormwater Detention Pond, supplied from the outfall on the north end of the site, containing native plants and fish will be located near the entrance. The pond will double as a storm water retention structure and containers will be buried to store and distribute captured runoff for use throughout the Gardens. Estimated $6m^3/s$ flow during large storm events, 4.3m depth required for storage.

- Biodome for public display and showcasing to draw more visitors to the garden, located on the south-east corner of SW Marine Drive and Stadium Road (highly visible for UBC traffic). Estimated $3.7M.

- Additional Components such as an entrance arch and gate, improved signage, landscaping, a pedestrian overpass, and programming options were considered.

The recommended components are given ranks based on merit and phasing based on funding.

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1. Project Background

Students have recognized the peaceful atmosphere at the UBC Botanical Garden as a great place for a relaxing walk for many years. UBC Botanical Garden was established in 1916 with 900 species of plants. By the late 1930s, the Botanical Garden included significant world-class collections of British Columbia native plants, such as willows, alpines, aquatics and medicinal herbs. It also features BC native exotic trees, such as magnolia, sorbus, and rhododendron. Many comprehensive educational programs, teaching programs and public outreach events are supported and conducted in the garden. By carefully reviewing the facilities within the garden, people realized that many systems were inefficiently utilized. A diverse stakeholder community has an interest to redevelop the garden area and expects that the redevelopment of the garden will integrate economic, social values with environmental values.

This project is intended to give opportunity to integrate and attain knowledge within a complex context. During this capstone design course, the whole project is accomplished within a design group of five to six members while responding the assigned tasks. All site information and requirements are available. In addition, weekly plenary sessions and review meetings are made to provide comprehensive assistance.

2. Scope

The scope of work includes review of existing components in the Garden, and through consultation with the UBCBG executive staff, the identification of areas in need of improvement. Once the problems were identified, a Mission Statement was formulated to address the most crucial issues. Goals, referred to as Concept Visions, were created to target the main themes outlined in the Mission Statement and several development concepts were considered. The concepts with the highest potential to satisfy the Concept Visions and Mission Statement were selected for further investigation and conceptual designs were developed.

2.1 Problem Identification

The UBCBG Mission Statement highlights the importance of maintaining and expanding their plant collection for research, conservation, education, public outreach and display. The goals of the Garden were used as the context to begin searching for areas in need of improvement.

In terms of research and education, the weather in Vancouver can make it difficult to maintain a robust supply of plants year-round. Indoor growing spaces would keep the Garden's research efforts productive during all seasons. Laboratories and classrooms may encourage UBC to investigate new programs for students, with the potential to appeal to the UBC Board of Governors for funding. Seasonal variation in visitors to the Garden hurts revenue – indoor spaces for display, education and conservation are in-line with the Garden's goals and will attract visitors year-round. Public outreach and awareness are also important to attract more people to the Garden and a landmarking structure would make an effective advertisement. New and attractive exhibits should be located throughout the Garden to encourage the movement (circulation) of visitors within the site. This circulation needs to be accessible and must be supported by safe and enjoyable infrastructure. Pulling visitors to the Garden will help generate revenue, but this could be supplemented by renting property to a commercial retailer or service provider, such as a café franchise. Finally, a sustainable approach to stormwater management must be adopted. The use of potable water for ponds and irrigation is unnecessary, and utilizing the stormwater from the UBC catchment would be in line with UBC's sustainable infrastructure initiatives.

Through consultation with the UBCBG executive staff, review of existing components and the goals of the Garden, APEX has summarized the following areas for improvement:

- Facilities dedicated to horticulture research, including laboratory and classrooms available to UBC students;
- Additional rental facilities for hosting year-round events and programs;
- Landmarking structures to increase public awareness and attract visitors;
- New ways to expand and showcase the Garden's collection;
- Eliminate or reduce the use of potable water for ponds and irrigation;
- Circulation of visitors through "anchoring" attractions, accessibility;
- Revenue generation through leasing of property, programming and diversifying event hosting to appeal to new demographics.
- Multi-functional components to maximize utility year-round

2.2 Mission Statement

The areas for improvement must be met by an encompassing Mission Statement to deliver focussed and effective development concepts.

Our Mission Statement for this project:

APEX will provide multi-functional development concepts that enhance and display the Garden's collection while promoting education, public awareness and revenue generation.

2.3 Concept Visions

Our Mission Statement was formulated to meet the identified areas for improvement and 11 Concept Visions were created to guide concept development towards the Mission Statement. **Figure 1** shows a checklist for the development concepts that met the most Concept Visions.

Concept Vision Checklist	Multi-purpose Learning Center	Biodome	Retention Pond, Water Storage Containers and Stream	Pathways, Footbridges, Overpass	Programming Options
Attraction of visitors all year round	✓	✓			✓
Improvement of public accessibility and circulation				✓	
Improvement of visitor experience	✓	✓	✓	✓	✓
Enhancement of research and learning	✓	✓	✓		
Revenue generation	✓	✓			✓
Expansion of plant collection		✓	✓		
Inclusion of native animals			✓		
Improvement of aesthetics	✓	✓	✓	✓	
Integration of surface water to enhance the garden			✓		
Incorporation of sustainable materials and technology	✓	✓	✓	✓	
Increase public awareness of the Gardens	✓	✓		✓	✓

Figure 1 - Concept Vision Checklist

3. Proposed Components

3.1 Learning Centre

Figure 2 - Learning Centre Concept

3.1.1 Features

The proposed Multi-purpose Learning Centre will include several classrooms, a multi-purpose hall, and a horticultural laboratory. It will also feature a greenhouse on its balcony as well as a café on its main floor, which will be the first of its kind at the UBC Botanical Gardens. Students and Faculty can use the classrooms for lectures and guest presentations. The laboratory will contain up to date equipment and can be used by horticultural students and Botanical Garden staff. The multi-purpose hall located in the main floor of the Learning Centre may be rented out to the public for various special events, such as weddings and dinners. The greenhouse on the second floor may be utilized to showcase certain plants, or students can store different species of plants inside the greenhouse for research. Lastly, the café will contain a small kitchen and provide a place for guests, students, and staff to purchase food and refreshments. There will also be several tables and chairs so that guests can eat and relax after a tour of the garden.

Benefits of the Learning Centre include:

- Promotes and enhances Botany research and learning

- Revenue Generation
- Attracts visitors all year round
- Increase awareness of the Botanical Gardens

