

Agricultural Road Walkway
Sustainable Sites Initiative - Water

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Table of Contents

Credit 3.1 and 3.2 (2-5 Points)	2
Credit 3.5 (5-10 points)	3
Credit 3.6 (3-9 Points)	7
Credit 3.7 (1-3 Points)	10
Credit 3.8 (1-4 Points)	12
Final Evaluation	14
Appendix 1: Calculations for 3.1 and 3.2	15

Credit 3.1 and 3.2 (2-5 Points)

3.1 (Prerequisite): Reduce potable water use for landscape irrigation by 50 percent from established baselines.

3.2 (2-5 Points): Reduce potable water use for landscape irrigation by 75 percent from established baselines.

0 Points

- Less than 75% potable water use was reduced.
- Satisfied prerequisite 3.1 but not 3.2.

Irrigation Calculation*

Part 1: Baseline Landscape Water Requirement (BLWR)

$$BLWR = ET_0 \times A \times C_u$$

Where:

ET₀ = average reference evapotranspiration (ET₀) for the site's peak watering month, provided locally (inches/month).

A = Area of irrigated landscape in square feet (area designed with permanent irrigation systems)

C_u = Conversion factor (0.6233 for results in gallons/month)

ET ₀ (inches/month)	A(square ft)	C _u	BLWR(gallons/month)
4.63	91300	0.6233	263480.7527

Part 2: Designed Landscape Water Requirement (DLWR)

$$DLWR_H = RTM \times [(ET_0 \times K_L) - R_a] \times A \times C_u$$

Where:

RTM = Run time multiplier, equal to 1/low quarter distribution uniformity (dimensionless)

ET₀ = average reference evapotranspiration (ET₀) for the site's peak watering month, provided locally (inches/month)

K_L = Landscape coefficient for type of plant in that hydrozone

R_a = Allowable rainfall (25% of average monthly rainfall for the site's peak watering month, provided locally (inches/month))

Zone	hydrozone Area (m ²)	(sq.ft.)	Plant Type	Landscape Coefficient	Irrigation Type	Distribution Uniformity	DLWR _H
1	3300	35520.9044	NA	NA	NA	NA	-
2	3090	33260.4832	turfgrass	0.65	Rotor/Spray	67.50%	85586.7875
3	2090	22496.5728	Trees/Shrubs	0.35	Rotor/Spray	67.50%	29034.4039
Total Area=	8480	91277.9603	Landscape Water Requirement for the Site(gal/month)				114621.191

Part 3: Results

Percentage Reduction = (BLWR - (DLWR - NPS))/BLWR

BLWR	DLWR _H	NPS	% reduction
263480.753	114621.191	0	56.497319

In conclusion, the designed landscape's percentage reduction in potable water use from the baseline case is 56.5%, satisfying the prerequisite only.

**See Appendix 1 for detailed calculations.*

Credit 3.5 (5-10 points)

Manage stormwater on site.

7 points

- *40% of total runoff was reduced*

For this section, points are earned based on the fraction of the difference between the initial water storage capacity and the target condition. In the case of Agricultural Road, it is treated as a "brownfield" which means widespread infiltration is not often an option due to contaminated soils and the potential for groundwater contamination, less improvement in water storage capacity is needed to achieve credit.

According to the "GUIDELINES AND PERFORMANCE BENCHMARKS 2009" by Lady Bird Johnson Wildflower Center at The University of Texas, Austin, the target water storage has been estimated as 70 (using Tr-55 curve numbers) for Humid West sections across the United States which has similar weather conditions to that of our site.

Note: since Tr-55 is a software developed in the United States, its weather data was basically collected around United States, thus we choose Seattle to do the calculations as it has the similar conditions to our site.

Calculations:

Note that we assume the considerable site is along Agricultural Road and up to the buildings on both sides.

Also, Vancouver has similar soil condition as Bellingham in the US which is in Group C of the Hydrologic Soil Groups.

