UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Sustainable Landscapes at UBC: An environmental and social sustainability assessment of UBC Vancouver's stormwater terraces using the SITES v2 Rating System and the UBC community's input

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Sustainable Landscapes at UBC: An environmental and social sustainability assessment of UBC Vancouver's stormwater terraces using the SITES v2 Rating System and the UBC community's input

UBC Stormwater Terraces, Krista Jahnke (2013).

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1.0 Abstract

UBC has an expansive landscape and would like to know the degree to which the existing landscapes meet the landscape sustainability criteria developed by The Sustainable Sites Initiative (SITES). The landscape assessed in this project is the stormwater terraces at UBC's Vancouver Point Grey Campus, which replaced a parking lot in 2013. Located near the heart of campus, it is also important to capture the thoughts and opinions of the UBC community on the stormwater terraces to reflect its social sustainability. The stormwater terraces are assessed for 1) environmental sustainability based on relevant Water and Soil & Vegetation criteria found in the SITES v2 Rating System from the Sustainable Sites Initiative program and for 2) social sustainability via a questionnaire completed by fifty randomly selected UBC community members in the vicinity of the terraces. The stormwater terraces do not meet most of the relevant Water criteria largely due to the lack of a site maintenance plan and the additional potable water usage (for maintenance and continuous flow) but they do meet the relevant Soil & Vegetation criteria. Should SITES certification be pursued for future UBC landscapes, it is recommended that projects follow SITES guidelines from start to finish and that maintenance plans be developed and followed (to document activities and improve communication between various working departments). The UBC community generally views the presence of the stormwater terraces as a positive aspect of campus, despite its use of extra potable water. Feasible recommendations to improve the social perceptions of the feature as suggested by the UBC community include reducing the amount of visible cement, making the anti-skateboarding ridges less obvious/obtrusive to sitting/lying in the area, and changing the shape of water funneling flutes in the terraces. Additional landscape assessments in the future would help to further the understanding of how UBC landscapes measure against the benchmark landscape sustainability criteria of SITES.

2.0 About the Authors

2.1.1 Swinzle Chauhan

Swinzle is a 4th year student at UBC, majoring in Environmental Science, with a double major in Human Geography. She has a multi-disciplinary approach to research perspectives and is able to combine scientific thought and socio-economic issues in many tasks. She has strong organisational and communication skills, coupled with experience in database building, environmental certification identification, and waste management, through working on Zero Waste initiatives at UBC Campus and Community Planning. Swinzle hopes that her prior knowledge and keen interest in sustainable design has contributed to making this project successful.

2.1.2 Eva Chu

Eva is an Environmental Science major with a specialization in ecology and conservation and has also taken courses in oceanography, remote sensing, sustainability, and hydrology. She has experience in field data collection from ecology labs and as a past volunteer with Proyecto Carey. From her co-op work terms, she has gained experience in a variety of professional environments and developed analytical and organizational skills with data compilation and analysis as well as report writing and formatting. Her interest in sustainability has been further explored with this project.

2.1.3 Cheng Kuang

Cheng specializes in land, air and water with a strong academic background in ecology, geochemistry and oceanography. She has gained practical field experience from ecology labs in UBC and her volunteer position as an environmental steward for Vancouver's urban watersheds. She also learned about basic soil properties from an introductory Soil Science class. She is proficient in using computer software to analyse data and generate high-quality reports. She is a quick learner and is able to grasp new knowledge and concepts by conducting literature research across disciplines. She enjoys nature and is dedicated to protect natural ecosystems through environmental consulting. She values this project as a great opportunity for her to learn more about sustainable development and specifically, green land design.

2.1.4 Brandon Wong

Brandon is an Environmental Sciences major, specializing in ecology and conservation with background knowledge on oceanography, ecology, hydrology, and remote sensing. He has gained hands on field experience through field labs offered by UBC. From his work experience through the UBC co-op program, he has developed skills in analytical chemical analysis, data management, and project management. In addition, he has experience with research, data compilation and manipulation, analysis, and technical writing. His knowledge and experience with environmental assessments can be furthered with this project.

3.0 Table of Contents

1.0 Abstract .... **i**
2.0 About the Authors .... **ii**
3.0 Table of Contents .... **iii**
3.1 List of Figures iv
3.2 List of Tables v
4.0 Introduction **1**
4.1 Project Overview 1
4.2 About SITES 4
5.0 Water Criteria Assessment **5**
5.1 Background Information 5
5.2 Methodology 6
5.3 Results and Discussion 7
5.4 Conclusion and Recommendations 8
6.0 Soil & Vegetation Criteria Assessment **10**
6.1 Background Information 10
6.2 Methodology 11
6.3 Results and Discussion 12
6.4 Conclusion and Recommendations 15
7.0 Social Aspects **17**
7.1 Background Information 17
7.2 Methodology 17
7.3 Results and Discussion 17
7.4 Conclusion and Recommendations 27
8.0 Final Remarks **29**
9.0 Acknowledgements **31**
10.0 Appendices **32**
10.1 Appendix A: SITES v2 Rating System Credits Exclusion 32
10.2 Appendix B: Ionic Copper Application 33
10.3 Appendix C: Copy of the Questionnaire Used for the Social Aspect 34
11.0 References **35**

3.1 List of Figures

Figure 1. Map showing location of the stormwater terraces, adapted from of Google Maps (Google Maps, 2015). A rough outline of the location of the terraces has been added by the project team. 2

Figure 2. Various photos of UBC Vancouver's stormwater terraces taken by Krista Jahnke in 2013 (left, centre) and our project team in 2014 (right). 2

Figure 3. An outline of the area of the stormwater terraces that will be assessed, taken from PFS Studio's *UBC University Boulevard - Phase I: East Mall to Main Mall Record Set (As-Built)* document (PFS Studio, 2014), with boundaries marked in red by the project team. 3

Figure 4. Actual percentage of vegetation cover on site for each transect compared to the planned vegetation cover (from the planting plan) in percentage of each transect. The planting plan (PFS Studio, 2014) scale shown here is 1:687. 13

Figure 5. Aerial photo of the site before construction. 14

Figure 6. Breakdown of respondents' relationship to UBC, with a further breakdown of how many respondents have been at UBC for 3 years or less, or 4 years or more. 18

Figure 7. All responses (A) to the questionnaire's open-ended question "what do you like about this water feature" (question 3 on the questionnaire) with a further breakdown of responses from respondents who have been at UBC for 3 years or less (B), and 4 years or more (C). 19

Figure 8. All responses (A) to the questionnaire's open-ended survey question "what do you dislike about this water feature" (question 4 on the questionnaire) with a further breakdown of responses from respondents who have been at UBC for 3 years or less (B), and 4 years or more (C). 20

Figure 9. Grouped responses to the questionnaire's open-ended question "what do you think is/are the main purpose(s) of this feature" (question 5 on the questionnaire). 21

Figure 10. Responses to the questionnaire question "how aesthetically pleasing do you find this water feature" (question 6 on the questionnaire) with a further breakdown of responses from respondents who have been at UBC for 3 years or less, and 4 years or more. 22

Figure 11. A representation of the frequency of responses towards a particular aesthetic rating from respondents who have spent different periods of time at UBC, grouped into five different categories of less than or equal to 1 year, 2 to 3 years, 4 to 5 years, 6 to 10 years, and greater than 10 years. 23

Figure 12. Responses to the question "in which season do you like to spend time at this water feature" (question 9 on questionnaire) 23

Figure 13. Questionnaire responses indicating if respondents prefer the current feature or the previous parking lot, and reasons for their answers. 24

Figure 14. Responses indicating whether respondents are happy with the presence of the stormwater terraces on campus, given that at some times of the year, additional resources are required to sustain it. A further breakdown of responses from respondents who have been at UBC for 3 years or less and for 4 years or more is also shown. 25

Figure 15. A comparison of numbers of respondents who said either “yes” or “no” to the question about the presence of the terraces and extra resource use (questionnaire question 11) and either “parking lot" or “stormwater terraces” to the question asking which landscape they preferred (questionnaire question 10). Numbers indicate the number of responses from respondents who have been at UBC for varying lengths of time and “n/a” encompasses any respondents who identified themselves as visitors and answered these questions. 25

Figure 16. The questionnaire given to the UBC community to fill out. 34

3.2 List of Tables

Table 1. Point value table for sites located in the temperate conifer forests biome, taken from the SITES v2 Rating System (Sustainable Sites Initiative™, 2014a). 12

Table 2. A list of species planted in the terraces according to the planting plan for the terraces. 13

Table 3. BDI calculations for the previous site. *Biomass density values are provided in the SITES v2 Reference Guide (Sustainable Sites Initiative™, 2014b) and are based on a literature review of leaf area index (LAI) for various vegetation types that includes about 1,000 historical estimates of LAI summarized by biome or cover type (Scurlock, Asner, & Gower, 2001). 14

Table 4. BDI calculations for the current site. *Biomass density values are provided in the SITES v2 Reference Guide (Sustainable Sites Initiative™, 2014b) and are based on a literature review of leaf area index (LAI) for various vegetation types that includes about 1,000 historical estimates of LAI summarized by biome or cover type (Scurlock, Asner, & Gower, 2001). 15

Table 5. Summary and quotes from the open-ended “other comments” section of the survey, with the number of that response in brackets. 27

Table 6. Scorecard from the SITES v2 Rating System, modified to only include credits that are applicable to the stormwater feature. 29

4.0 Introduction

4.1 Project Overview

4.1.1 Context

UBC, the University of British Columbia, is a global sustainability leader with a mandatory policy for all new campus construction and major renovations projects (since 2008 and over 600 m^2 in area) to achieve a Gold certification from LEED, which is the Leadership in Energy and Environmental Design program for green buildings (UBC Sustainability, 2015b). There are currently a total of 10 LEED certified buildings on campus, with another 15 projects in the process of certification (UBC Sustainability, 2015a). While green building rating systems such as LEED have been extensively developed, there are no internationally accepted guidelines or rating systems for landscapes. The Sustainable Sites Initiative program, SITES, aims to provide those guidelines and transform conventional land design, development, and use as the value and benefits of ecosystem services are mostly underestimated (Sustainable Sites Initiative™, 2015d).

As UBC has an expansive landscape, whether or not the existing landscapes are meeting the benchmark landscape sustainability criteria developed by SITES is not yet well understood. In 2014, a team of four ENVR 400 students conducted the first site assessment at UBC using SITES criteria. Their project assessed the current state of and the planned renovations for Sustainability Street, also located on UBC's Vancouver Point Grey Campus. The criteria used for assessment was Section 4 (Soil and Vegetation) of the SITES Guidelines and Performance Benchmarks 2009, which is version 1 of the SITES Rating System (Sustainable Sites Initiative™, 2015a). Overall, the assessment of Sustainability Street met the requirements for SITES 2009 Soil and Vegetation criteria (Chan, Lam, Law, & Lee, 2014).