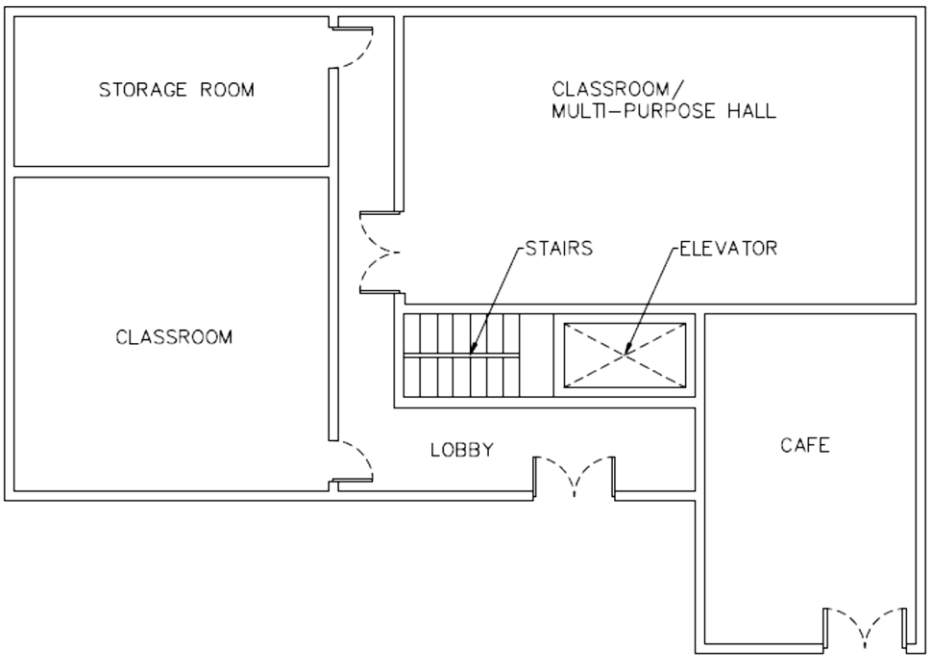

Figure 3 - Learning Centre Floor Plan - Ground Floor

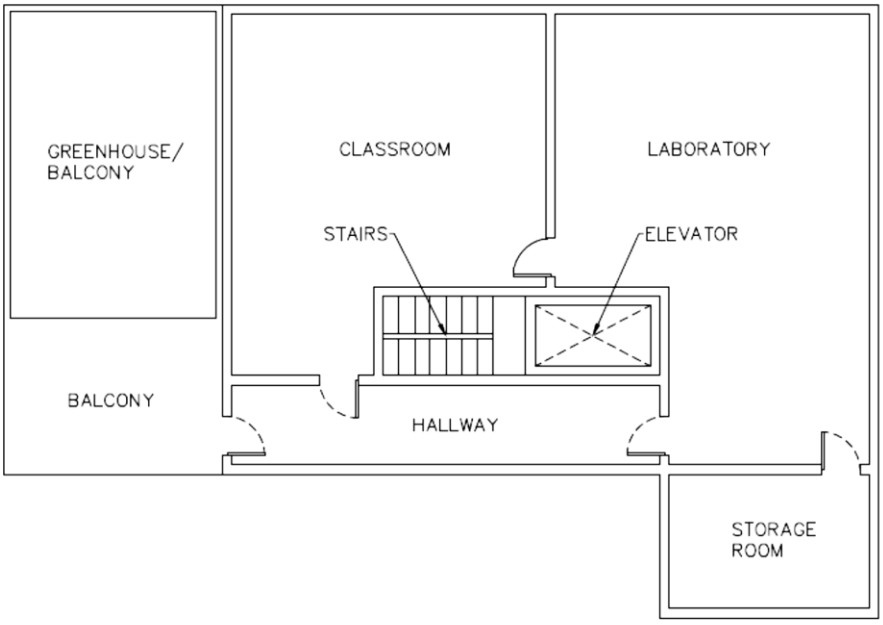

Figure 4 - Learning Centre Floor Plan - Second Floor

3.1.2 Sustainability

To meet UBC's sustainability goals, the Multi-purpose Learning Centre will be constructed to achieve a LEED Silver Certification. The building will incorporate the use of pine beetle infested timber as structural members and for the exterior of the building. The two floor slabs will be constructed using LEED mix concrete, which contains more fly ash to reduce the use of cement in concrete. This is a sustainable way of constructing concrete elements in a building because the production of cement emits CO_2 into the environment. The Learning Centre will also include a green roof. The green roof will be capable of retaining storm water and redirecting it to the greenhouse on the balcony. Instead of using potable water, the collected storm water can be used to irrigate the plants inside the greenhouse.

3.1.3 Education and Research

The Learning Centre fulfills various objectives set out in the mission statement. Incorporating classrooms and a laboratory in the design enhances horticultural education and research for students. These classrooms allow the UBC Botanical Gardens to have more space for lectures. More classrooms will also provide an adequate space for botanists in the industry to hold presentations and seminars in the Botanical Gardens property. The addition of a greenhouse on the balcony of the Learning Centre further promotes research because it gives students an opportunity to grow specific plants for examination in a controlled environment. UBC Botanical Garden Faculty can also use the facilities to advance their own research in their respective fields. In addition, since Vancouver's climate is optimal for growing plants, building a Learning Centre may attract professors and horticulturists from other Botanical Gardens and universities to carry out their research in UBC. The Learning Centre can provide a place and opportunity for other horticulturalists to complete their botany studies, and UBC botany students will benefit by being able to participate in the research. This could further improve UBC's reputation in botany and increase public awareness of the Botanical Gardens.

Figure 5 - Balcony Greenhouse Concept

3.1.4 Revenue Generation

The Learning Centre presents several opportunities for revenue generation for the Botanical Gardens. The café built into the Learning Centre has the possibility of generating a lot of revenue, especially since it will be the first establishment in the Botanical Gardens property to serve food and refreshments. To entice more guests to visit the café, it can serve lunch specials and specialty drinks, such as coffee and lattes made from coffee beans grown on the Gardens. Another way that the Botanical Gardens can earn a profit from the Learning Centre is to rent out its Multi-purpose Hall for special occasions like wedding receptions and themed dinners. Combined with the visual aesthetics that the Gardens provide, the Learning Centre has the potential to be a popular place for guests to rent. The café can also benefit from guest occupancy of the Multi-purpose Hall because more guests at the Learning Centre will result in more business for the café. Furthermore, UBC Botanical Gardens can hold gardening classes for the public at the Learning Centre. By providing public programs that regular visitors can enrol in, the Botanical Gardens can generate revenue not only from student courses but also from public courses. In addition, if professors and horticulturalists from other botanical gardens decide to carry out their research at UBC, it will lead to more revenue for the UBC Botanical Gardens.

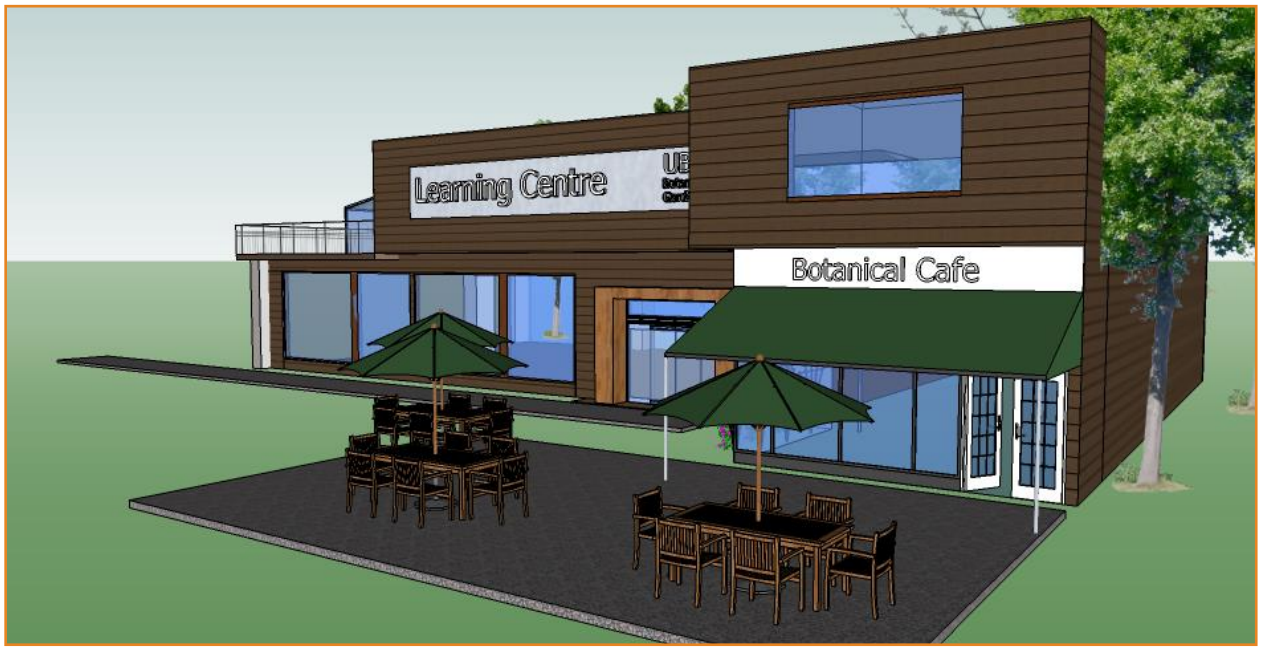

Figure 6 - Botanical Cafe Concept

3.1.5 Improved Visitor Experience

The UBC Botanical Gardens currently has problems attracting visitors in the winter. This is due to the lack of interest in guests to tour the Gardens when the weather is cold. A shortage of visitors in the winter can be resolved by developing the Multi-purpose Learning Centre. With the implementation of horticulture or gardening programs that will be made available to the public, guests and local botany enthusiasts have incentive to visit the Botanical Gardens during winter. Since the Learning Centre will have a greenhouse on its balcony, UBC can showcase their plants inside the greenhouse for visitors to view as well. The addition of a café to the Learning Centre also improves visitor experience because they can enjoy snacks and refreshments purchased from the café while they tour the Botanical Gardens. The construction of a Multi-purpose Learning Centre can give the UBC Botanical Gardens the ability to attract guests all year round, which will also lead to an increase in revenue, and improve visitor experience.