Definition of Group C soil:

Group C soils have slow infiltration rates even when thoroughly wetted. They have a layer that impedes the movement of water downward. Group C hydrologic soils are moderately fine-to-fine in texture. It forms a more cohesive ball than Group B soils when squeezed in the hand. The rate of water filtration is 0.05 to 0.15 inch per hour. Garden soil of this group type benefits from adding compost increasing its water filtration rate.

Initial condition:

Area of pavement is found as 171 m²

Planting area:

- 1. Outside Klinck Building: 240 m²
 - 2. Outside Geography Building: 123.9 m²
 - 3. Outside Mathematics Building: 65 m²
- Total planting area: 428.9 m²

Figure below shows the Tr-55 Curve Number of the site before construction which is **79**:

Land use for agri rd	Area	HSG
Paved parking lots, roofs, driveways	0.042	C
Meadow -cont. grass (non grazed)	0.106	C

Project Area(ac) Summary Screen Off On Sub-Area Area (ac) Weighted CN:

Final condition:

Area of pavement: 171 m²

Planting area:

- 1. Outside Klinck Building 233 m²
 - 2. Outside Geography Building: 183.2 m²
 - 3. Outside Mathematics Building: 99.6 m²
- Total panting area: 515.8 m²

Figure shows the Tr-55 Curve Number of the site after construction which is **77**:

Land use for agri rd	Area	HSG
Paved parking lots, roofs, driveways	0.042	C
Meadow -cont. grass (non grazed)	0.137	C

Project Area(ac) Summary Screen Off On Sub-Area Area (ac) Weighted CN:

Therefore, by looking at the table below (obtained from Sustainable Sites Handbook 2009), 7 points are earned due to the construction.

TABLE 3.5-F: HUMID WEST COAST (Reference Site: Portland, OR)
BROWNFIELD / Target Curve Number = 70

Initial Curve Number	Final Curve Number																												
	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70
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5 points = 20 percent reduction in runoff volume
7 points = 40 percent reduction in runoff volume
10 points = 60 percent reduction in runoff volume

EXISTING CONDITIONS ON SITE:

1. On-site topsoil designated to remain undisturbed in-situ, must be assessed, tested, amended, protected from compaction and weed infestation, and otherwise managed for the duration of the project as required and/or directed according to project drawings, specifications, soil test results or as directed by the Project Landscape Architect in consultation with UBC Building Operations Head Landscape Technologist and/or Landscape Designer.
2. On-site topsoil infested with pernicious perennial weeds such as horsetail, vetch or morning glory etc. shall be excavated to depth necessary to prohibit future recurrence and removed from UBC Campus. Alternative remedial strategies must be presented in writing and reviewed and approved by the Project Landscape Architect in consultation with UBC Building Operations Head Landscape Technologist and/or Landscape Designer.

3. On-site topsoil intended for use as growing medium, or as component of growing medium, shall be protected against contamination from invasive or pernicious weeds, insect pests, plant pathogenic organisms and other extraneous and non-organic materials and environmental toxins or contaminants.
4. On-site sub-soil must not be used as a component of growing medium unless endorsed by Soil Consultant and whereby it can be amended to meet requirements of growing medium.
5. Following rough grading, examine existing sub-grade conditions and signify acceptance in writing to the Project Landscape Architect.
6. Ascertain the size and location of all existing services and sub-grades prior to the work.
7. Repair damage resulting from failure to exercise such precautions immediately at no cost to the Owner.

STRATEGIES:

1. All materials to be handled and adequately protected to prevent damage or contamination.
2. Stockpile materials in bulk form in paved area(s) approved by Project Landscape Architect. Take all precautions to prevent contamination of basic materials from wind-blown soil particles, weed seeds and from insects. Contamination of the ingredients may result in their rejection for use. Where paved surfaces are not available prevent contamination of on-site soil or sub-soil or construction materials.
3. Store fertilizer and chemical ingredients in the manufacturer's original containers.
4. Store growing medium and/or excavated topsoil in a dry area or covered and protected from weed infestation, contamination, damage, water saturation, compaction or erosion.
5. Maintain all stockpiled growing medium, excavated topsoil and all related amendments free of weed infestation prior to installation and throughout the duration of the project.

