TABLE 57: SUMMARY OF CTQ STORMWATER UPGRADE RECOMMENDATIONS

CTQ STORMWATER PLAN: RESEARCH ROAD IMPROVEMENTS	RECOMMENDATION AS PER CTQ PLAN
2011 Stormwater Plan: Main Parking Lot Improvements	SWM-1 suggests to improve the filtration of the Main parking Lots. This might reduce the measures recommended for Parking Lot Improvements, but would need to be analyzed further in an updated SWMP. Until then, allowance for this measure is still recommended.
2011 Stormwater Plan: Future Research Park—Pond #1	The *2011 Plan* proposes 920 m^3 a retention pond (infiltration pond) to detain the 100-year, 1-hour storm event from Catchment #3 and #10. The proposed SWM-1 new wetland area (Wetland 2) is intended to increase filtration from the main parking lot which will enhance the performance of the pond, but for the 100-year, 1-hour storm this pond is probably still recommended. A detailed SWMP is required to confirm the pond size in combination with the newly proposed wetland. This proposal emphasizes wetlands rather than ponds for storage.
2011 Stormwater Plan: Backflow Prevention	The *2011 Plan* general recommendation proposed.
2011 Stormwater Plan: Stormwater Monitoring	The *2011 Plan*'s general recommendation proposed.
2011 Stormwater Plan: Upper Cascades Townhouses—Storage Tank #2	The *2011 Plan* recommends an 88 m^3 storage facility to reduce the peak flows from the future Upper Cascades Townhouse development. SWM-2 proposes to incorporate raingardens/ swales that will reduce the volume and flow which will impact the size of the tank. A detailed SWMP analysis is required to confirm the tank size requirements and to understand if the 2011 measure would be obsolete. Until then, allowance for this 2011 measure is still recommended.
2011 Stormwater Plan: Building K—Tank #2	The *2011 Plan* recommends a 70 m^3 storage facility for future building K2 and University Plaza. With suggested SWM-2 measures, volume and peak flows are anticipated to be reduced, which could result in a smaller tank system. A more detailed SWMP analysis is required to confirm tank size requirements and to understand if the 2011 measure would be obsolete. Until then, allowance for this 2011 measure is still recommended.
2011 Stormwater Plan: University Way—Pond #2	The *2011 Plan* recommends a dry retention Pond #2 be located by University Way/ Hollywood Road to control larger stormwater events. The location of Pond #2 is proposed to be moved to the northern side of University Way to connect with the wetland complex as per SWM-1, Wetland 2 and 3. Stormwater swales along University Way are also proposed in the *2011 Plan* along with SWM-1. The size and capacity of *2011 Plan* Pond #2 might be reduced due to the LID methods proposed. A more detailed SWMP analysis is required to confirm pond sizing. Until then, allowance for this 2011 measure is still recommended.
2011 Stormwater Plan: Knowledge Lane Improvements	The *2011 Plan* recommends storm-pipe upgrades on Knowledge Lane to reduce the 100-year overland peak flow and volumes from the adjacent buildings. SWM-2 suggests measures to reduce the runoff from buildings, but the storm-pipe upgrades are still likely required for the 100 year peak flow. An updated SWMP is required to confirm storm-pipe size while taking into account SWM-2 measures. Until then, allowance for this 2011 measure is still recommended.