3.1.6 Cost vs. Benefits

To get a cost estimate of the Muilt-purpose Learning Centre, the Wayne & William White Engineering Design Centre (EDC) was used as a reference building. The EDC was completed in 2011, and the Learning Centre will start construction in 2015. Similar to the proposed location for the Learning Centre, the EDC is located on the UBC Vancouver Campus. The Learning Centre and the EDC also have similar purposes and functions, which is to be a multi-purpose building for student learning. Because of its location and function, the EDC is a good

comparison to obtain a cost estimate of the Learning Centre. Various factors were used in the cost estimate to account for the different sizes of the two buildings and for the inflation rate from 2011 to 2015. In addition, because the Learning Centre is designed to achieve a LEED Silver Certification, a 20% contingency was included in the cost estimate to account for the difficulty in procuring the sustainable construction materials such as pine beetle wood. The final cost estimate for the Learning Centre is $5,100,000. The potential benefits that the Learning Centre can provide to the UBC Botanical Gardens outweigh the cost of the building. The Learning Centre will allow the Botanical Gardens to generate more revenue, even during the winter, which is one of the staff's concerns. The Learning Centre will further promote botany research and learning, and subsequently, increase the public awareness of the Botanical Gardens. It can also attract botanists from other botanical gardens to carry out their research at UBC. In addition, to satisfy UBC's sustainability goals, the Learning Centre is designed to be sustainable through the use of a green roof and environmentally-friendly construction materials.

3.2 Biodome

One of the redevelopment components proposed for UBCBG is a geodesic Biodome structure. A Biodome is an enclosed atmosphere that tries to recreate the natural existing biomes. The type of biomes which can exist in a region is greatly dependent on its climate and geography. Major biomes include deserts, forests, grasslands, tundra, and several types of aquatic environments. For the case of UBCBG, the Biodome will serve as a greenhouse for multipurpose uses, such as for public display and showcasing to draw more visitors, expansion of the garden's collections, as well as enhancing research capacity and providing shelter to sensitive plants in their off-seasons.

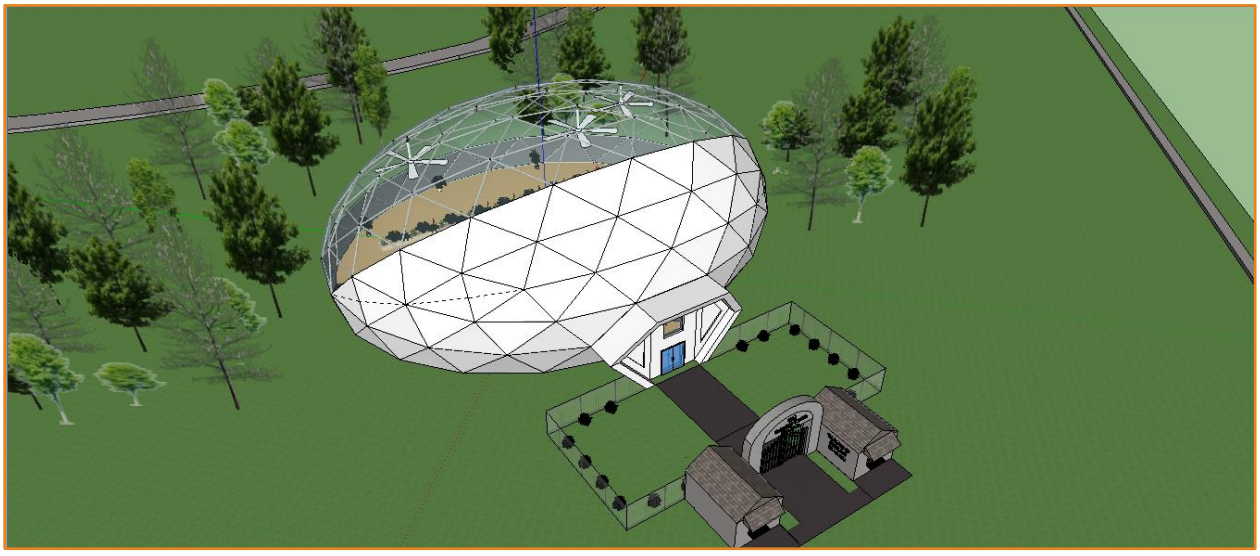

Figure 7 - Biodome Concept

3.2.1 Conceptual Design

The Biodome's diameter will be approximately 25 meters, and the estimated floor area will be 500 square meters. The Biodome will be a geodesic dome consist of several triangles made by steel trusses connected together, enclosed by glass. **Figure 8** below displays how the proposed Biodome looks like from the back view, where the front gate is facing towards SW Marine Dr. The construction of Biodome involves expertises in multidisciplinary areas in Civil Engineering, including structural, geotechnical, construction and project management, as well as environmental.

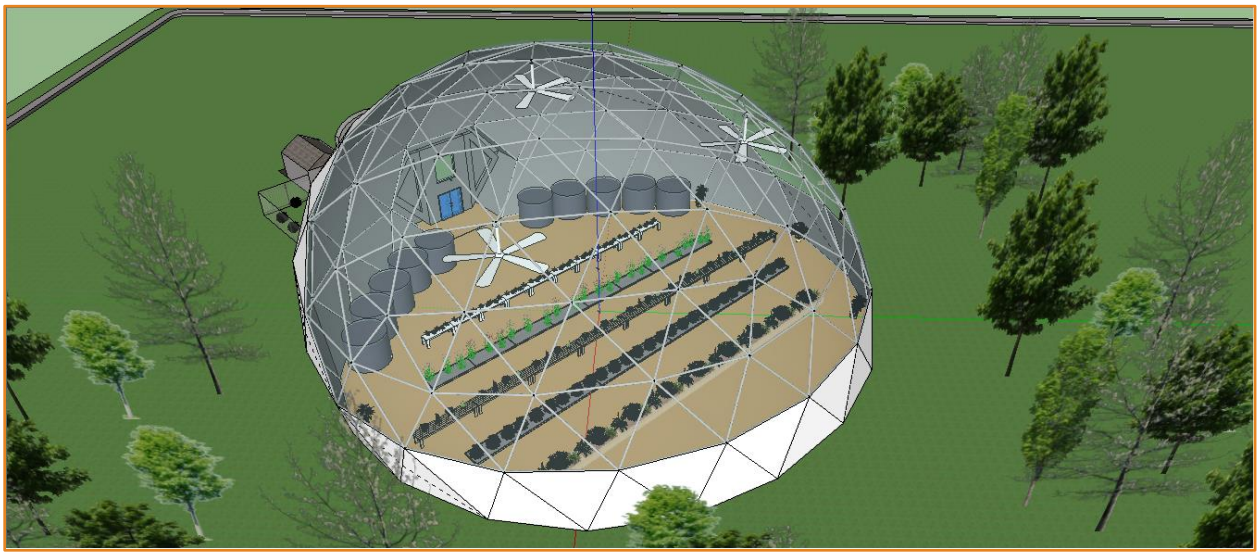

Figure 8 - Biodome Concept, Back View

3.2.2 Visitor Attraction and Landmarking

The incorporation of a biodome in UBCBG can increase the visitor attraction to the garden. The Biodome is proposed to be located at the undeveloped area on the south-east corner of SW Marine Drive and Stadium Road, which is highly visible to passing by traffic. **Figure 9** shows the proposed location of the Biodome. The Biodome will be designed as a landmark or an "anchor" structure for the Garden, being a massive structure drawing attention from passing by traffic. It is also desired that the unique structural display of the dome, as well as the extensive collections of plants in the dome, will improve the aesthetics of the area, adding favor to the visitors' touring experience, and improving public outreach and awareness of the Garden.