Credit 3.6 (3-9 Points)

Protect and enhance on-site water resources and receiving water quality

9 Points

- *A total of 95 percent of average annual volume of runoff discharged from the developed portion of the site receives stormwater treatment for pollutants of concern.*
- *The site uses soil- and vegetation-based systems to treat 100 percent of the treated water volume.*
- *At least 95 percent of the water makes its way into bioswales and gets treated for pollutants.*
- *No major pollutants affecting site.*

List of Exterior Materials

The Agricultural Road Walkway upgrade included simple exterior materials including concrete for the walkway itself and grass, soil and rock for the lawn on either side. The following is a list of paving types and their contribution in minimizing stormwater pollutants to runoffs:

- Concrete unit paving, light blasted concrete paving and asphalt/concrete paving are concrete based materials that do not contribute to stormwater runoff. The concrete unit paving has pervious cuts between each block and they trap many pollutants which then go underground and out of the runoff.
- Gravel paving, another surface on the Walkway, has a very permeable surface great for absorbing large amounts of water and trapping pollutants, keeping them out of water systems.
- There are also a few sections along the Agricultural Road Walkway that have Grasspave, a type of paving with a wearing course that allows stormwater to infiltrate back into the groundwater while at the same time reducing pollutants.
- Lastly, there are the bioswales into which all the runoff from the Walkway and the green spaces drain into, where they are fully treated.

Measures to Reduce the Volume of Stormwater Runoff

The unit paving Walkway and the green space are features that help reduce the stormwater runoff by 30% and 60% respectively. The remaining runoff from the walkway and the green space drain into the bioswales where they are 100% treated by soil and vegetation based systems. Any excess runoff is collected into a permeable pond in a rain garden at the end of the Walkway, where the water is retained and restored back into the garden upon demand. Therefore, none of the water runoff enters water systems or receiving waters.

All water runoff that is treated is treated to an average discharge concentration of less than 25 milligrams/litre total suspended solids (TSS) discharge through use of a water quality wet pond at the end of the Walkway as well as bioswales along the length of the Walkway.

	Area (m ²)	Runoff Coefficient (r)	Precipitation in 1992 (m)	Total Volume (m ³)	Runoff Volume (m ³)
			p	P=p*A	R=r*P
Walkway	564.0	0.60	1.1365	640.99	384.59
Green space	729.9	0.35	1.1365	829.53	290.34
Total Volume/year					674.93

List of Pollutants of Concern

This Walkway receives no major pollution as it is located in the heart of UBC, away from vehicle access and other forms of polluting agents. Still, a few minor pollutants of concern are salt from de-icing the walkway, which happens very few times in the winter, and fertilizer. The following is a Best Management Practices Matrix (BMP) that shows how the BMPs implemented treat the pollutants of concern.

Best Management Practices Matrix

	Does it reduce or add to runoff?	Does it reduce nutrient loss to runoff?	Does it minimize de-icing salt runoff?	Does it contain vehicle contamination?	Does it reduce fertilizer loss?
Bioswales	Reduce runoff	No	Yes, it takes all the polluted water with salt away from soil and vegetation	Yes	During high rainfall, any overflow is taken by the bioswales, restricting fertilizer loss
Containment Ponds (<i>Rain Garden</i>)	Reduce runoff by containing excess until required by vegetation	Yes, it contains the water with the nutrients and it soaks slowly back into the soil	No, overflow may contain some salt.	N/A	Yes, it is absorbed by the soil
Vegetated Buffers (small plantations)	Reduce runoff, absorbs water	Yes, it keeps the nutrients in the soil	Yes, leftover from swales is absorbed by vegetation (minimal)	Yes, it absorbs any of the minimal contamination it receives	Yes, the soil and plants absorb it
Semi-permeable pathways	Reduce runoff by draining into soil underneath	To an extent, it filters the nutrients back into the ground	Those pathways are not de-iced	N/A	Yes, gets absorbed back into ground
Drip Irrigation	N/A. It is well monitored with sensors	Yes, it maintains slow irrigation, which causes no water to exceed soil level.	N/A	N/A	Yes, prevents overflow/loss outside