Ultimately, it is hoped that SITES can be a standard to which all campus landscapes are designed and maintained. This project will be the second landscape assessment using SITES criteria at UBC to determine the degree to which the current, existing UBC landscapes are meeting SITES criteria. The stormwater terraces is the landscape being assessed for this project under the recommendation of Dean Gregory, the campus land architect, and because of the team's interest in this particular well-known, and perhaps controversial, campus landmark (more information in 4.1.2 Stormwater Terraces).

4.1.2 Stormwater Terraces

The stormwater terraces on University Boulevard (Figure 1 and Figure 2) are one of a few sustainably designed water features at UBC's Vancouver Point Grey Campus. Stormwater is collected from the nearby catchment area (a portion of Main Mall) and fed into the terraces, where it then flows through eight terraced pools from west to east (Main Mall towards East Mall) on University Boulevard. The stormwater is cleaned via biofiltration by the vegetation within the terraces and then subsequently stored in an underground cistern when the terraces are at capacity. Excess stormwater is released to the stormwater system in a more controlled manner that reduces the erosive effects of larger volumes of water (UBC Campus + Community Planning, 2013). Specifically, the stormwater terraces discharge the excess to the spiral drain outfall for the North Catchment, which is one of the four large stormwater catchment areas that drain from campus (UBC Campus + Community Planning, 2014).

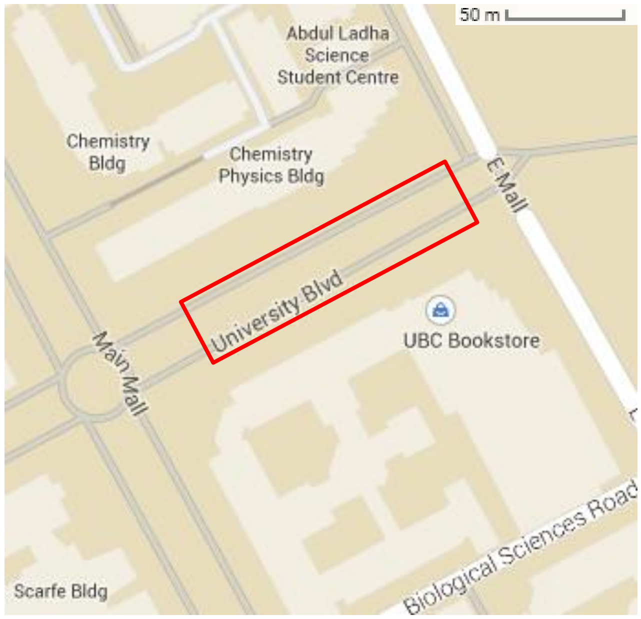

Figure 1. Map showing location of the stormwater terraces, adapted from of Google Maps (Google Maps, 2015). A rough outline of the location of the terraces has been added by the project team.

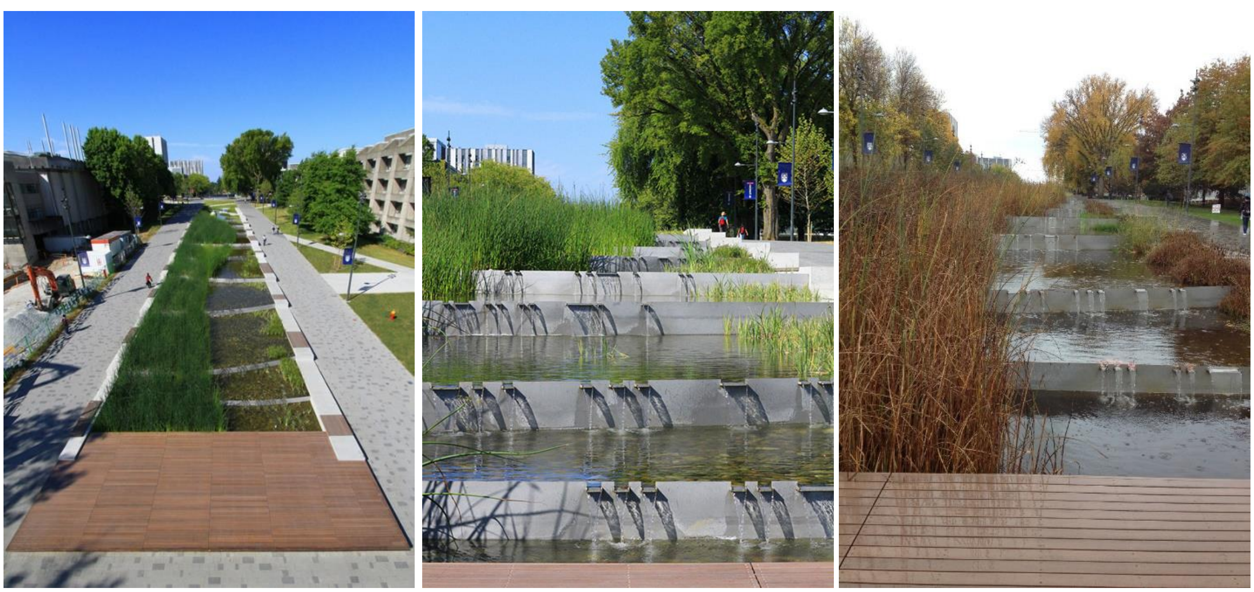

Figure 2. Various photos of UBC Vancouver’s stormwater terraces taken by Krista Jahnke in 2013 (left, centre) and our project team in 2014 (right).

In concept, the terraces are meant to be self-sustaining, meaning that they require no additional water aside from natural precipitation and runoff from the surrounding environment. However, during dry summers where there was not enough natural precipitation, it has been necessary to add potable water into the system in order to ensure that water continues to flow through the pools. There has also been the application of ionic copper as an algaecide, which has been questioned by some members of the UBC community.

4.1.3 The Project

This community project is a collaborative effort between a team of four Environmental Science 400 (ENVR 400) students and the University of British Columbia's (UBC) Social Ecological Economic Development Studies (SEEDS) Program. This project aims to assess UBC Vancouver's stormwater terraces on University Boulevard at the Point Grey Campus (site boundaries in Figure 3) based on the relevant Water and Soil & Vegetation criteria found in the SITES v2 Rating System from the Sustainable Sites Initiative program. The criteria relevant to the stormwater terraces and used for assessment are as follows:

- Water Prerequisite 3.1: Manage precipitation on site
- Water Prerequisite 3.2: Reduce water use for landscape irrigation
- Water Credit 3.3: Manage precipitation beyond baseline
- Water Credit 3.4: Reduce outdoor water use
- Water Credit 3.5: Design functional stormwater features as amenities
- Soil & Vegetation Prerequisite 4.1: Create and communicate a soil management plan
- Soil & Vegetation Prerequisite 4.2: Control and manage invasive plants
- Soil & Vegetation Prerequisite 4.3: Use appropriate plants
- Soil & Vegetation Credit 4.6: Conserve and use native plants
- Soil & Vegetation Credit 4.8: Optimize biomass

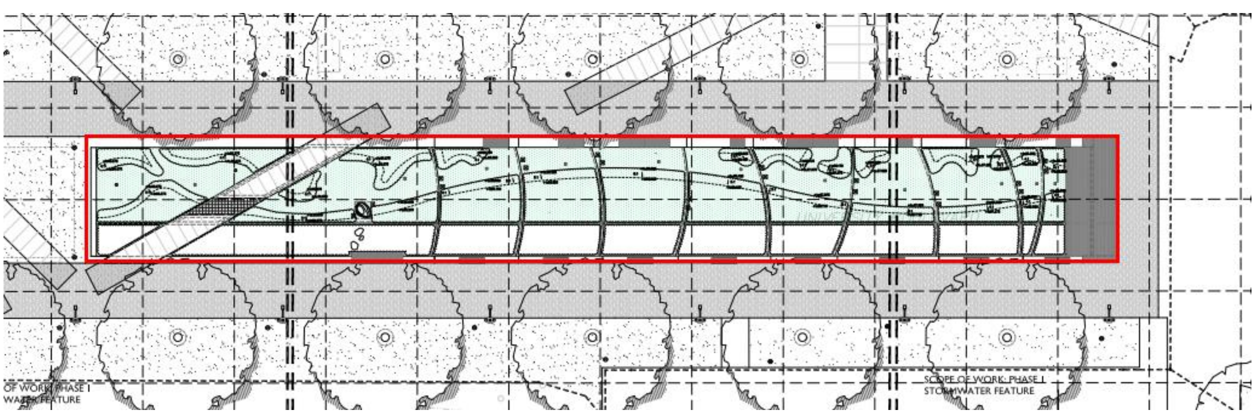

Figure 3. An outline of the area of the stormwater terraces that will be assessed, taken from PFS Studio's *UBC University Boulevard - Phase I: East Mall to Main Mall Record Set (As-Built)* document (PFS Studio, 2014), with boundaries marked in red by the project team.

Based on the results of our findings, the sustainability score of the stormwater terraces as well as advice and/or suggestions for any appropriate improvements to the stormwater terraces and/or for future site developments at UBC are detailed. In addition, this project will determine the social sustainability of the stormwater terraces by examining the opinions and thoughts of the UBC community on the stormwater terraces. Feasible recommendations from the UBC community will be suggested.

4.2 About SITES

The Sustainable Sites Initiative (SITES®) is an interdisciplinary program which provides guidelines and tools for developing sustainable landscapes. Sustainable land features create communities which are resilient to environmental disturbances such as fires, droughts and storms. SITES acknowledges the importance of built landscapes and green infrastructure in protecting and restoring natural ecosystems. Healthy ecosystems have beneficial ecological functions such as carbon sequestration, erosion control, water, and air filtration. Land architects, designers, engineers, and others who influence land design and management practices can use SITES to develop “green” landscapes that enhance ecosystem services. SITES has developed the SITES v2 Rating System to quantitatively measure project sustainability (Sustainable Sites Initiative™, 2015a).

4.2.1 SITES v2 Rating System

The SITES v2 Rating System measures the sustainability of a site by taking into account 18 prerequisites and 48 credits that total 200 potential points. It provides performance measures rather than specific practices for 10 different sections (all are various site aspects) that can range from before site construction to after site completion (Sustainable Sites Initiative™, 2014a). The two sections this project will focus on are Section 3: Site Design – Water and Section 4: Site Design – Soil & Vegetation. Using the rating system e-document along with the reference guide, both of which contains the detailed information for each prerequisite and credit, this project will assess the stormwater terraces site and assign a sustainability score. The relevant criteria from the Water and Soil & Vegetation sections for this project are summarized in the following sections, respectively, in 5.1 Background Information and in 6.1 Background Information.

5.0 Water Criteria Assessment

5.1 Background Information

The water criteria assesses the ability of the landscape to conserve water, maximize the usage of precipitation, and protect water quality (Sustainable Sites Initiative™, 2014b). Ideally, a landscape would be able to restore or mimic a natural system. Prerequisites and applicable credits for the stormwater terraces are detailed below (see Appendix A: SITES v2 Rating System Credits Exclusion for credits excluded in this assessment).