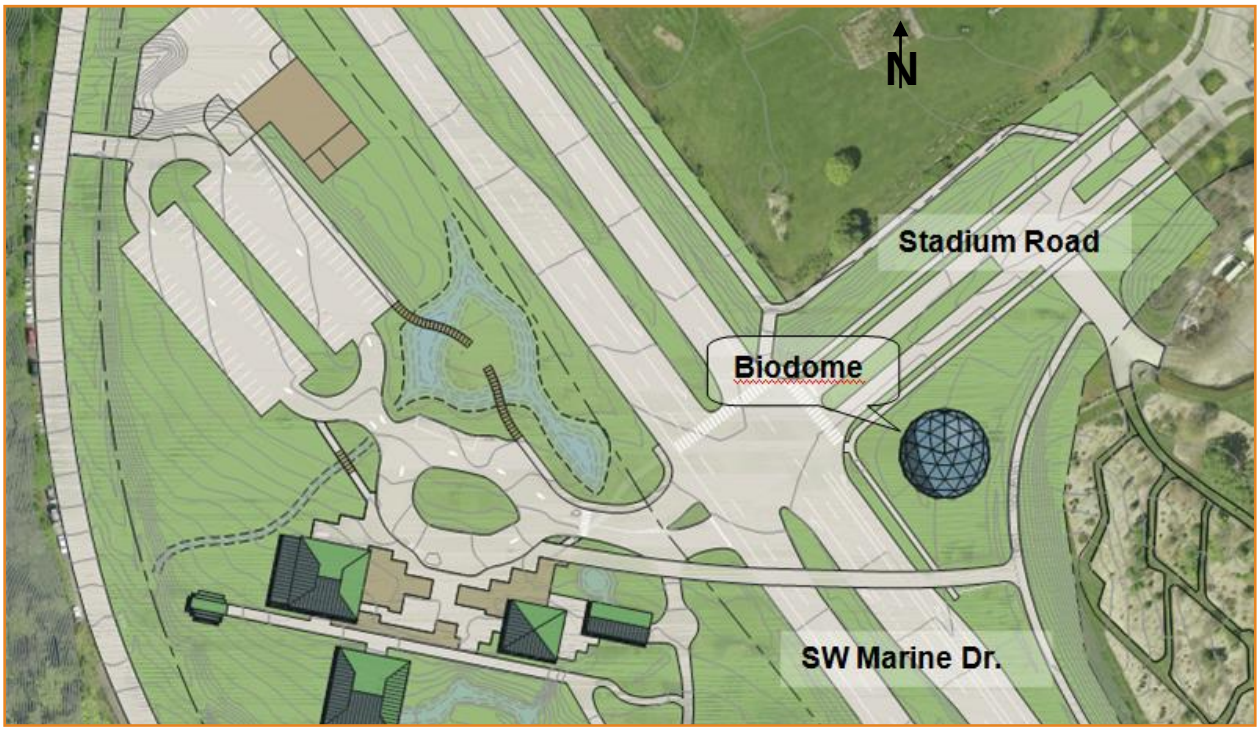

Figure 9 - Biodome Location

3.2.3 Revenue Generation

One of the challenges UBCBG encounters is budget distribution and constraints. The Garden is currently operating under a tight budget, and it is in the client's interest to have a revenue generator redevelopment. Seasonal variations have an impact on the visitor flows to the Garden, which hurts the Garden's revenue. The Biodome will be an indoor, public showcasing structure, which can be available to visitors all year round. This will be able to contribute to revenue generation, even during the off-seasons. The Biodome will provide an enclosed indoor touring space for visitors, with a possibility of hosting events such as exhibition shows and attract visitors from all ages.

3.2.4 Expansion of the Plant Collection

In many botanical gardens, plants and species collection is usually what identifies the garden. It was also in the UBCBG executives' interest that the Garden's first priority be put on the collections of the Garden, with a desire to draw more attention to the garden. The weather in Vancouver does not allow a diversity of supply of plants year-round. A closed, indoor ecological system will provide growing environment which can feature non-native plants in a tropical environment or several separate environments. In addition, the structure also provides shelter to

tender plants that needs protection in the winter, or in environments they are sensitive to and difficult to survive.

3.2.5 Research and Learning

As mentioned in previous section, the Biodome is able to expand UBCBG's plant collections. The diversity of plant supply for research can further enhance the research capacity of UBCBG to possess a more variety of plant collections and conduct research for non-native plants onsite. Furthermore, scheduled tour inside the Biodome can be implemented for school groups to have learning and teaching sessions. Exhibition shows featuring different collections can also be planed for educational purposes.

3.2.6 Incorporation of Sustainable Materials and Technology

The building materials for the Biodome will be mostly steel and small amount of concrete relatively. Materials will be chosen based on their sustainability, and the structure will include recycled materials from building demolitions for back-filling of the site and steel. Furthermore, the Biodome will be constructed to obtain LEED Silver certification to meet UBC's sustainability goals. A hybrid of passive and active mechanical systems will be designed to minimize energy uses. Depending on the type of biomes atmospheres the client wants to recreate, the energy usage will be greatly affected. Nevertheless, the glass envelop enclosing the Biodome can work to reduce heating and cooling in winter and summer. Careful design considerations on sustainability will be taken into account for the proposed Biodome.

3.2.7 Accessibility

The accessibility to the Biodome is also a concern in the design criteria. The Biodome is proposed to be built on the undeveloped south-east corner of SW Marine Drive and Stadium Road for the purpose of capturing passing by traffic attention and making use of that undeveloped corner. This poses some challenges for accessing the Biodome since it's located on the other side of the entrance, and for the current Garden configuration, one would need to cross the SW Marine Dr. in order to get to the other side from entrance. This will not be very convenient due to the traffic volume and high speed travelling vehicles on SW Marine Dr. It is proposed in this conceptual redevelopment that in the long term, if the budget allows, a pedestrian overpass to be built across SW Marine Dr. from the main entrance to the undeveloped corner at the south-east side. Another issue of concern is that since the Biodome will be a separate structure on the other side of the entrance, additional staff for separate admission and security purpose may be required. To minimize the additional labour required, it

is suggested that during weekdays or the off-seasons, tours inside the Biodome be scheduled at certain hours of the day and a staff member will guide the visitors from main entrance to the Biodome. The Biodome be opened only during the scheduled tour period, so that no staff need to be present at the Biodome gate at all time. During weekends or busy seasons, a staff member may be required to stay at the Biodome gate at all time and visitors can pay for admission from the gate.

3.2.8 Preliminary Cost Estimate

The preliminary cost of constructing the Biodome is estimated to be approximately $3.7 million dollars. The cost is estimated based from a reference building, the Bloedel Conservatory located in Queen Elizabeth Park in Vancouver. The Biodome proposed in this conceptual redevelopment plan is similar to the Bloedel Conservatory in structure as a closed ecological system. The Bloedel Conservation is larger in size, with a diameter of 42 meters and floor area of 1430 square meters. The cost were adjusted considering size, location, time and inflation factors in accordance to R.S. means Construction Cost Estimating Method and Square Footage Method. Since the Bloedel Conservatory was constructed in 1969, a higher percentage of contingency is introduced to account for the longer time adjustment. A more detailed preliminary cost estimate of the Biodome can be seen in Appendix B. Even though there will be costs associated with the Biodome conceptual design, including construction cost, operation and maintenance cost, as well as contingency throughout the building's life cycle, the benefits from the Biodome, as mentioned and discussed in the previous sections, will be able to outweigh the costs and contribute to the Garden greatly in the long run.