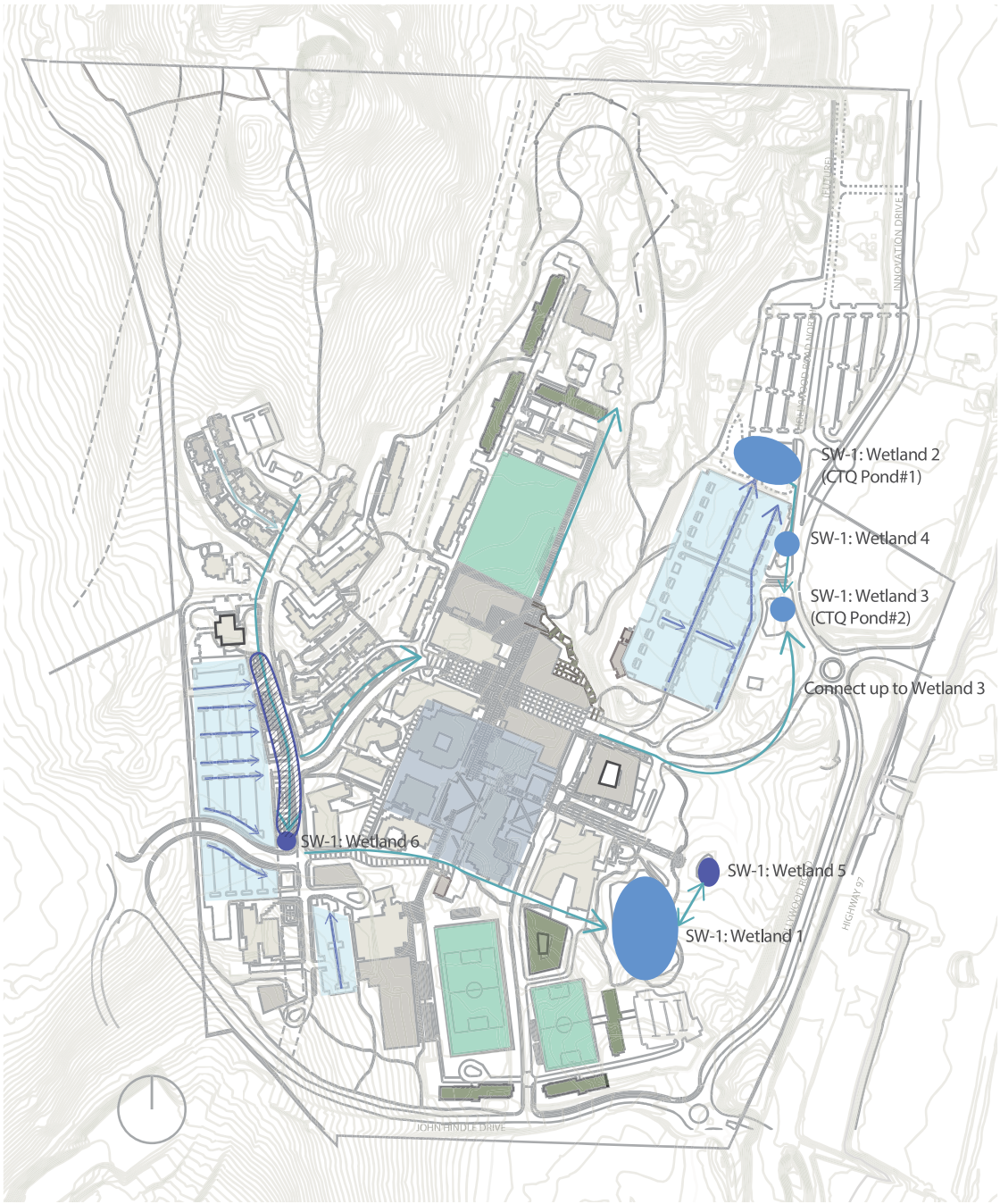

FIGURE 58: STORMWATER CONCEPT PLAN

7.3 BENEFITS AND CHALLENGES

Similar to the section on Ecological Landscape and Biodiversity, there are a number of qualitative benefits and challenges with the stormwater measures presented above that should be weighed as part of the broader decision-making process (Table 58).