Irrigation (nozzle)	N/A. It is monitored and will not cause any runoff	N/A	N/A	N/A	Yes, the nozzles are placed in a way that water doesn't leave lawn. All nutrients stay.
Bark mulch	Reduce. Absorbs the water and release to soil on demand	Yes, does not allow runoff	N/A	N/A. Vehicle contamination does not reach vegetation.	Yes, it doesn't allow water to seep out.

Credit 3.7 (1-3 Points)

Design rainwater/stormwater features to provide a landscape amenity

2 points:

- *75 percent of rainwater/stormwater features on site are designed as amenities and are visible from high-use portions of the site.*
AND
- *At least one rainwater/stormwater feature is visible and accessible from sidewalks, and contact is not prohibited. Water elements where limited human contact is allowed must meet local and/or state health requirements. In some situations, this may require additional treatment methods such as ozonation or thermal treatment.*

For this particular credit of the Sustainable Sites Initiative, the Agricultural Road has been given 2 points out of the possible 3. This is because:

- Not 100% of rainwater/stormwater features are visible and accessible from the high-use portions of the site
- There are no rainwater/stormwater features that are completely accessible and designed for full contact such as primary contact recreation

Jeff Nulty, a landscape designer from UBC's Department of Building Operations, led a tour on February 2, 2012 along the western half of Agricultural Road. Nulty explained during the tour the different features of the walkway that relate to the site's maintenance and sustainability. While the University of British Columbia does not have a lot of time allocated to site maintenance due to the vastness of the campus, the rain and stormwater features along Agricultural Road are quite sustainable and provide an amenity to the surrounding landscape. The following are water features incorporated in the design of the Agricultural Road walkway:

Bioswales

Many landscapes today have begun to use the element of bioswales, which are water channels designed onto the natural terrain. They are very useful as they serve multiple purposes. Bioswales can collect surface water runoff and cleanse the runoff by removing silt and pollutants before it enters the water table. Material wise, bioswales are generally formed with the natural soil of the landscape, covered organic materials such as vegetation or compost. It is worthwhile to note that the soil used for the landscape is rarely fertilized by actual fertilizer, but rather, compost from the UBC composting unit. The benefit of using this compost is that it is an environmentally friendly soil created from organic materials and mulch. This prevents any extensive use of chemical substances on the site.

As previously mentioned, bioswales are incredibly important as they have the ability to trap silt and various types of water pollutants. In the case of Agricultural Road, such pollutants can include contaminants from service vehicles that may be passing by, salt from de-icing the walkway, chemicals from pesticides, or any other foreign substances that passersby may introduce into the environment. Fortunately, Jeff Nulty explained that the frequency of vehicles passing through or amounts of pesticides used on the surround environment at Agricultural Road are generally fairly low. As a result, it can be seen that bioswales are very sustainable water features that are capable of minimizing the contribution of common rainwater/stormwater pollutants.

Rain Garden

Just a little beyond some of the bioswales located at the corner of West Mall and Agricultural Road is a small rain garden. Rain gardens are extremely beneficial as they essentially can collect large amounts of stormwater if there is excessive rainfall. With the addition of being able to store greater amounts of water, the functions of rain gardens are quite similar to those of bioswales.

The biggest purpose that they have is to help improve the water quality by filtering the runoff for any pollutants. This greatly reduces the chances of stormwater pollutants flowing into the water table of the soil. Because of their design, they do not require fertilizer and any water stored generally infiltrates the ground within a day.