3.3 Stormwater Retention System

Storm water retention pond is one of the most important design components in this project. Retention ponds are used to maintain a relatively constant amount of water in addition to detaining stormwater. Since the existing pond at the entrance of UBC botanical Garden is not fully utilized and is not functioning properly, the incorporation of a pond in the redevelopment area is certainly needed and the pond would become a great feature in the UBC garden. See **Figure 10** for the location of the proposed pond near the entrance.

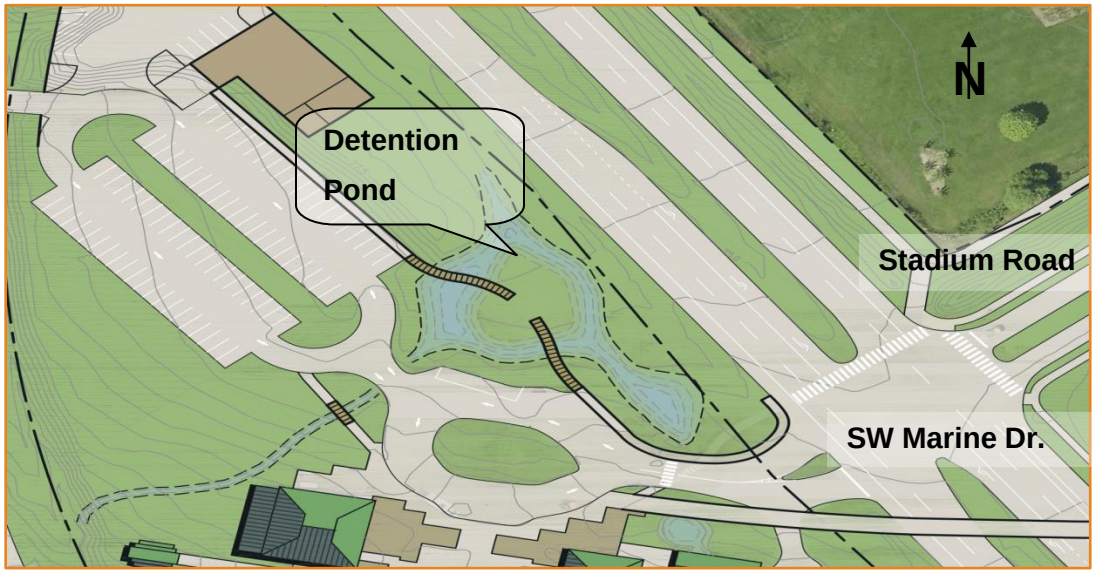

Figure 10 - Stormwater Detention Pond Location

3.3.1 Design Goals

Stormwater Retention System will divert stormwater from the north end of the site. The pond will function as a storm water retention structure and containers will be buried to store and distribute captured runoff for use throughout the Gardens. The pond will also contain native plants and fish. There are many advantages of having a retention pond. The pond collects the stormwater periodically and releases most of the excess water over a period of days, slowly returning to its normal depth of water.

- Improvement of Storm water management;
- Improvement of surface water to enhance the garden;
- Integration of biodiversity, provides space to grow aquatic plants for research;
- Improvement of visitors touring experience;
- Landscape improvement;

- Potential fire protection;
- Gravitational settling of suspended particulates;
- Biological uptake of pollutants by plants;
- Decomposition of some pollutants.

3.3.2 Conceptual Design

Based on the landscape layout and contour map of the redevelopment area, a rough conceptual design of the proposed retention pond is created. In order to make use of the existing pond, it has been decided to modify it and add more components to it to create a new multi-functional pond.

Figure 11 - Detention Pond Concept

The pond is reconfigured to have two wood bridges for visitors to walk on and a little island is added in the center of the pond for aesthetic purpose. The bridges are used to connect SW Marine Drive with the entrance of the garden. It would be good to include some plants around the edge of the pond since the pond is one of the display features in the garden.

Also, flow schematic for the redevelopment area is developed. After examining the contour map, it is found that the elevation is the lowest at the NW concern of the area, thus a pump installed at the NW concern would be a good idea to divert the water from the north end of the site. To

ensure the storm water will go to the pump and the retention pond, it is necessary to install pipe buried underground. When the pond is about to reach its max capacity, the excess water will be diverted through buried pipe to the collection tank for other use. Also, an overflow diversion can also be helpful to remove excess storm water to ditch.

It has come to concern that the storm water collected from north side of the site may have huge momentum due to pumping. Thus, in order to protect pipe and the pump, it is essential to install energy dissipation structures through the storm water system. Such structure can be installed around the pump and at the inlet of the retention pump.

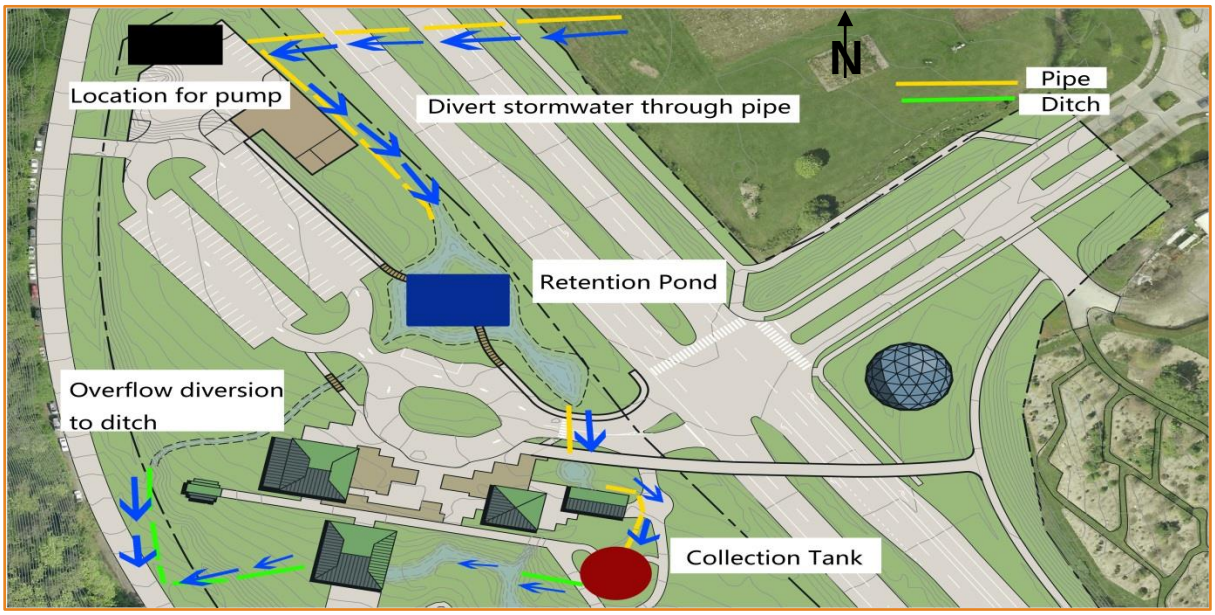

Figure 12 - Flow Diversion Schematic

Capacity and Size Estimation

To design a pond, it is needed to consider the estimated storm runoff and drainage path, taken into account the capacity of the pond; thereafter the approximate size and depth of pond can be determined. In addition, the ground soil condition also needs to be considered for digging the pond and building retaining wall for the pond. This would require some geotechnical work on assessing the soil properties and calculating soil strength.

The approximate excess runoff of the redevelopment area based on UBC IDF (intensity-Duration-Frequency curve) is calculated and the approximate depth of the retention pond is obtained from calculation. Refer to **Figure 13** for the IDF curve. Assume 100-year flood to be conservative, the peak flow can be calculated by Rational Method using equation:

$$Q = CiA/360$$

Where Q is the peak flowrate, C is a dimensionless runoff coefficient, i is the rainfall intensity, and A is the contributing catchment area.