5.1.1 Water Prerequisite 3.1: Manage precipitation on site (Required)

This prerequisite requires reducing negative impacts to specific aspects of the environment (aquatic ecosystems, channel morphology, and dry weather base flow) by imitating natural conditions and retaining precipitation. This requires retaining the 60th percentile volume of precipitation, calculated from daily historical rainfall data over 30 years. A site maintenance plan is required and must include maintenance activities that ensure stormwater features to have long-term effectiveness.

5.1.2 Water Prerequisite 3.2: Reduce water use for landscape irrigation (Required)

This prerequisite requires the conserving water resources and minimizing energy use by limiting the use of specific types of water for landscape irrigation after the vegetation's establishment period. A site maintenance plan should include anticipated water use schedule as well as the process for maintaining irrigation from non-potable water sources.

5.1.3 Water Credit 3.3: Manage precipitation beyond baseline (4 – 6 points)

This credit aims to manage precipitation greater than the minimum 60th percentile precipitation volume. Points are awarded for retaining or treating precipitation volumes at the 80th, 90th, and 95th percentile. This credit requires a site maintenance plan that details the maintenance activities used to ensure stormwater features to have long-term effectiveness of stormwater features and includes water quality treatment activities.

5.1.4 Water Credit 3.4: Reduce outdoor water use (4 – 6 points)

This credit aims to conserve water and minimize energy use by limiting or eliminating the use of portable water, natural surface water, and groundwater withdrawal. Points are awarded based on how much water usage is reduced. This credit also requires a site maintenance plan that adequately describes appropriate maintenance activities that will not involve use of chemicals that are likely to harm aquatic life as well as ensures that mosquito habitat will not be created.

5.1.5 Water Credit 3.5: Design functional stormwater features as amenities (4 – 5 points)

This credit aims to manage stormwater with aesthetically pleasing and physically accessible features in order to connect to local climate and hydrology. This applies to stormwater features that use precipitation as the only source of water and points are awarded for treating precipitation as an amenity for at least 50 or 100 percent of the total area of stormwater features. This credit also requires a site maintenance plan that adequately describes appropriate maintenance activities that will not involve use of chemicals that are likely to harm aquatic life as well as ensures that mosquito habitat will not be created.

5.2 Methodology

5.2.1 Manage Site Precipitation

We used climate data that was gathered and recorded by an Environment Canada weather station to determine site precipitation data over the last 30 years, from 1983 to 2013. The weather station is located at the Vancouver International Airport and has the thirty years of daily precipitation records as required by SITES.

To determine the precipitation percentile volumes, we followed the methodology listed in the SITES V2 Reference Guide. Rainfall events with volumes equal to or less than 2.5mm are removed from the data sets because they do not typically cause runoff. Precipitation volumes are then ranked from highest to lowest in an Excel spreadsheet. A percentile column is created by calculating the percentage of rainfall events that are less than each ranked event. For example, if there are 3000 rainfall events in the 30 year period and the heaviest rainfall was 10 cm, then 2999 events (or a percentile of 2999/3000, or 99.97%) were less than the 10 cm rainfall event. The rainfall volume at the 60 percent is the 60^{th} percentile rainfall event. The percentile volume is multiplied by the total area of impervious surfaces in the catchment to obtain the volume of stormwater runoff that needs to be managed on site. The runoff volume is compared with the designed storage capacity of the cistern to see if the cistern will be adequate for managing the runoff on site.

5.2.2 Reduce Water Use for Landscape Irrigation

We attempted to obtain a site maintenance plan that would detail the type and amount of water used for the stormwater terraces, but a site maintenance plan could not be located. Instead, we contacted the plumber with UBC Building Operations who is responsible for the stormwater terraces to find out information pertaining to the maintenance of the stormwater terrace.

5.2.3 Manage Precipitation Beyond Baseline

The method for calculating the 80th, 90^{th}, and 95th percentile storm events is the same one detailed in the earlier 5.2.1 Manage Site Precipitation section. The percentiles are multiplied by the total area of impervious surfaces in the catchment to get the volumes of stormwater runoff that needs to be managed on site. The runoff volumes are compared with the designed storing capacity of the cistern to see if the cistern will be adequate for managing the runoff on site.

5.2.4 Reduce Outdoor Water Use

This credit also requires a site maintenance plan. In its absence, information was provided by the UBC Building Operations' plumber responsible for the stormwater terraces. We also reached out to the company that applies algaecide to the terraces in the form of ionic copper for more information to find out if the use of this chemical.

5.2.5 Design Functional Stormwater Features as Amenities

We looked into how stormwater is received, conveyed, and managed for the feature and the total percentage of the feature that relied on stormwater. As the plant life is a feature of the terrace, we observed how stormwater was being managed for the feature's vegetation. Information for this credit is also from the UBC Building Operations' plumber responsible for the stormwater terraces. We also reached out to the company that applies algaecide to the terraces in the form of ionic copper for more information to find out if the use of this chemical.

5.3 Results and Discussion

5.3.1 Management of Site Precipitation

The 60th percentile precipitation event calculated from the 30 year period was 9.8mm. With a total catchment area of 9660m^2, of which 45% (4347m^2) is impervious, the total volume of stormwater runoff for the stormwater terraces is 42.6m^3. The cistern has a maximum design capacity of 25.8m^3. The 60th percentile precipitation event is almost double the volume that can be managed on site. The stormwater terrace did not meet prerequisite 3.1, and therefore was not allotted any points for credit 3.3 as well.

5.3.2 Reducing Overall Water Use

Prerequisite 3.2 and credits 3.4 and 3.5 pertain to reducing water usage. Prerequisite 3.2 is not met as the system cannot sustain itself solely by precipitation. Potable water is used to fill the stormwater terraces on two occasions, 1) in the summers when the water level is low and there is not enough precipitation to sustain the system, and 2) after the stormwater terrace has been drained for maintenance. Credit 3.4 relates to the prerequisite in terms of reducing outdoor water use, and is not allotted any points. To score 4 points, the stormwater terrace would require 50% of its annual make-up water to be from non-potable water resources, or use less than 37,854.12 litres (10,000 gallons). When the stormwater terrace is drained for maintenance and refilled, it is 100% filled with potable water. With a design capacity of 1,000,140 litres (264,209 gallons), the stormwater terrace uses more than 37,854.12 litres. The stormwater terrace meets neither of the requirements. For credit 3.5, we scored the terraces the maximum 5 points as the entirety of the stormwater features of the stormwater terrace are to treat and manage stormwater, though it should be noted that the site lacks a maintenance plan.

5.3.3 Site Maintenance Plan and Algaecide

As all prerequisites and credits require a site maintenance plan, the stormwater terraces would not be able to score any points under the SITES Water section because no maintenance plan exists.

During the summers, UBC has added ionic copper into the terraces to remove algal blooms. Ionic copper can prevent algal growth by inhibiting cell division and other cellular functions such as photosynthesis and enzyme production (Stauber & Florence, 1987). The use of ionic copper is effective in terms of removing algae from the open water area of terraces. The methodology behind the use of ionic copper to remove algae blooms is available in Appendix B: Ionic Copper Application, provided by a representative (from the company who treats the terraces) who specializes in ionic copper research and product development (B. Lightowlers, personal communication, November 20, 2014).

It is recommended by SITES that materials that are sources of pollutants in stormwater should be avoided or minimized when managing sites (Sustainable Sites Initiative™, 2014b). Introducing ionic copper, a potential pollutant into the water body seems contradictory to the recommendation. British Columbia's Ministry of Environment has standards of a maximum of 2-3 ppb depending on the environment and recommends alternatives to copper as a biocide such as controlling the source of nutrient input, placing water intakes appropriately, aerating the bottom water, and the precipitating of nutrients by liming (Province of British Columbia, 2015).

The stormwater terraces are typically treated at 1ppm ionic copper when full of algae and the level is maintained at 0.1-0.3 ppm over the winter (B. Lightowlers, personal communication, November 20, 2014). This becomes further diluted (to below Ministry of Environment standards) when the excess stormwater from the terraces discharges into the spiral drain outfall, though the absolute level is not known.

5.4 Conclusion and Recommendations

Overall, the stormwater terrace does not meet the two prerequisites and scores 5 points out of a possible 15 points based on the water section of the SITES v2 Rating System. This is a minor stretch as this is only possible by forgoing the lack of a site maintenance plan (and the use of ionic copper). Each prerequisite and credit of the water section requires a completed site maintenance plan and there is no site maintenance plans specific to the stormwater terraces.

In order to meet prerequisite 3.1 for precipitation management, the cistern would need to be able to hold a volume of 42.6m^3 based on the calculation of the 60th percentile rainfall event. To receive credit in 3.3, the cistern would need be much larger. As the stormwater terrace is constantly running, the system is always at capacity, and therefore precipitation would need to be held by a larger cistern to be managed and filtered.

To reduce overall water usage, ideally, a new method should be developed where the stormwater terrace does not need to be drained in order for it to be cleaned and maintained. This would negate the need to use additional water to refill the terrace. In the summer, when there are low levels of precipitation and high evaporation, water is added to keep the feature 'on.' Instead of adding water, the feature could be 'turned off' in times of low precipitation, saving water. This would allow the system to meet prerequisite 3.2, and score points in credit 3.4. However, it would still be difficult to validate a score due to the lack of a site maintenance plan. A site maintenance plan would ensure that there is more accurate data about the stormwater terrace. It is also recommended that UBC install flowmeters into the stormwater terrace to understand the volume of water that is inputted into the system and measure the volume of water that goes straight into the runoff system.

As SITES requires maintenance activities to not use chemicals that are likely to harm aquatic life, the use of ionic copper in the terraces would mean that the credits with this requirement would not be met. While levels of ionic copper are within the BC Ministry of Environment's guidelines, SITES does not explicitly define what is considered "aquatic life". Since algae is an important part of most aquatic environments and would normally be included within aquatic life, the use of ionic copper as an algaecide does not seem to meet SITES standards.

6.0 Soil & Vegetation Criteria Assessment

6.1 Background Information

This criteria requires proper management of soil and vegetation in a landscape. Healthy soil and vegetation can filter pollutants in water, reduce stormwater runoff and minimize erosion (Brady & Weil, 2010). Some key strategies outlined in this criteria are using appropriate plants, managing invasive species and restoring biodiversity on site (Sustainable Sites Initiative™, 2014b). Prerequisites and applicable credits for the stormwater terraces are detailed below (see Appendix A: SITES v2 Rating System Credits Exclusion for credits excluded in this assessment).

6.1.1 Soil+Veg Prerequisite 4.1: Create and communicate a soil management plan (Required)

This prerequisite requires the existence of a soil management plan which aims to limit soil disturbance during construction and to plan for soil restoration in the design stage.