Walkway

The walkway itself was designed purposefully. Constructed with concrete bricks, the walkway has a very low permeability and as a result, stormwater does not percolate through easily. In addition, the pathway is curved to the side, so stormwater can flow into the bioswales located along the sides of Agricultural Road.

Stormwater Drainage

In addition to the bioswales built along Agricultural Road, there are also drainage systems located along the walkway. These include elevated storm drains on the grass, situated to store water underneath the ground. They help lengthen the time that it takes for stormwater to infiltrate into the soil and water table. There are also drainage pipes on the walls of buildings facing towards Agricultural Road. These pipes connect from the roof and lead to the ground. The water that flows out of these pipes sometimes percolates into the ground or enters the bioswales nearby.

Credit 3.8 (1-4 Points)

Maintain water Features to Conserve Water and Other Resources

4 Points

- *3 points for rain garden being filled by sustainable water resources.*
- *Additional point for water circulation without human intervention (gravity).*

In this section, we analyzed the water features in and their ability to conserve potable water in the west section of the Agricultural Road Walkway. The water features are:

- Bioswale
- Rain Garden

Along the north side of the walkway, bios wale is installed to treat non-potable surface water of its pollutants. Since the walkway itself is almost impervious, it is slightly tilted in order to allow rainwater to flow towards the bios wale.

The only created water feature is a rain garden that is located near the intersection of West Mall and Agricultural Road Walkway. Although this rain garden is not for aesthetic purpose, it can collect non-potable rain water for irrigation.



Rain Garden

Water Feature Make-up Credit

Since the rain garden is filled by sustainable water sources (non-potable rain water) and requires no make-up water from potable sources, the site receives a full 3 points. In addition, water movement/circulation are all caused by gravity and no electricity is used. Therefore, an additional point is rewarded, totaling it to 4 points.

Construction and maintenance of the water features will not affect receiving waters due to following reasons:

- Agricultural Road Walkway is not near any streams, wetlands, or any other water bodies
- There is rarely any need to perform maintenance since water features are maintained naturally
- In the event of soil maintenance, no harmful chemicals are used

Final Evaluation

The Agricultural Road Walkway obtained a total of 22 out of 31 points, excluding the 13 points for sections 3.3 and 3.4, which will be evaluated by Sustainable Sites.

The Sustainable Sites Initiative evaluates sites on a 4-star rating system, on which Agricultural Road Walkway obtained **3 Stars** (for having at least 60% of the points). This is great news for UBC as it furthers their sustainable structures on the Vancouver Campus.

As City of Vancouver is trying to achieve the goal of making Vancouver the greenest city by 2020, the renewal of Agricultural Road also represents UBC's commitment to being a leader in sustainability and support the goal of the city.

Appendix 1: Calculations for 3.1 and 3.2

ET₀ & R_a

vancouver (Lat 49° 15' 0" N Long 123° 6' 0" W)

	P50 (Mm/month)	Rainfall (P75) (mm/month)	Temp (mean) (deg. C)	(DTR) (deg. C)	Ref Humid (%)	Sunshine (% of Hrs)	Wind Run (m/s)	Penman ET ₀ (mm/day)
Jan	180.39	133.83	3.10	5.30	84.00	19.00	3.80	0.57
Feb	144.53	103.75	5.00	6.50	83.00	29.00	3.70	0.83
Mar	129.21	100.31	6.70	7.60	79.00	35.00	3.80	1.40
Apr	91.94	69.41	9.10	8.40	75.00	40.00	3.70	2.18
May	67.94	47.85	12.40	9.00	74.00	48.00	3.30	3.00
Jun	49.20	31.28	15.40	8.90	74.00	47.00	3.40	3.53
Jul	39.91	22.64	17.50	9.70	73.00	58.00	3.20	3.92
Aug	41.88	23.99	17.70	9.60	76.00	57.00	3.10	3.29
Sep	70.94	45.43	14.70	8.80	80.00	48.00	3.00	2.08
Oct	141.25	100.81	10.30	7.30	85.00	37.00	3.30	1.05
Nov	195.98	147.36	6.10	5.80	85.00	23.00	3.90	0.67
Dec	222.36	182.57	3.60	5.20	85.00	20.00	4.00	0.53

Data from IWMI Water & Climate Atlas (www.iwmi.org)

According to International Water Management Institute's World Water and Climate Atlas, the peak-watering month for Vancouver is July.