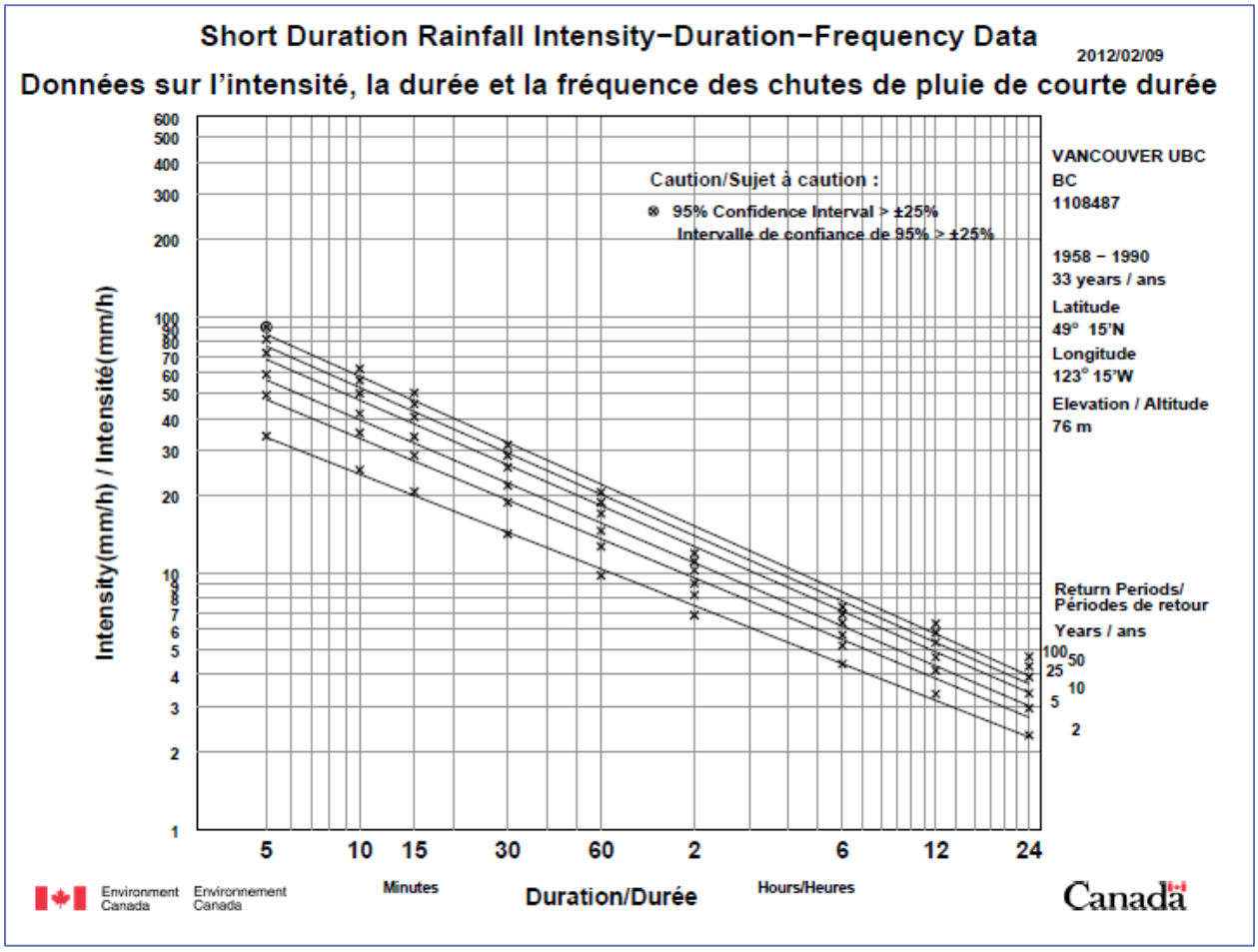

Figure 13 - UBC IDF Curve, Environment Canada

Assume the area of redevelopment area is grass/urban type of land, thus, C=0.65. Catchment area = 0.56km^2 = 56acres (from UBC Infrastructure Development). Rainfall intensity i = 60mm/hr (conservative assumption) from a 100 year 10 minute duration storm event.

$$Q = 56(0.65)(60)/360 = \mathbf{6.07 m^3/s}$$

For the pond to adequately handle all the incoming flow from a 100 year 10 minute storm event, the depth of the pond should be known. Pond storge needed can be calculated by:

$$\text{Volume of stormwater} = (6.07 m^3/s \text{ flow})(10 \text{ minute storm})(60 \text{ seconds/minute}) = \mathbf{3640 m^3}$$

Assuming the area of pond to be 850m^2, from the proposed site plan, the depth of the pond required will be:

$$Depth\ of\ pond = 3640m^3/850m^2 = \mathbf{4.28m}$$

3.3.2 Stormwater Treatment

The retention pond helps reduce frequent large stormwater discharges from the north end of the site. Peak flows are delayed because the pond is likely to have a large volume capacity. Also, the retention pond will help to provide storm water treatment such as gravitational settling of suspended particulates and decomposition of pollutants. It has been proven that retention ponds provide more effective pollutant removal than other stormwater management devices. **Table 1** shows the general capacity of retention pond to remove pollutants.

Table 1 – Stormwater Treatment Performance of Detention Pond

Pollutants	Removal Capacity
Nutrients	
Phosphorus	*Moderate to High*
Nitrogen	*Moderate*
Sediment	
Suspended Solids	*High*
Metals	
Lead	*High*
Zinc	*Moderate*
Organics	
Biochemical Oxygen Demand	*Moderate*
Oils	
Oils and Greases (petroleum)	*High*
Bacteria	
Present on solids	*High*

3.3.3 Irrigation

A collection tank is installed at the south corner of the site for storing excess water from the pond. As the retention pond reaches its maximum capacity, the excess water will be directed through the pipes buried under ground to the collection tank, then distributed to the southern garden exhibits.

3.3.4 Biodiversity

One of the important features with the retention pond is to increase the variation of life forms. Landscaping with such pond and different varieties of plants can add to the environment. Featuring the pond with different plants around the edge and with fishes in the pond will certainly increase variety of life in the ecosystem in the garden.

Planting trees around the pond for birds is also a way to increase the biodiversity. To attract visitors, it is also a good idea to provide nesting, roosting and supplementary feeding for birds.

Possible plants around pond for increasing biodiversity:

- *Acer* (maples) from Asia and North America;
- *Magnolia* from Asia and North America;
- *Rhododendron* from Asia and North America;
- *Clematis* from Asia.

3.3.5 Improved Touring Experience

Another purpose of the design of the retention pond and the bridges is to make this area a beautiful place to take photos so that visitors would like to take photos at the site before they leave the garden.

3.4 Accessibility

The visitor accessibility and circulation throughout the UBC Botanical Gardens has been discussed as an area requiring further improvements. The proposed upgrades to the existing infrastructure will enhance visitor experience, improve circulation throughout the garden space, and provide a safe and enjoyable passage to each of the proposed exhibits. The following sections are intended to provide information regarding the existing conditions found within the Gardens and discuss the proposed improvements in order to the address each of these areas of concern.

3.4.1 Existing Visitor Circulation & Parking Environment

Visitor Access and Circulation

The Botanical Gardens consists of several separate and independent sites located on the UBC campus. The two main areas open to the public and under review for redevelopment are the main gardens located to the west of S.W. Marine Drive, and the accompanying gardens located to the east.

Areas of concern associated with access of the site include the entrance to the UBC Botanical Gardens and parking area. Entry to the main Garden area is not highly visible from the road and creates the impression that the facilities are used for UBC operations and not intended for public use. The entrance also provides minimal attractions to grab the public's attention.