TABLE 58: BENEFITS AND CHALLENGES—STORMWATER MEASURES

MEASURE	BENEFITS	CHALLENGES
Stormwater Measure 1 Collect and filter stormwater to enhance wetlands	• Increased biodiversity • Stormwater managed on site • Increased capacity to respond to storm events	• Increased cost and maintenance • Potential lack of water to sustain wetlands • Low perception and dried-out landscape during summer months when water flows are low
Stormwater Measure 2 Infiltrate Runoff from Buildings and Impervious Surfaces in the Campus Core	• Increased biodiversity • Stormwater managed on site, near to where impervious surfaces are located • Improved envelope performance with green roofs (energy conservation) • Improved outdoor comfort (heat island reduction) • Provide opportunity for food production, learning landscapes • Creates social spaces with landscape vistas • Provides additional water quality benefit	• Potential increased cost for maintenance of some types of LID methods • Consider appropriate location + infiltration potential • Use for select number of buildings or parking areas as determined where most suitable for LID methods • Assess impact of snow removal and winter maintenance • Potential negative perception of dried out green roof (brown roof) during summer months
Stormwater Measure 3 Implement specific stormwater improvements relative to *2011 Plan*	• Provides a comprehensive understanding of the proposed stormwater measures and their potential implementation opportunities, making the campus planning and capital budgeting tasks more efficient and reliable	• Additional engineering analysis required to incorporate the recommended measures and reflect the 2015 Campus Plan

Additional Benefits

This *Infrastructure Plan* places an emphasis on expanding the permanent and seasonal wetland complexes on campus not only to assist with mitigating stormwater rate and flow, but also to enhance the ecological and biodiversity functions on campus. These features will offer the following additional benefits:

- Demonstrate UBCO's stewardship of the natural environment;
- Provide for an ecologically rich campus environment which the campus and broader community can connect with;
- Potential ability to attract new donors who are interested funding natural landscape elements;

- Increase research opportunities to link academic research with government or non-government research based programs that are focused on for example, ecological restoration, endangered species, climate change adaptation etc.;
- Create potential for water conservation benefits associated with implementing a naturalized landscape;
- Create potential for stormwater diversion benefits associated with expanding the wetland network and infiltration strategies to manage stormwater runoff on campus; and
- Potential long-term maintenance savings associated with transitioning to a more naturalized landscape across the campus.

7.4 COST ANALYSIS

Similar to the Ecological Landscape and Biodiversity section, creating a business case for the stormwater management measures must consider a broader set of criteria beyond a strict financial analysis. UBCO's baseline for stormwater management is strong as 100% of stormwater is already managed on site. The recommendations set forth in this *Infrastructure Plan* augment the *2011 Plan* which identified costs for the nine recommended measures.

For the purpose of this study, the economic modelling analysis presents an order-of-magnitude capital cost for the various measures presented along with some unit rate costs for the LID stormwater management strategies (Table 59). Appendix E includes further information regarding the stormwater costing assumptions. In addition, a summary of the costs for each of the *2011 Plan* recommendations is summarized below.

TABLE 59: STORMWATER MANAGEMENT COST BY MEASURE

MEASURE	COST
SWM1: COLLECT AND FILTER STORMWATER TO ENHANCED WETLANDS	
Stormwater Swales	$185,200
Rain Gardens	$368,400
Wetlands / Permanent Retention Ponds (Wetlands #1-4)	$1,863,300 ($72.5/m^2)
Seasonal Retention Ponds	$294,200
SWM2: INFILTRATE RUNOFF FROM BUILDINGS AND IMPERVIOUS SURFACES IN THE CAMPUS CORE	
Lid Strategies Permeable Landscaping / Paving In Campus Core	$196/m^2
Areas For Infiltration	$33.4/m^2
Captured Surface Runoff (Filtration Through Planting)	$22.80/m^2
Green Roof System	$507.5/m^2

TABLE 60: SUMMARY OF THE 2011 PLAN RECOMMENDATIONS AND COSTS

MEASURE	COST
Research Road Improvements	$16,755
Main Parking Lot Improvements	$2,190
Future Research Park—Pond #1	$63,020
Okanagan Commons (Building K)—Storage Tank #2	$45,210
Upper Cascades Townhouses—Storage Tank #1	$55,070
University Way—Pond #2	$15,070
Knowledge Lane Improvements	$118,510

Evaluation Criteria

Based on the four evaluation criteria established for the project, overall the stormwater measures are supportive of:

1. Contributing to meeting the following whole systems infrastructure study goals by 2050;
2. Minimizing life-a cycle costs;
3. Being relatively easy to implement and maintain; and
4. Contributing to the long-term adaptability and resiliency of the campus.