6.1.2 Soil+Veg Prerequisite 4.2: Control and manage invasive plants (Required)

This prerequisite requires the control and management of invasive plants, ensuring that invasive species are not brought to site. The requirements for this prerequisite include: a finished and appropriate site assessment regarding presence of invasive species, not planting any invasive plants, removing invasive plants, and the existence of an appropriate site maintenance plan regarding control and management of invasive plants.

6.1.3 Soil+Veg Prerequisite 4.3: Use appropriate plants (Required)

This prerequisite requires native plant or non-native species to be used, which will improve landscape performance and reduce resource use.

6.1.4 Soil+Veg Credit 4.6: Conserve and use native plants (3 – 6 points)

This credit aims to create habitat for native species that will allow for plant reproduction. This credit requires the conservation of existing appropriate native plants and/or installing new native plants. Since the site was a parking lot prior to the stormwater terraces, there was not conservation of native plant species but there was installation of new native plants.

6.1.5 Soil+Veg Credit 4.8: Optimize biomass (1 – 6 points)

This credit aims to support the water, nutrient, atmospheric gas, and climate regulation ecosystem service benefits provided by the vegetation. This credit requires conservation and/or restoration of vegetation biomass on site to a level appropriate to the site's region.

6.2 Methodology

6.2.1 Soil Management Plan

We attempted to obtain a soil maintenance plan that would detail soil related activities during and after construction for the stormwater terraces, but a soil maintenance plan was not found.

6.2.2 Identification of Plants on Site

We obtained a list of planted species from the planting plan and we checked the site to see if all of the planted species are present and if any additional species have colonized the area.

6.2.3 Actual Vegetation Cover

We measured the length (west-east direction) and width (north-south direction) of the entire stormwater terrace using a 30-metre measuring tape. Since this feature is rectangular, we calculated the total area by multiplying the length by the width. We then set up 20 transects of equal areas by dividing the total length of the terraces into 20 equal sections. We held two measuring tapes across the width of the terrace as the boundaries between transects and estimated the percentage of plant coverage for each transect. We multiplied the percentage by the square metre area of each transect to obtain an area of plant coverage. The last step was to sum up the vegetated areas of all transects and divide this number by the total area of the feature. The result is the overall vegetation cover for this site.

6.2.4 Planned Vegetation Cover

We estimated the vegetation cover from the planting plans to examine whether it agrees with the field data. The vegetation plan for the site was divided into 20 sections as well, in order to be consistent with our methodology used to determine the actual vegetation cover. We estimated the percentage of vegetated area in each transect and compared the values with the site's actual plant coverage in percentages.

6.2.5 Biomass Density Index

Biomass Density Index (BDI) is the density of vegetation that covers the ground. The method for determining the BDI values is adopted from the SITES V2 Reference Guide. It is calculated by summing biomass values as a proportion of the total site area for all on site land cover/vegetation types (Sustainable Sites Initiative™, 2014b). The biomass values are constants assigned for different zones.

SITES requires a comparison of the previous and current site BDI to assign a score for credit 4.8. Due to lack of data for the previous site conditions, we relied on an aerial photo of the site from the past to determine zones of land cover and vegetation types that existed at the site. We used the field data we collected to calculate the current site BDI.

After calculating the BDI values for both the previous and present site, we used the region-specific point table in the SITES v2 Rating System to determine how many points the site can earn under credit 4.8 (Sustainable Sites Initiative™, 2014b). The biome within which the site is located in is determined using World Wildlife Fund Wildfinder. UBC is in the Temperate Coniferous Forests Biome (World Wildlife Fund, 2015), which corresponds to Table 4.8-C in the SITES v2 Reference Guide and is reconstructed into a simpler table in this paper (Table 1).

Table 1. Point value table for sites located in the temperate conifer forests biome, taken from the SITES v2 Rating System (Sustainable Sites Initiative™, 2014a).

		Current Site BDI					
		0–1	>1–2	>2–3	>3–4	>4–5	>5
Previous Site BDI	0–1	1 point	3 points	5 points	6 points	6 points	6 points
	>1–2	No Credit	1 point	3 points	5 points	6 points	6 points
	>2–3	No Credit	No Credit	1 point	3 points	5 points	6 points
	>3–4	No Credit	No Credit	No Credit	1 point	3 points	5 points
	>4–5	No Credit	No Credit	No Credit	No Credit	1 point	3 points
	>5	No Credit	No Credit	No Credit	No Credit	No Credit	1 point

6.3 Results and Discussion

6.3.1 Plant Identification and Percentage Cover of Vegetated Area

According to the planting plan, the wetland species planted in the stormwater feature include:

a. *Scirpus acutus* (hardstem bulrush)
b. *Sagittaria latifolia* (broadleaf arrowhead)
c. *Carex obnupta* (slough sedge)
d. *Iris missouriensis* (western blue flag)

A summary of the plant species we found on site is presented in Table 2. We did not find any species that were not in the planting plan. Sampling time is a potential factor that could have influenced the results. The entire terrace was drained and the plants growing in the terrace had been trimmed for maintenance purposes. It is possible that plant species that were introduced to the terraces after initial planting were removed during maintenance. Due to the lack of a written maintenance plan, we were unable to determine any changes in plant species before and after the maintenance.

Table 2. A list of species planted in the terraces according to the planting plan for the terraces.

Scientific Name	Common Name	Native to BC	Presence in Terraces
Scirpus acutus	hardstem bulrush	Yes	Present
Sagittaria latifolia	broadleaf arrowhead	Yes	Unable to Identify / Not Present
Carex obnupta	slough sedge	Yes	Present
Iris missouriensis	western blue flag	Yes	Present

Based on our field data, 40.5% of the water feature is covered with wetland plants. Based on our estimates from the planting plan, the plant cover should be 50.0%. Therefore, the actual percent cover is less than what was planned. 16 out of 20 transects have lower plant cover at the actual site than in the planting plan when comparing the actual and planned plant cover in percentage for each transect (Figure 4). Each transect measures 5.64m (east to west) by 13.82m (north to south), giving an area of 77.94m^2.

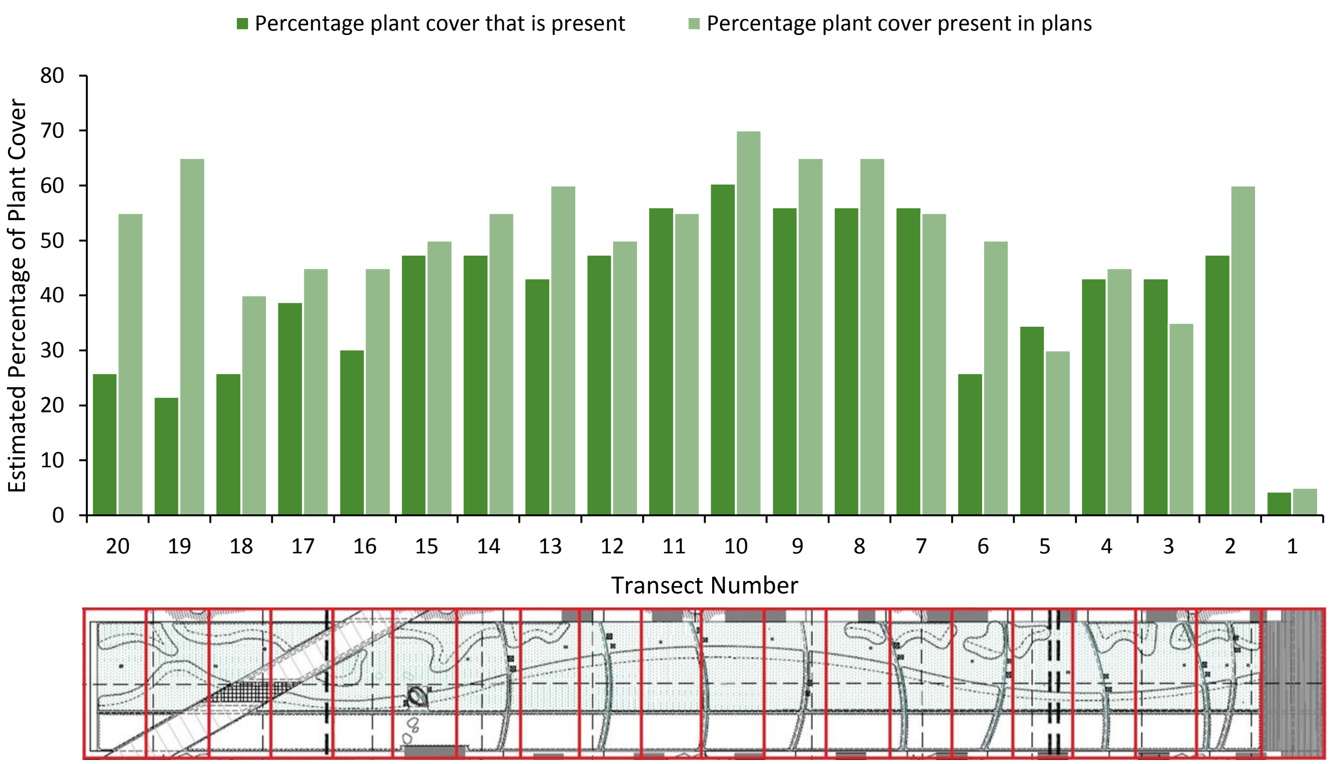

Figure 4. Actual percentage of vegetation cover on site for each transect compared to the planned vegetation cover (from the planting plan) in percentage of each transect. The planting plan (PFS Studio, 2014) scale shown here is 1:687.

6.3.2 BDI Measurement and Credit 4.8: Optimize Biomass

Figure 5. Aerial photo of the site before construction.

Table 3. BDI calculations for the previous site. *Biomass density values are provided in the SITES v2 Reference Guide (Sustainable Sites Initiative™, 2014b) and are based on a literature review of leaf area index (LAI) for various vegetation types that includes about 1,000 historical estimates of LAI summarized by biome or cover type (Scurlock, Asner, & Gower, 2001).

Vegetation Type	Biomass Density Value *	Percent of Total Site Area	Biomass Density Value X Percent of Total Site Area
Trees Without Understory	4	1%	0.04
Managed turf < 3''	2	4%	0.08
Shrubs	3	10%	0.3
Impervious cover	0	85%	0
Site BDI value			0.42

Table 4. BDI calculations for the current site. *Biomass density values are provided in the SITES v2 Reference Guide (Sustainable Sites Initiative™, 2014b) and are based on a literature review of leaf area index (LAI) for various vegetation types that includes about 1,000 historical estimates of LAI summarized by biome or cover type (Scurlock, Asner, & Gower, 2001).

Vegetation Type	Biomass Density Value *	Percent of Total Site Area	Biomass Density Value X Percent of Total Site Area
Wetlands	6	40.5%	2.43
Impervious cover	0	59.5%	0
Site BDI value			2.43

Comparing previous and current site BDIs (Table 3 and Table 4) to the point value associated with BDI values (Table 1), the stormwater terraces would be score 5 out of a possible 6 points for credit 4.8.