Visitor circulation throughout the Garden has also been suggested as an area requiring further improvement. For visitors to view the entire garden display they must travel a significant distance from the main entrance to reach the facilities and displays located on the easterly portion of the lot. When exiting the Gardens, visitors are required to backtrack through the underpass in order to return the main parking lot. The current arrangement imposes a segregated viewing experience and makes it less desirable to access the various facilities and displays located on the extents of the Garden. Wheelchair accessibility is also considered an area of concern due to inadequate accommodations.

Parking

The current parking infrastructure can accommodate 83 personal vehicles (including 2 handicapped stalls), parking for a full-sized bus, and parking for a smaller shuttle vehicle. Additional parking can also be acquired along Old Marine Drive, however the road is maintained and operated under Metro Vancouver and is not considered under the locality of UBC's

operations. The Gardens' parking lot is not equipped with any accompanying sidewalks to provide passage to the admittance and other facilities, except for a short wheelchair access at the west end.

During large events or during peak hours of operation the parking lot reaches its maximum capacity; requiring visitors to find alternate locations to park. Other than the available space along Old Marine Drive there is minimal overflow parking within close proximity to the Gardens, subsequently making large events difficult to accommodate. Currently there is a shuttle service that operates during larger events which transports passengers from the parking structures found within the UBC campus.

3.4.2 Proposed Components & Improvements

The following components and provisions have been proposed in order to enhance the following features:

- Public foot traffic and wheelchair accessibility;
- Visitor experience;
- Aesthetics;
- Entry signage; and
- Increased visitor parking.

Refer to **Appendix A** in order to reference the schematic of each of the proposed component listed below.

Walking Path and Footbridge

A walking path has been proposed along the entrance and parking area in order to link the Multi-purpose Learning Center from the upper portion of the parking lot to the admittance and accompanying facilities. The pathway will allow for a safer passage through the entrance roadway and will also accommodate wheelchair accessibility. In addition, information signage will be incorporated along the pathway to educate and engage visitors on various topics. The UBC Botanical Gardens and surrounding area has a diverse and unique ecological habitat, thus providing information panels will make the experience more informative and enjoyable. Topics may include: aquatic and bird habitats, unique species of plants featured in the area, hydrological cycle and use of the proposed retention pond, and history of the UBC area and Botanical Gardens.

In order to enhance aesthetics at the main entrance and to provide additional attractions, a footbridge has also been proposed which will be incorporated with the proposed walking path. The footbridge will consist of two individual spans which will extend across the proposed retention pond and join up with a central island. The design features will include an arched bridge design with a unique roof structure intended to enhance visual appeal of the entrance and parking area. **Figures 14 & 15** below provide the anticipated conceptual look of the pedestrian footbridges. Materials expected for the design of the bridge may feature cambered glulam beams and reclaimed pine beetle infested wood for the decking, roofing, and other non-structural elements. The materials should be locally sourced for environmental considerations.

Figure 14 - Maistatt Bridge (Schladming, Austria)

Figure 15 - Pedestrian Bridge (Pirkach, Austria)

Entry Sign & Gate

Appropriate signage near the entrance has been proposed in order to advertise and increase public awareness of the Garden. Incorporating a distinctive gated entry will also enhance the visual impact to the entrance.

Additional Parking

Improving the parking capacity has also been proposed in order to accommodate the anticipated increase in visitors to the Gardens. The proposed Multi-purpose Learning Center will also require additional parking in order to accommodate staff and intended occupants, as well as the passage of vehicles required for the operation of the facility. The diversion of the existing stream intended to supply the proposed retention pond will no longer occupy the drainage path along Old Marine Drive; therefore the area north of the proposed Multi-purpose Learning Center is ideal for redevelopment in order to accommodate additional parking. The proposed parking lot will occupy an area of approximately 1000 m^2 and will allow for 25 additional parking stalls. Subsequently however, development will require the removal of existing trees and vegetation

occupying this area. Earthworks will also be required to excavate approximately 2500 m³ of fill and re-grading of the embankment.

Providing additional parking in excess of the proposed parking addition will ultimately take away from the natural landscape and appearance of the surrounding area. In order to accommodate large groups of visitors for the various events held at the Gardens, using the existing shuttle service is the most practical option.

Overpass Structure

The overpass structure is intended for future implementation once it has been proven economically viable to construct of the pedestrian overpass. The proposed structure is intended to improve the visitor circulation throughout the Gardens such that visitors can enter either section of the Garden after admittance. This will also allow for direct access to the proposed Biodome and existing Amphitheatre and Garden Pavilion facilities. The proposed alignment for the overpass will begin near the main entrance and exit near the proposed Biodome structure. **Figures 16 & 17** below provide the anticipated conceptual look for the overpass structure.

Figure 16 - Griffiths Pedestrian Overpass (Burnaby, BC)

Figure 17 - Winston Pedestrian Overpass (Burnaby, BC)

3.5 Programming Options

The UBC Botanical Gardens is less known to the general public outside of the UBC campus area. This may be attributed to its isolated location at UBC and its use tailored more specifically towards a certain demographic. In order to attract more visitors to the Gardens, several programming options have been drafted with the expectation of increasing public awareness, encouraging varied demographics, and increasing revenue generation. Implementation of these

programming options does not require any additional infrastructure and therefore can be easily implemented in yearly event planning.

3.5.1 Fireworks Display

A fireworks display is unique opportunity to draw in large crowds of people from all ages to make use of the Gardens. A similar attraction is held at the Butchart Gardens in Victoria, B.C. and is considered to be the Gardens' more popular activity. Incorporating this event would create a fun atmosphere for the public while also acting as a marketing tool to increase public awareness for the Garden. A suggested location to host the fireworks display would involve having the visitors view the show from the eastern Great Lawn area while operating the fireworks from the western region of the Garden.

3.5.2 Photography Competition

Hosting a photography competition would be a great opportunity for the general public and students to get involved with and to view the Gardens throughout the year. The photographs could subsequently be used as a marketing tool to promote the Gardens by displaying the winning photographs on the website or publicly displaying them at the Gardens' facilities.

3.5.3 Beer & Wine Tasting

An event hosted by either local breweries or wineries to have a social event held at the Gardens. This event is a great opportunity to broaden the current demographics such that it encourages people who would not normally view the Gardens to visit the area. This event could be hosted either indoors or out and could make use of the existing Garden Pavilion facility or the proposed Multi-purpose Learning Center.

3.5.4 Winter Light Show

Hosting a light show during the winter months would be a great opportunity to draw people into the Gardens during the inactive months of the year. Similar events exist around Vancouver including the Bright Nights held at Stanley Park and the Festival of Lights held at VanDusen Botanical Gardens.

4. Recommendations

The proposed components were ranked based on merit and given phasing priority contingent on funding availability.

4.1 Component Ranking

APEX understands that the UBCBG has a limited budget for operation and even less for contracting new development. Without funding from UBC or outside groups and individuals, implementing all of the components suggested for this development concept would certainly strain the Garden's budget for years. A ranking system provides a useful tool for decision-making when balancing goals, costs, revenues and risks.

Qualitative measures were created as Concept Visions at the beginning of this project, and they were tallied to give weight to each component. Other factors, including estimated cost, time for implementation, and expected revenue generation must also be considered to determine the rank of each component.

4.1.1 Ranking Method

The total number of satisfied Concept Visions (refer to **Figure 1**) was taken as the base score for each component, summarized in **Table 2.** The base score was then modified by the following three score modifiers:

- **Estimated Cost, K_c** – Total relative (estimated) cost for implementation of the components, including construction costs (if applicable) and operation of the component
- **Time for Implementation, K_T** – Duration until the components can begin satisfying their Concept Visions, partially based on likelihood of funding and time for construction
- **Expected Revenue Generation, K_R** – Relative direct and indirect returns from the components, including sales and visitor attraction

Because of the preliminary/conceptual nature of this project, the three score modifiers above were given relative scores ranging from 0.0 to 0.4 in increments of 0.1. A score modifier of 0.1 effectively increases the Base Score by 10%. The Final Score was then computed according to the following formula:

$$Final\ Score = Base\ Score * (1 + K_C + K_T + K_R)$$

For example, the Biodome is expected to have the highest Estimated Cost (its K_C score modifier should not improve its rank relative to other components) and therefor receives a K_C = 0.0. Conversely, the Programming Options are expected to have the lowest Time for Implementation and the lowest Estimated Cost, and therefor receives the maximum 40% modifiers of K_T = 0.4 and K_C = 0.4. The scores were distributed among the development concepts using best judgement, and the final scores were calculated in **Table 2**.