A summary of the evaluation is presented in Figure 59 Evaluation of Stormwater Measures.

FIGURE 59: EVALUATION OF STORMWATER MEASURES

Funding Mechanisms

A multi-pronged approach to funding the stormwater measures, similar to the recommendation presented for the Ecological Landscape and Biodiversity measures, is required and will necessitate a combination of capital project funding, and donor funding:

1. **Public- Private Partnership Funding:** Similar to the approach for biodiversity, the development of wetland complexes, which have a strong biodiversity component, are suitable for partnerships with outside funders both from senior levels of government, and from the private sector. Species at risk conservation is suitable for a range of federal funding sources. The partnership opportunities could build upon UBC's vision for the Campus as a 'Living Lab' from which direct learning results can benefit the larger community, policy makers and industry as it relates to ecological preservation and restoration.
2. **Major Project Funding:** Large projects (>$100k) such as new wetlands for stormwater management can be funded as capital projects under UBCO's long-term budget process. They can either be stand-alone projects or linked to capital projects focused on the development or retrofitting of the landscape.
3. **Donor Funding:** As part of the broader effort to secure donor funding for the Campus Plan, discrete stormwater measures with strong ecological and biodiversity functions should be identified as part of a donor funded campaign program.

7.5 IMPLEMENTATION PLAN

Implementation of the stormwater measures should be kick-started immediately and will require ongoing update and monitoring as the Campus proceeds with its development plans. The following outlines the recommended sequencing of these measures (see Table 61).

TABLE 61: IMPLEMENTATION PLAN FOR STORMWATER MEASURE

Stormwater Measures	<5 years	5-10 years	10-20 years
SWM 1—Collect and filter stormwater to enhance wetlands.			
Update the *2011 Stormwater Management Plan* to address rainfall capture, infiltration, and wetland creation.	●		
Expand the number of wetlands associated with parking areas or other larger impermeable areas.	●		
Increase the range of wetland types for biodiversity enhancement (open water, marshes, willow thicket, seasonally flooded areas).	●	●	
Monitor stormwater quality within the campus drainage system.		●	
SWM 2—Infiltrate Runoff from Buildings and Impervious Surfaces in the Campus Core.			
Complete a geotechnical soil investigation to understand infiltration rates of different locations throughout the campus and to identify the potential for infiltration opportunities for the location and design of LID stormwater features.	●		
Test best practices for using LID methods in certain areas on campus.	●		
Consider, as part of updating UBCO's *Design Guidelines*, a recommendation on which buildings are best suited for a green roofing strategy, recognizing that green roofs may not be suitable for all buildings. Include recommendations for plant species selection for LID Strategies in order to minimize maintenance costs, ability to sustain dry seasons, and maximize ecological value.	●	●	●
SWM 3—Implement specific stormwater improvements relative to 2011 Plan.			
Update the *2011 Stormwater Management Plan* to reflect the 2015 Campus Plan and measures SWM-1 and SWM-2. The SWMP will need to confirm the size of the expanded wetland complex .	●	●	●
General Policy / Plans Recommendations			
Establish a program for monitoring and maintaining the performance of the campus stormwater system.	●	●	●
Plan for repair and replacement of stormwater facilities on an as-needed basis. A good ongoing maintenance plan can help reduce costly replacement costs.		●	●
Develop a donor strategy or campaign to secure funding for biodiversity and stormwater measures.		●	
Expand opportunities and resources to use natural areas as part of the campus' research and learning program.	●	●