1) Average reference evapotranspiration (ET₀) for July is 3.92 mm/day.

$$ET_0 = \frac{3.92 \text{ mm}}{\text{day}} * \frac{30 \text{ days}}{\text{month}} * \frac{0.1 \text{ cm}}{\text{mm}} * \frac{1 \text{ in}}{2.54 \text{ cm}} = 4.63 \text{ inches/month}$$

2) Average monthly rainfall for July is 22.64 mm/month

$$R_a = 0.25 * \frac{22.64 \text{ mm}}{\text{month}} * \frac{0.1 \text{ cm}}{\text{mm}} * \frac{1 \text{ in}}{2.54 \text{ cm}} = 0.223 \text{ inches/month}$$

Areas



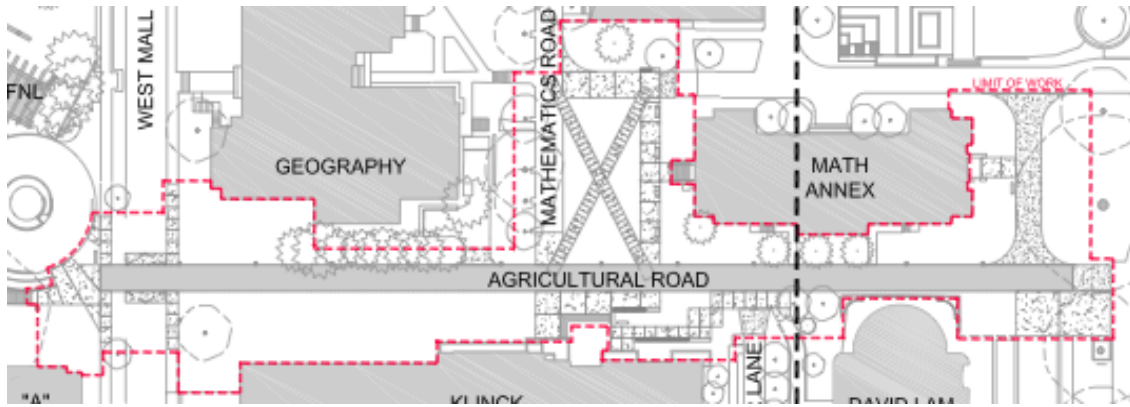
Area of limit of work: 3140 m²

Area of land without irrigation: 1100 m²

Area of turf: 840 m²

Area of trees/shrubs/ground cover: 1200 m²

2)



Area of limit of work: 5340 m²

Area of land without irrigation: 2200 m²

Area of turf: 2250 m²

Area of trees/shrubs/ground cover: 890 m²

Total area of limit of work: 8480 m²

Total area of land without irrigation: 3300 m²

Total area of turf: 3090m²

Total area of trees/shrubs/ground cover: 2090 m²

Landscape Coefficient (K_L)

With most intuitional landscape plantings, plant species selected are tough, easy to maintain and reasonably drought tolerant for plantings on Agricultural Rd. Therefore, these plantings are average medium-low water requirements.

Plant Type	K _L
Ground Cover	0.35
Shrubs	0.35
Trees	0.35
Turfgrass	0.65

Distribution Uniformity

The irrigation system for Agricultural Rd is a mixture of sprays and rotors, so the average value of DU or EU of spray and rotor is taken.

$$DU \text{ or } EU = \frac{0.70 + 0.65}{2} = 0.675 * 100\% = 67.5\%$$