Table 2 - Component Rank Calculation

Development Component	Base Score = # Satisfied Concept Visions	K_C	K_T	K_R	Score Modifier = (1+ΣK)	Final Score = Base Score * Score Modifier	**Rank**
Learning Centre	7	0.2	0.2	0.4	1.8	12.6	**1**
Stormwater Detention Pond and Distribution System	7	0.3	0.3	0.1	1.7	11.9	**2**
Biodome	8	0.0	0.1	0.3	1.4	11.2	**3**
Programming Options	4	0.4	0.4	0.2	2.0	8.0	**4**
Pedestrian Overpass	5	0.1	0.0	0.0	1.1	5.5	**5**

Based on the ranking in **Table 2**, the Learning Centre shows the most promise for meeting the Concept Visions while satisfying the Garden's goals. The Stormwater Detention Pond and Distribution System comes in second, followed by the Biodome then Programming Options. Finally the Pedestrian Overpass comes in fifth.

4.2 Project Phasing

Ranking each component is helpful to decide which component has the most value to the Garden, but if funding is scarce then implementing some of the more expensive components simply cannot happen right away. It is for this reason that the Programming Options (Rank 4) should be investigated immediately as they have relatively low capital costs. If funding is not

available immediately, the Stormwater Detention Pond and Distribution System (Rank 2) should also be given precedent over the Learning Centre (Rank 1) on the grounds that the Learning Centre will be a more expensive investment and the new stormwater system may gain more traction with the UBC Board of Governors and thus receive earlier funding. The following Project Phasing Streams in **Figure 18**, contingent on the availability of funding, are recommended for this development concept:

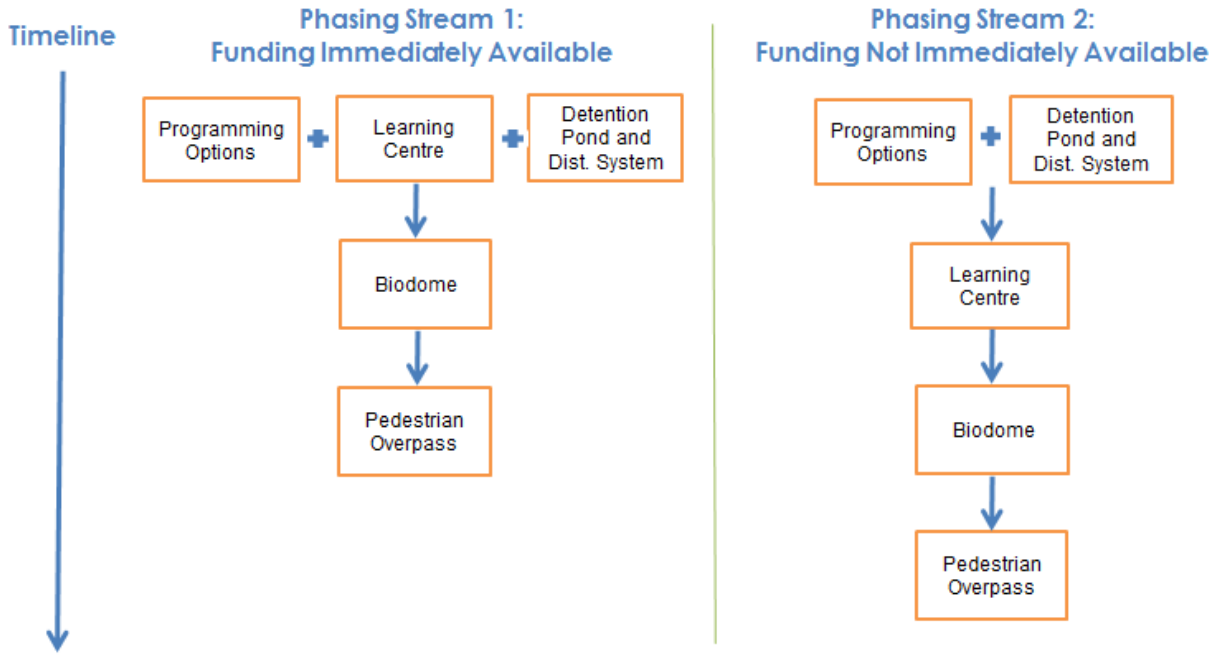

Figure 18 - Project Phasing Streams

5. Conclusion

To meet our mission statement of improving public accessibility, revenue generation, and education promotion, APEX mainly proposed three components and programming options. This report provides detailed analysis on each component on its features, function and compares their feasibility based on the time for implementation, estimated cost and expected revenue generation of each component. APEX concluded that building a learning centre is considered to be the most promising solution to meet the requirements. It provides a multi-purpose structure to offer educational opportunities and various food services. In long-term, APEX also proposed other components, such as an overpass, which improves the accessibility of the garden, and an attractive garden entrance to increase popularity.

In addition, by considering the existing problems and further development, APEX has scheduled to collect information about future development considerations. If funding is sufficient, many other programs and facilities can be proposed to attract people of all ages to this garden. APEX is currently considering developing a new cooking program, a smart phone application and a fountain inside the pond to for a weekly fountain performance.

APPENDIX A

Proposed Site Plan

APPENDIX B

Preliminary Cost Estimates

- Learning Centre
- Biodome

PROPOSED REDEVELOPMENT - PLAN VIEW

Preliminary Cost Estimate
Learning Centre

Building Information

Proposed Building	**Learning Centre**
Estimated Floor Area	850 Square Meters
Estimated Date	2015
Location	Vancouver
Reference Building	**Engineering Design Centre**
Cost	$8,500,000
Floor Area	1888 Square Meters
Construction Date	2011
Location	Vancouver

Wayne & William White Engineering Design Centre Info:
http://design.engineering.ubc.ca/engineering-design-centre/

Cost Calculation

Base Cost = $8,500,000

Assumptions	**Size Factor**	**Cost Adjustment**
Size Factor = 850sq.m/1888sq.m	0.45	$3,826,801
	Location Factor	**Cost Adjustment**
Same Location	1.00	$3,826,801
	Time Factor	**Cost Adjustment**
Assumed Inflation:		
From 2011 to 2013 = 2.5%	1.05	$4,020,533
From 2013 to 2015 = 2.5%	1.05	$4,224,072
Time Factor = (1+i)^(T2-T1)		
20% Contingency		$5,068,887
Rounded Cost		**$5,100,000**

Preliminary Cost Estimate
Biodome

Building Information

Proposed Building	**Biodome**
Estimated Diameter	25 Meters
Estimated Floor Area	500 Square Meters
Estimated Date	2015
Location	Vancouver
Reference Building	**Bloedel Conservatory**
Cost	$1,250,000
Diameter	42 Meters
Floor Area	1430 Square Meters
Construction Date	1969
Location	Vancouver

Bloedel Conservatory Info:
http://www.emporis.com/building/bloedelconservatory-vancouver-canada

Cost Calculation

Base Cost = $1,250,000

Assumptions	**Size Factor**	**Cost Adjustment**
Size Factor = 500sq.m/1400sq.m	0.35	$437,063
	Location Factor	**Cost Adjustment**
Same Location	1.00	$437,063
	Time Factor	**Cost Adjustment**
Assumed Inflation:		
From 1969 to 2013 = 4.3%	6.38	$2,786,465
From 2013 to 2015 = 2.5%	1.05	$2,927,530
Time Factor = (1+i)^(T2-T1)		
25% Contingency		$3,659,412
Rounded Cost		**$3,700,000**