6.4 Conclusion and Recommendations

6.4.1 Prerequisite 4.1

There is no soil management plan for the stormwater terraces. Therefore, this prerequisite is not met. For future sustainable landscape development, a soil management plan should be created prior to construction. According to the SITES v2 Reference Guide (Sustainable Sites Initiative™, 2014b), the following information needs to be included in the plan:

1. Locations of existing healthy soils on site and any Vegetation and Soil Protection Zones. Strategies proposed to protect these areas from any disturbance during construction are required.
2. Describe in detail how to minimize soil disturbance during construction.
3. Identify any disturbed soil that will be restored and specify the planned treatment for disturbed soils.
4. Communicate the soil management plan with the site contractor through drawings and written specifications.

6.4.2 Prerequisite 4.2

No invasive species were found on site, but there is no site maintenance plan, thus this prerequisite is not satisfied. Regular site visits are necessary to check if any additional plant species have been possibly introduced to the site via wind and/or animals. It is important to assess whether colonization of the new species will cause any harm to the local ecosystem. Invasive plants should be removed promptly. A specific section regarding the control and management of invasive plants should be included in the site maintenance plan. Details of what species are removed and how they are removed each time should be recorded.

6.4.3 Prerequisite 4.3

Only native species are planted, thus this prerequisite is satisfied. *Sagittaria latifolia* (broadleaf arrowhead), which is one of the planted species listed in the planting plan, is not present on site. There are multiple possible explanations for the absence of this species. It is possible that *S. latifolia* was outcompeted by other plants such as *Scirpus acutus* (hardstem bulrush), which was planted together with *S. latifolia* according to the planting plan (PFS Studio, 2014). For future landscaping, interspecies plant interactions should be taken into more consideration prior to planting. Some plants are more competitive and should be grown alone while others are better as communities of multiple species that co-exist. The goal is to make sure that all species can survive in their shared environment. Another possibility is that the abiotic environment in the terraces is not suitable for the growth of this species. It is recommended to create and regularly update a record of plant status for site maintenance activities in order to track changes in the plant community.

6.4.4 Credit 4.6

This credit requires the use of the SITES Native Plants Calculator to determine a native plant score for the site. However, only registered projects have access to the calculator. We are unable to evaluate this credit based on the SITES criteria because the site is not registered for official SITES assessment, though we can note that all the planted species are native. Based on the information we have, we can conclude that 40.5% of the site is covered with vegetation and that 100% of the vegetation present is native.

6.4.5 Credit 4.8

The stormwater terraces score 5 out of 6 possible points based on the previous and current site BDI values. The result would be more precise if there was a plan drawing of the previous site that maps zones of land cover/vegetation types.

7.0 Social Aspects

7.1 Background Information

Although we are not evaluating the stormwater terrace against the Human Health and Wellbeing criteria of the SITES v2 Rating System, we did decide to investigate a social component of the terrace which would help us better understand what people think of the feature. With the terraces potentially not doing well if a SITES assessment were done, it was important to find out what worth the UBC community saw (or, in some cases, did not see) in this feature and see if it did provide some component of social sustainability to UBC.

7.2 Methodology

Fifty members of the UBC community nearby the stormwater terraces were asked to fill out a questionnaire between 12pm to 2pm on Friday, March 6, 2015 and between 11:30am to 12:30pm on Monday, March 9, 2015. The stormwater terraces were referred to as 'water feature' in the survey, to not hint to students what the purposes of the feature may be. Twice as many individuals were approached, but many refused due to time constraint reasons. There was a mixture in what respondents were doing when they were approached, including: sitting on the sides of the feature, walking past it on their way somewhere, and standing near the feature. Responses to open-ended questions were grouped into broader categories (similar responses became one category) for analysis and all responses were analyzed and kept anonymous. Not all respondents answered all the questions, so there may be some discrepancies in results that are broken down into certain groups of respondents. See Appendix C for a copy of the questionnaire used.

7.3 Results and Discussion

Overall, most questionnaire respondents, 37 out of 50, were students, with 23 out of the 37 mostly consisting of respondents who have been at UBC for three years or less (Figure 6). The stormwater terrace began construction three years ago in 2012, so respondents who have been at UBC for three years or less (19 out of 50) would not have seen the previous parking lot and many of them may not even have seen the construction and only the finished stormwater terraces.

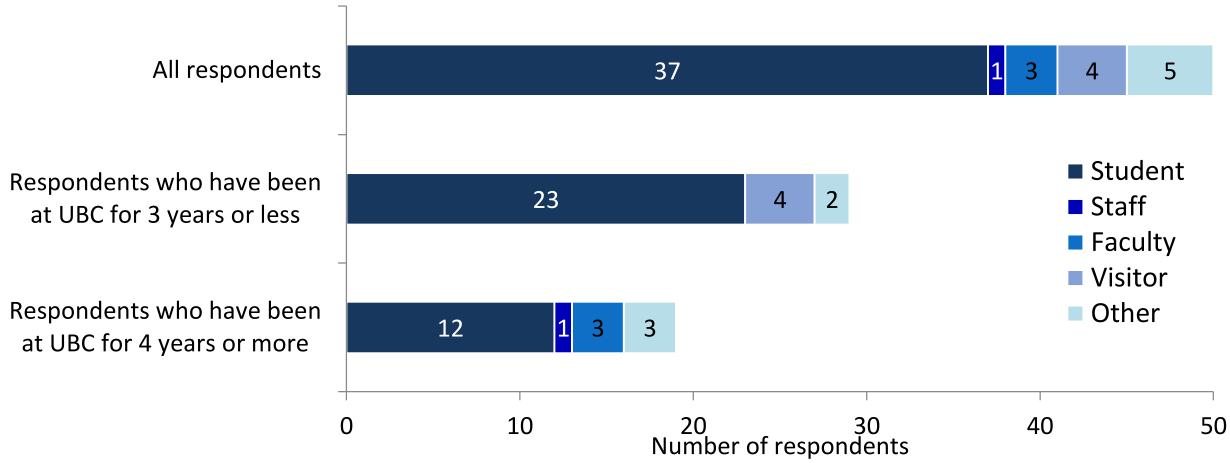

Figure 6. Breakdown of respondents' relationship to UBC, with a further breakdown of how many respondents have been at UBC for 3 years or less, or 4 years or more.

Since the questionnaire was conducted in the vicinity of the study area, it is likely that many respondents may have identified with faculties/departments located close to the area and thus do not represent the view of UBC as a whole. We received a wide diversity of responses in terms of respondents' relationship to UBC ranging from visitors to students, faculty, and staff from the faculties of Arts, Science, Education, Applied Sciences, Land and Food Systems, Forestry, and Medicine as well as the schools of [Sauder School of] Business and Kinesiology.

Respondents were asked what they like/dislike about the stormwater terraces. Responses are shown in the pie charts below (Figure 7).

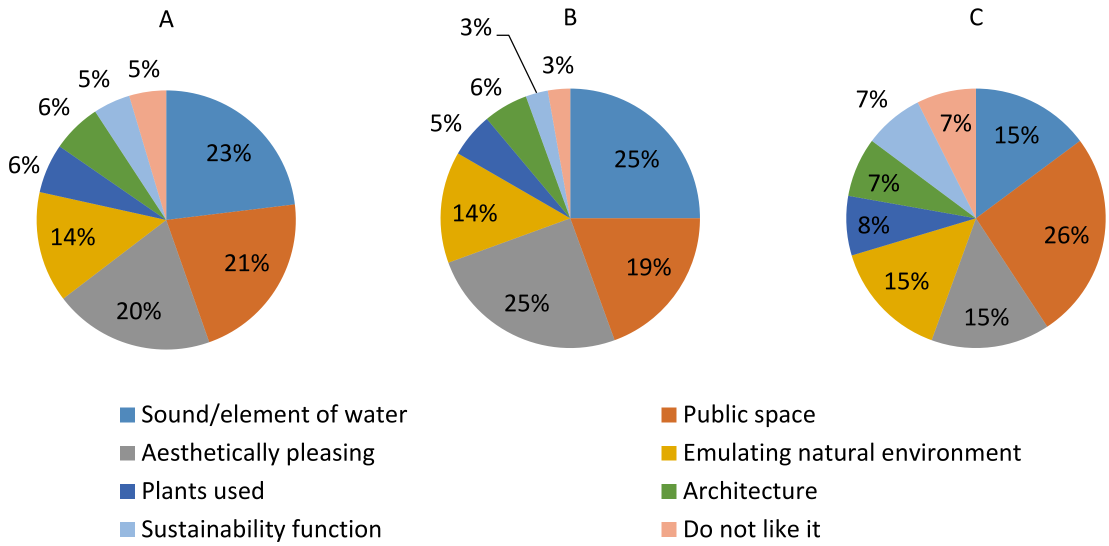

Figure 7. All responses (A) to the questionnaire's open-ended question "what do you like about this water feature" (question 3 on the questionnaire) with a further breakdown of responses from respondents who have been at UBC for 3 years or less (B), and 4 years or more (C).

The top three reasons for liking the terraces fell into the categories of "sound/element of water", "public space", and "aesthetically pleasing", which respectively take up 23%, 21%, and 20% of all responses, and also take up a large part of responses in the "4 or more years at UBC" and the "3 years or less" categories. All reasons for liking the terraces included: the sound/element of water, a provision of public space, an aesthetically pleasing feature on campus, a landscape emulating [the] natural environment, the plants used, the architecture, and the fact that is has some component of sustainability associated to it.

Overall, 5% of respondents simply answered that they did not like the feature, though there was a difference in the distribution of this answer, depending on the length of time the individual had been at UBC: 7% in the group who had been at UBC for four years or more compared to 3% in the group who had been at UBC for three years or less. Reasons for these differences may be due to the changing perception that students have towards the area. It is possible that more respondents who have been here for longer may say that they do not like the feature for reasons of nostalgia, associating the construction of the terraces as a "waste of time or money", using the previous location for parking their cars or as a pick-up/drop-off point, or constantly seeing the area under construction for many years.

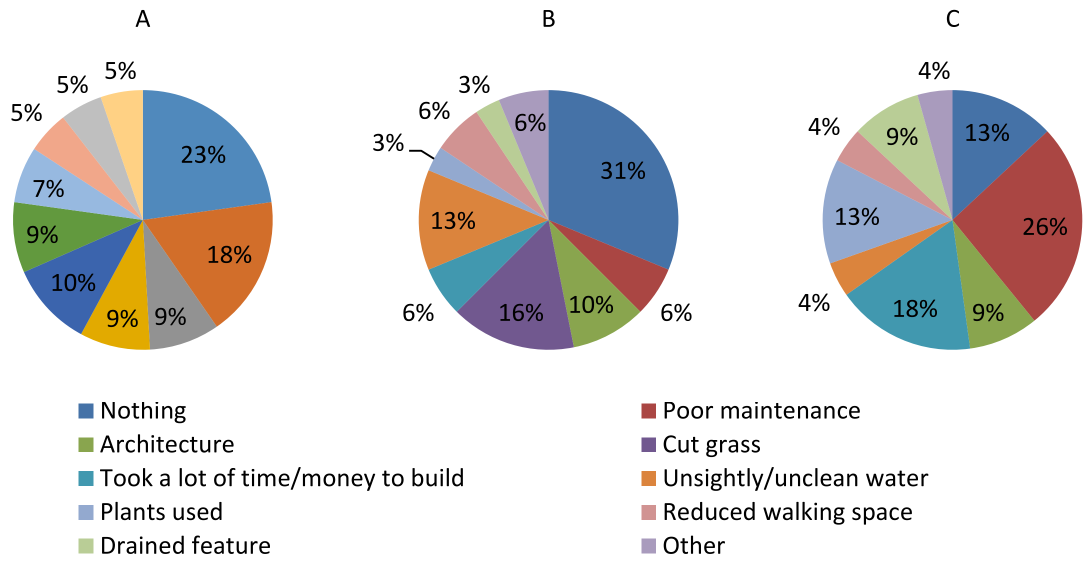

Figure 8. All responses (A) to the questionnaire's open-ended survey question "what do you dislike about this water feature" (question 4 on the questionnaire) with a further breakdown of responses from respondents who have been at UBC for 3 years or less (B), and 4 years or more (C).

The top response for "what do you dislike about the terrace?" was "Nothing" (23%), followed by answers that fell into the categories of "Poor Maintenance" and "Architecture". Under Poor Maintenance, the answers revolved around dilapidated plants (in some seasons), litter, and unclean look in general. For Architecture, respondents said they disliked the metal anti-skate tacks on the feature, and also the water flutes that funnel water from terrace to terrace, saying they were too narrow and resembling "pipe drainage".

Other reasons for not liking the terrace included: dislike the cut "grass" the fact that it took a lot of time/money to build, the unsightly "sewage-like" water, the kinds of plants used in the feature, the fact that it takes up a lot of space and reduces walking space, when the feature is drained, "bugs", that it is a "mock sustainability feature", it does not look good in all seasons, and disliking the "Storm the Wall" advertisements on the terraces' concrete.

Again, there is an interesting difference in responses between those who have been at UBC for longer versus those who have not. Those at UBC for three years or less responded "nothing" to what they dislike 18% more (31% vs. 13%) than those who had been in UBC for longer. The latter group also had a larger proportion (18%, compared to 6% in the group at UBC for three years or less) of respondents say that the feature was expensive and took a lot of time and money to construct. Out of the 13% who had been at UBC for 4 years or more, 8% was made up of respondents who had been at UBC for six years or more, while the remaining 5% were respondents who had been at UBC for four to five years.

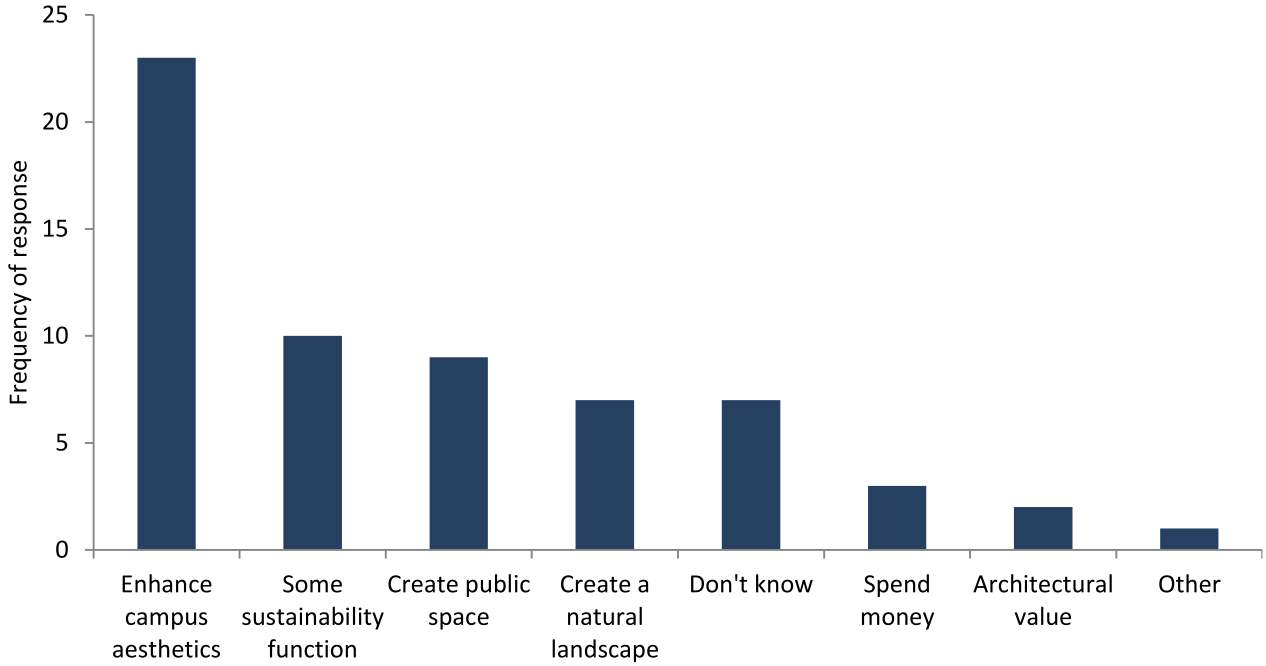

Figure 9. Grouped responses to the questionnaire’s open-ended question “what do you think is/are the main purpose(s) of this feature” (question 5 on the questionnaire).

We asked respondents what they thought was/were the main purpose(s) of the water feature to find out if the UBC community was aware that the terraces were part of UBC’s stormwater management plan, in addition to being a public space at UBC (Figure 9). The most common responses were grouped into the category “enhance campus aesthetics” (37% of all responses). The second most common response (16% of all responses) was that the feature had “some sustainability function”, with some respondents specifying that the function was linked to water filtration. Other categorically grouped responses to the main purpose of the feature included: “create public space”, “create a natural landscape”, “spend money”, create “architectural value”, and “other”. 11% of respondents said they did not know what the purposes of the feature were.

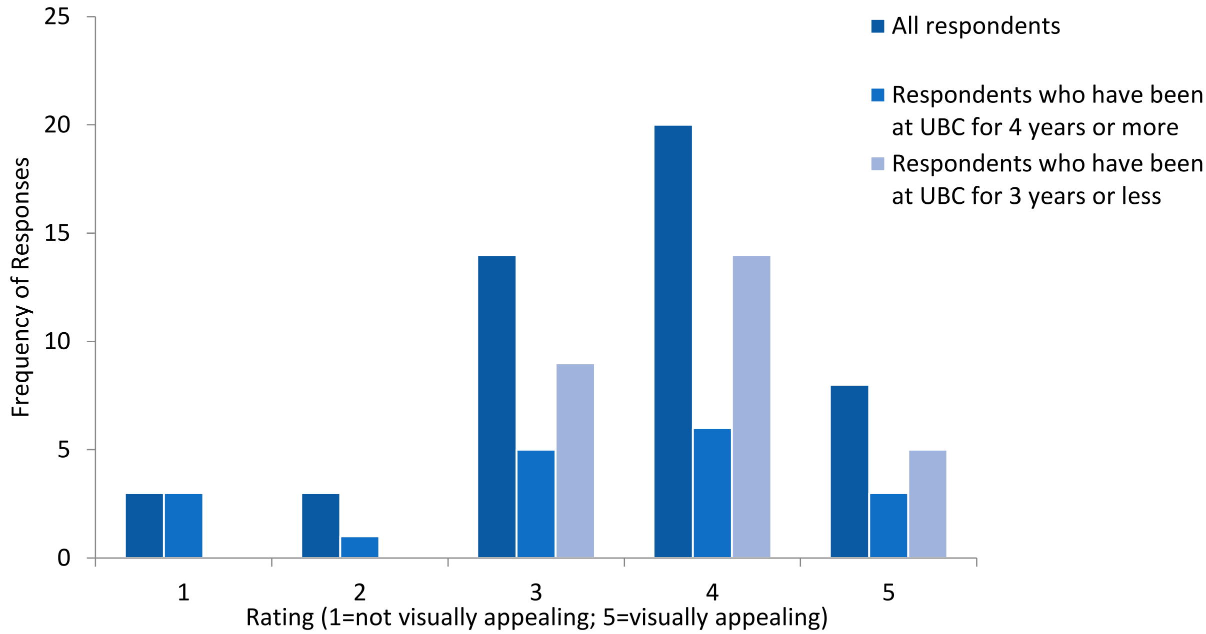

Figure 10. Responses to the questionnaire question "how aesthetically pleasing do you find this water feature" (question 6 on the questionnaire) with a further breakdown of responses from respondents who have been at UBC for 3 years or less, and 4 years or more.

Most respondents (87.5%) rated the feature a "4" in its aesthetics, while very few (12.5%) gave it "1" or "2". Those who had been at UBC for three years for less selected values of "3" or higher, while those who had been at UBC for four years or more were the only group who selected "1" or "2". Two respondents did not specify how long they had been at UBC, which makes up the difference in "All respondents" and "Respondents who have been at UBC for 4 years or more". While this appears to show that respondents who have been at UBC for longer find the feature less attractive, this is not necessarily so (Figure 11).

The lowest aesthetic ratings came from the group of respondents who have been at UBC for 4-5 years. This was also the group with the most diverse response. The least diverse responses and highest ratings came from those at UBC for more than six years. Respondents at UBC for three years or less held the bulk of responses that rated the aesthetics of the features as "3" or lower.

These results suggest that it is the cohort close to graduating (as all but two respondents from this group were students) that have the most negative opinions about the terraces and supports the earlier idea that this group may have social/personal reasons for these choices, as the group has most likely seen the project from its start to finish.

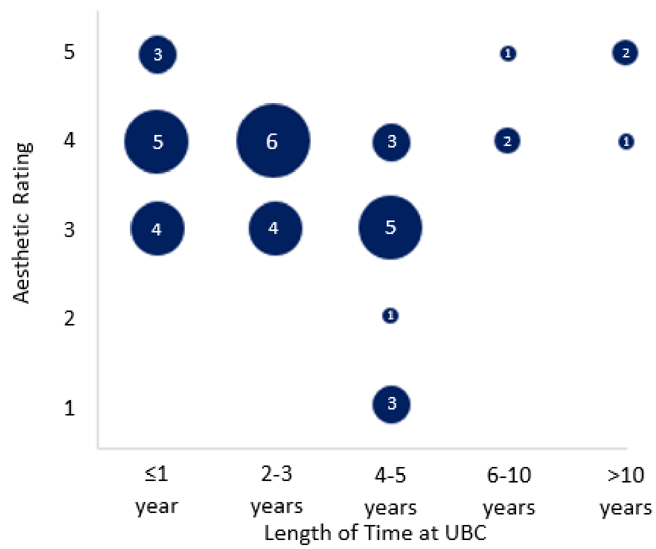

Figure 11. A representation of the frequency of responses towards a particular aesthetic rating from respondents who have spent different periods of time at UBC, grouped into five different categories of less than or equal to 1 year, 2 to 3 years, 4 to 5 years, 6 to 10 years, and greater than 10 years.

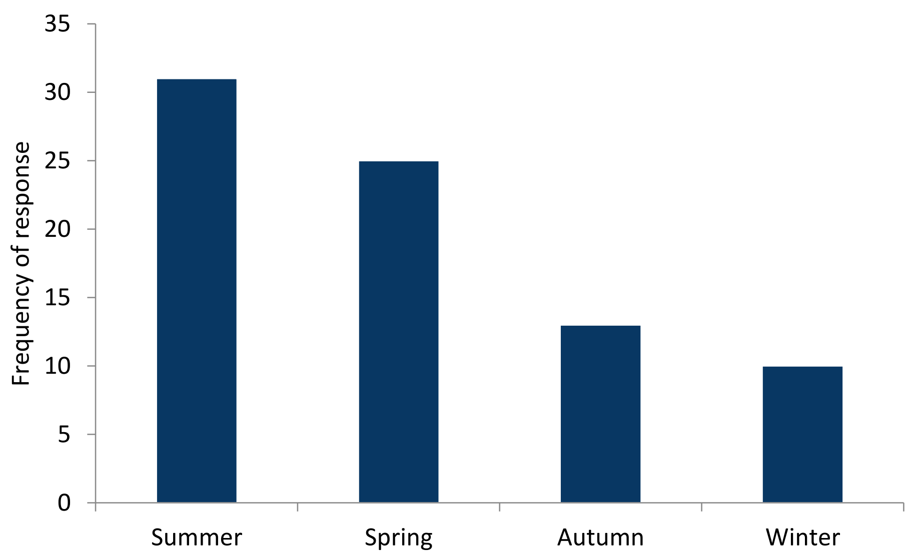

Figure 12. Responses to the question "in which season do you like to spend time at this water feature" (question 9 on questionnaire)

Summer was seen as the most popular time of the year that respondents found the terraces most appealing and spend their time there (39% of responses), while winter falls as the least popular choice (13% of responses). The choice of spring (31% of responses) was higher than that of autumn (16% of responses).

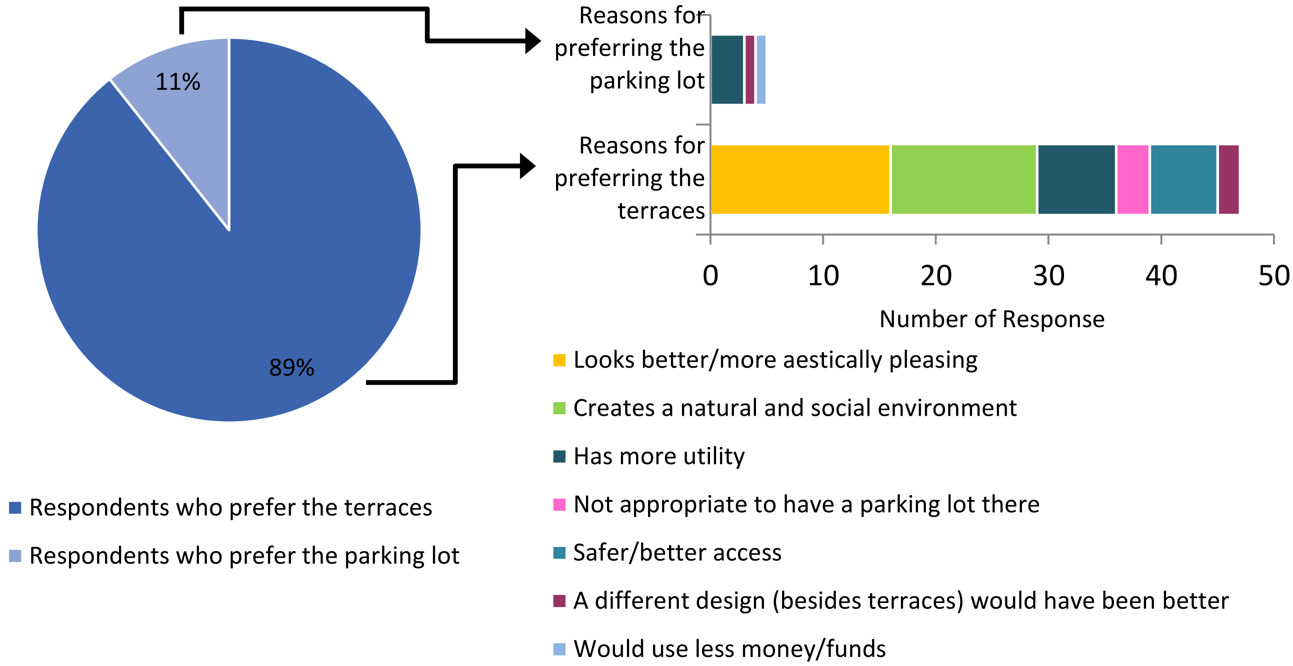

Figure 13. Questionnaire responses indicating if respondents prefer the current feature or the previous parking lot, and reasons for their answers.

Respondents were asked "this site used to be a parking lot before this feature was constructed. Which landscape do you prefer and why". The vast majority (89%) said they preferred the terraces, while 11% said they preferred the parking lot. There were also respondents who picked one response over the other, but added that on the whole, they would have preferred something different instead (such as a different design that was neither the parking nor the terraces). None of the respondents said that they preferred either landscape for sustainability reasons.

Other than preferring a different design, reasons for preferring the parking lot were that it had more utility and it required less money to construct/maintain. This last point also came up in reasons for preferring the stormwater feature. Other reasons for preferring the stormwater terraces were that the stormwater terraces look better than the parking lot, the feature provides a public space, has more utility, is safer, and is pedestrian friendly (allowing for safer/better access).

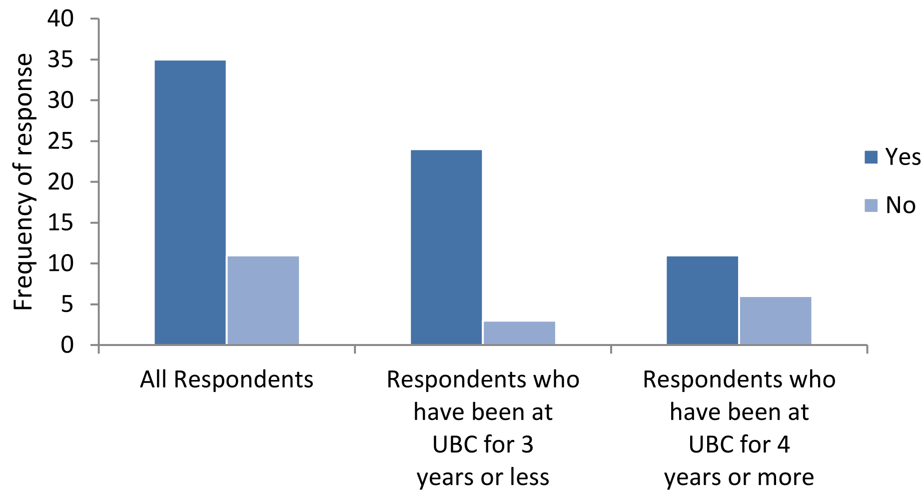

Figure 14. Responses indicating whether respondents are happy with the presence of the stormwater terraces on campus, given that at some times of the year, additional resources are required to sustain it. A further breakdown of responses from respondents who have been at UBC for 3 years or less and for 4 years or more is also shown.

On the whole, respondents were "happy" with the feature on campus, even if it uses additional resources at certain times of the year. Those who have been at UBC for three years or less favoured the terraces more than those who have been at UBC for four years or more.

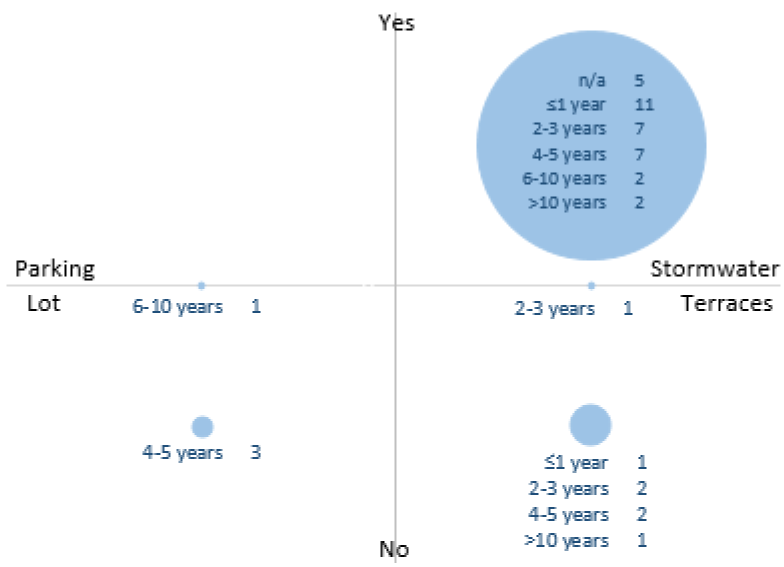

Figure 15. A comparison of numbers of respondents who said either "yes" or "no" to the question about the presence of the terraces and extra resource use (questionnaire question 11) and either "parking lot" or "stormwater terraces" to the question asking which landscape they preferred (questionnaire question 10). Numbers indicate the number of responses from respondents who have been at UBC for varying lengths of time and "n/a" encompasses any respondents who identified themselves as visitors and answered these questions.

There are no respondents who did not prefer parking lot and said “yes” (top left quadrant) were “happy” with the presence of the stormwater terraces (Figure 15). Logically, this makes sense because if someone preferred the landscape of the parking lot, they are unlikely to support the presence of the feature on campus once they find out that extra resources are required to keep continuous flow throughout the year). The highest combination of answers from respondents was “yes” (they are “happy” with the terraces) and “preferred terraces” (over the previous landscape of the parking lot), with 32% of those respondents having been at UBC for one year or less. The only group who said they were both not “happy” with the stormwater terraces and preferred the parking lot (bottom left quadrant) were those who had been at UBC for four to five years.

Two respondents did not specify “yes” or “no” to question 11 (regarding presence of the terraces and extra resource use), but one who had been at UBC for six to ten years said they preferred the parking lot, while another who had been a UBC for two to three years said they preferred the stormwater terraces.

On the whole, the stormwater terraces do provide a positive social component to the campus for the UBC community as 68% of respondents prefer the terraces and are “happy” with the presence of the feature on campus. As seen previously, it is the respondent group who have been at UBC for four to five years that have the most negative feelings towards the feature.

Responses to the other comments section of the questionnaire were summarized (Table 5). Very few respondents, only 13, answered this section.

Table 5. Summary and quotes from the open-ended "other comments" section of the survey, with the number of that response in brackets.

Positive Comments	Negative Comments	Suggestions for the Stormwater Terraces
• Feature looks good and I like it (3) • It looks pretty when plants are not cut down (1) • I would like to see more of such features on campus (1)	• "My perception may be more negative if I knew how much more water is used" (1) • The parking lot was better (1)	• There should be a pathway on the eastern end (1) • "The design should be modified" (no specifics given) (1) • "Water flutes and lighting (not multi-coloured) should be changed" (1) • "Something new should be constructed here" • "There should be a way to make it beautiful and not use extra energy" (1) • "Add fish" (1)

7.4 Conclusion and Recommendations

Overall, respondents liked the presence of the stormwater terraces on campus. Respondents who had been at UBC for four to five years (and thus seen the landscape change from the parking lot to the terraces) seemed to have a more negative and critical opinion of the terraces than students who have been here for a shorter period of time. The majority of respondents were also happy with the presence of the feature despite the use of additional resources, which indicates that there is a social sustainability or human health and wellbeing component being fulfilled by the terraces.

One thing to note is that while there were a large number of responses towards liking the terraces, we did conduct the survey near the feature, which may bias responses (i.e. people are near the terraces because they enjoy them). Additionally, with a small sample size of 50 respondents, one individual has a large influence on the averages and the totals (1 individual = 2% of results, or more in some cases). Additionally, not all questions on all questionnaires were completed, which may result in some data inaccuracies.

The implications of the results show that the UBC community is largely happy with the presence of the stormwater terraces on campus, despite its use of water. It is likely that if this questionnaire is conducted again, when the student cohort that has spent four to five years at UBC have graduated or left, there may be a larger proportion of positive responses towards the terraces, since other groups of respondents had a more positive attitude towards the stormwater terraces.

In terms of how this can affect the environmental sustainability of the stormwater terraces, the option to leave the terrace dry in the summertime (to save on the usage of potable or hydrant water) will come at the cost of fewer people enjoying it and may be detrimental to the vegetation in the terraces. It will, however, resolve the problem of having to clean the algal bloom (discussed in 5.3.3 Site Maintenance Plan and Algaecide) from the feature.

There are two recommendations to improve the perception of the feature on campus and to increase its value (without making structural modifications to the feature). First, to put in place a better maintenance plan where there is more consistency in how the terraces are managed. This would entail a) all parties (Campus and Community Planning (C+CP), Building Operations (Building Ops), and Plumbing) knowing when the scheduled time is to drain the stormwater terraces or cut the tall reeds and b) including a plan that outlines under what circumstances it is (or is not) appropriate to treat algae, drain the terraces, cut plants and refill the terraces.

Second, to have an educational component to the feature that reaches out to students. For example, a poster, display or infographic at Achievement Square or at Martha Piper Plaza outlining the purposes of the feature. Of course, C+CP will have to decide what to include in the poster so as to not 'greenwash' the feature, but also not highlight its flaws – perhaps outlining the function of the feature as a place to foster social sustainability.

The possibility of adding a First Nations Pole to the top terrace when the Alumni Centre opens (as Dean Gregory said may happen) is likely to add more value to the feature and further increase its reception within the UBC Community, as it will hold more cultural significance.

Modifications to the feature itself, assimilated from comments and responses to the questionnaire, include: adding fish, reducing the amount of visible cement, making the anti-skateboarding ridges less obvious/obtrusive to sitting/lying in the area, and changing the shape of water funneling flutes in the terraces. Feasible possibilities may include the latter three since the idea of fish will have many other challenges and will require much more research to determine what fish species are appropriate and what modifications need to be made to the system in order to ensure their longevity in the system (e.g. what would happen when the fish reach the opening to the cistern or what would happen when the system needs to be drained).

8.0 Final Remarks

In conclusion, UBC Vancouver's stormwater terrace do not meet most of the relevant Water and Soil & Vegetation criteria selected for assessment in the SITES v2 Rating System (Table 6). Better management of precipitation, actually reducing water use, and development of a detailed site maintenance plan will be required in order to meet requirements and achieve a better score, respectively, for the two prerequisites and two credits not met under the Water section. In addition, the use of ionic copper as an algaecide would not meet SITES criteria. Two of the three Soil & Vegetation prerequisites that are not met will require soil and site management plans while the not applicable credit requires official SITES certification pursuit in order to assign a score.

Table 6. Scorecard from the SITES v2 Rating System, modified to only include credits that are applicable to the stormwater feature.

Requirement Met or Points Obtained	3: SITE DESIGN – WATER		Possible Points:	17
No	**WATER P3.1**	Manage precipitation on site		
No	**WATER P3.2**	Reduce water use for landscape irrigation		
0	**WATER C3.3**	Manage precipitation beyond baseline		**4 to 6**
0	**WATER C3.4**	Reduce outdoor water use		**4 to 6**
5	**WATER C3.5**	Design functional stormwater features as amenities		**4 to 5**
	Total Water Points			**5**

Requirement Met or Points Obtained	4: SITE DESIGN - SOIL + VEGETATION		Possible Points:	12
No	**SOIL+VEG P4.1**	Create and communicate a soil management plan		
No	**SOIL+VEG P4.2**	Control and manage invasive plants		
Yes	**SOIL+VEG P4.3**	Use appropriate plants		
N/A	**SOIL+VEG C4.6**	Conserve and use native plants		**3 to 6**
5	**SOIL+VEG C4.8**	Optimize biomass		**1 to 6**
	Total Soil +Vegetation Points			**5**

The practices involved in the upkeep and maintenance of the terraces need to be improved in order to come closer to fulfilling the criteria. With missing components such as:

- a site maintenance plan,
- water usage tracking (e.g. flowmeters), and
- a soil maintenance plan,

the stormwater terraces cannot be effectively assessed by the SITES v2 Rating System. The existence of an accurate and updated site maintenance plan is crucial to obtaining SITES certification. Should a SITES certification be pursued for future UBC landscapes, the entirety of the project from start to finish will have to be taken into consideration as SITES guidelines encompasses the project life cycle from the planning stages to demolition.

The UBC community mainly views the presence of the stormwater terraces on campus as a positive aspect, despite its use of extra water. Feasible recommendations to improve the social perceptions of the feature as suggested by the UBC community include reducing the amount of visible cement, making the anti-skateboarding ridges less obvious/obtrusive to sitting/lying in the area, and changing the shape of water funneling flutes in the terraces.

Conducting additional landscape assessments at UBC in the future would help to further the understanding of how UBC landscapes measure against the benchmark landscape sustainability criteria developed by SITES. This process of reviewing existing landscapes contributes to the ultimate goal of developing future landscapes to be more sustainable.

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10.0 Appendices

10.1 Appendix A: SITES v2 Rating System Credits Exclusion

The criteria from the Water and Soil & Vegetation sections of the SITES v2 Rating System not included in this project include the following:

- Water Credit 3.6: Restore aquatic ecosystems
- Soil & Vegetation Credit 4.4: Conserve healthy soils and appropriate vegetation
- Soil & Vegetation Credit 4.5: Conserve special status vegetation
- Soil & Vegetation Credit 4.7: Conserve and restore native plant communities
- Soil & Vegetation Credit 4.9: Reduce urban heat island effects
- Soil & Vegetation Credit 4.10: Use vegetation to minimize building energy use
- Soil & Vegetation Credit 4.11: Reduce the risk of catastrophic wildfire

The majority of the above credits do not apply to the stormwater terraces because the landscape that existed before the development of the terraces was a parking lot. There were no aquatic ecosystems to restore and no vegetation and soils to conserve from the parking lot landscape. The stormwater terraces were not intended to address the urban heat island effect, minimize building energy use (this site does not include regularly occupied buildings as per SITES requirements), or reduce wildfire (this site is not at risk for wildfires).

10.2 Appendix B: Ionic Copper Application

The following is an excerpt of the response email regarding the application of ionic copper to the stormwater terraces at UBC's Vancouver Point Grey Campus (B. Lightowlers, personal communication, November 20, 2014).

"We initially treated the water feature when it was completely full of algae. This treatment was conducted at 1 ppm ionic copper (60.000:1 product dilution) and the feature was cleaned of algae after treatment. The ionic copper strength slowly decreases as the product comes into contact with bacteria and algae from normal airborne and other sources. The residual copper ions react quickly with the new microbial tenants and this process slowly reduces the ionic Cu level. Under typical conditions, the ionic copper is maintained above 0.1-0.3 ppm over the winter and we monitor to maintain a minimum residual to maintain control of the algae population. During winter, there is a significant input of microbial material with rainfall as well as a loss of water from the overflow conditions expected in this weather. This is why the levels need to be monitored. It is more cost effective to maintain ongoing control of algae by maintaining minimal levels that to restart the process in the spring when algae levels are building up."

10.3 Appendix C: Copy of the Questionnaire Used for the Social Aspect

This is the questionnaire that was filled out by the UBC community regarding the stormwater terraces (Figure 16).

ENVR 400 SITES Research Project Questionnaire

If this questionnaire is completed, it will be assumed that consent has been given.

1. What is your connection to UBC?
☐ Student ☐ Faculty ☐ Staff ☐ Visitor ☐ Other: ________

2. If applicable, how long have you been at UBC and which faculty or department are you in?

3. What do you like about this water feature?

4. What do you dislike about this water feature?

5. What do you think the main purpose(s) of this water feature is/are?

6. How aesthetically pleasing do you find this water feature?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Least Pleasant — Most Pleasant

7. How do you spend your time near this water feature (e.g. hanging out, meeting place, quiet time, etc.)?

8. How often do you spend time here?
☐ Never ☐ Once a week ☐ More: ________
☐ Once a month ☐ 2-3 times a month

9. Which season and what time of day do you like to spend time here? Select all that apply.
☐ Spring ☐ Summer ☐ Autumn ☐ Winter
☐ Morning (6am-11am) ☐ Around noon (11am-1pm)
☐ Afternoon (1pm-5pm) ☐ Evening/night (5pm-6am)

10. This site used to be a parking lot before the construction of this water feature. Which landscape do you prefer and why?

11. At certain times of the year, additional resources (e.g. potable/hydrant water, energy, etc.) are required to sustain the system. Considering this as well as the functions the water feature provides, are you happy with the presence of this water feature on campus?
☐ Yes ☐ No

12. Do you have any other comments regarding this water feature?

Thank you for your time and for completing this questionnaire!

Figure 16. The questionnaire given to the UBC community to fill out.

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