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# APPROACH+METHODOLOGY





## 2.1 BACKGROUND ASSESSMENT

An extensive review of UBCO's technical information and data related to buildings, systems, utilities, infrastructure on campus and supporting documentation describing the campus, was undertaken to support the analysis through the lens of achieving the long-term sustainability goals and objectives. Information provided by UBCO included, but is not limited to, UBCO's updated Campus Plan, applicable campus plans (building and infrastructure), campus policies, utility data, commissioning reports, energy audit data, operations and maintenance manuals of existing buildings, retro-commissioning reports, district energy system (DES) system and central heating plant (CHP) operation, VFA Ltd. Asset Funding Needs Report, UBCO's 2011 Stormwater Management Plan, ecological assessments, irrigation reports and occupant and behavior change reports.

Additional follow up meetings were held with UBCO technical staff and CTQ Consultants to discuss existing conditions pertaining to ground conditions and performance of existing infrastructure, and to understand how proposed strategies could fit on campus based on previous considerations. CTQ Consultants served as a technical advisor based on their extensive history of working on the UBCO Campus. Rocky Mountain Institute served as a special advisor to the infrastructure planning process.

Meetings were held with the local utility, FortisBC (local electricity and gas provider) and UBC/UBCO technical staff to determine current and future power capacity and distribution to the campus, and issues with projected growth and utility rates.

The key purpose of this phase was to gain a deeper understanding of current operations, actual performance, areas of challenges for UBCO's maintenance and facility staff, and opportunities for improvements in performance. A summary of key baseline performance conditions and assumptions will be presented in subsequent sections.



TABLE 5: BASE CAMPUS DATA

ITEM	UNIT	CURRENT (2013 DATA)	PROJECTED ADDITIONAL 2030	TOTAL PROJECTED 2030
Buildings Area Total	m <sup>2</sup>	132,286	155,646	287,932
Academic	m <sup>2</sup>	82,743	87,000	169,743
Residential	m <sup>2</sup>	49,543	68,646	118,189
Campus Area	acres	516	0	516
Number of students	#	7,439	8,400	15,839
Number of faculty & Staff	#	1,048	1,048	2,096
Campus housing	# of beds	1,676	1,700	3,376

## 2.2 PERFORMANCE ASSUMPTIONS + MODELLING

Building upon the background assessment, a range of measures for improvement were identified for the various building typologies and campus scale infrastructure, and for restoring, protecting, and managing the overall ecological system of the campus. Performance measures are based on the guiding principles of:

1. understanding the baseline performance;
2. establishing agreed upon modeling assumptions;
3. conserving and reducing the overall need for resource use (i.e. water and/or energy);
4. assessing how resources can be used more effectively and efficiently;
5. supplying resources from renewable sources;
6. evaluating measures against of set of qualitative and quantitative criteria; and
7. determining which measures are strategic in meeting the long-term sustainability goals of the campus.

### Campus Development Growth Rate Assumptions

Key assumptions and baseline conditions related to campus growth projections up until 2030 were established in collaboration with the UBCO team. The following assumptions have been used to project the population growth on campus between now and 2030:

- 7% per year for 2015-2020
- 5% per year for 2020-2025
- 2% per year for 2025-2030
- At 2030: double capacity

UBCO provided the following projected building areas from now until 2030, resulting in close to doubling of building areas (see Table 5).

It was agreed upon that the doubling of area is an aggressive growth projection, but that it made sense to keep this as a base analysis scenario. Similarly, in consultation with UBCO, it was decided that the same split of academic building program areas on campus today would remain consistent as part of the projected growth. For example, it was identified that the current percentage of wet labs is close to 4% and dry labs is close to 7% (including general labs and workshops) of total campus program area. A breakdown of UBCO program areas are summarized in Table 6.

TABLE 6: SUMMARY OF UBCO CAMPUS PROGRAM AREAS

BUILDING / SPACE TYPE	RATIO
<b>ACADEMIC</b>	
Classroom	9%
Wet Lab	4%
Dry Lab	7%
Computer Lab/IT Rooms	2%
Offices / Meeting	13%
Support / Others	9%
Circulation	13%
Washroom	2%
Kitchen	2%
Gym	2%
Library	2%
<b>RESIDENTIAL</b>	
Suites	19%
Bathrooms	3%
Kitchen	1%
Offices / Meeting	1%
Support / Others	4%
Circulation	7%
<b>TOTAL AREA (CALC)</b>	<b>100%</b>

- Dry Lab category: includes general lab spaces.
- Computer Labs: include IT rooms.
- Office/Meeting: includes study rooms.
- Support Others: Includes audio spaces, controls, telecoms, electrical rooms, elevator rooms, garbage rooms, shelled spaces, mechanical rooms, storage spaces, etc.
- Circulation: includes lobby area and waiting area.
- Washroom: includes shower areas.

## Expected Development Phasing

In order to recommend milestone implementation of the proposed measures between now and 2030, assumptions were made regarding the phasing of future development as part of the 2015 Campus Plan (illustrated in Figures 11, 12, and 13). It is recognized that this phasing may differ as the campus grows, but for the purposes of this infrastructure plan it is intended to form a framework for determining how and when performance measures could be implemented to achieve the long-term goals established by UBCO. Based on the growth assumptions, the approximate increase in building area per phase is as follows:

- Phase 1— 2015-2020                      57,635 m<sup>2</sup>
- Phase 2— 2020-2025                      52,348 m<sup>2</sup>
- Phase 3— 2025-2030                      44,136 m<sup>2</sup>



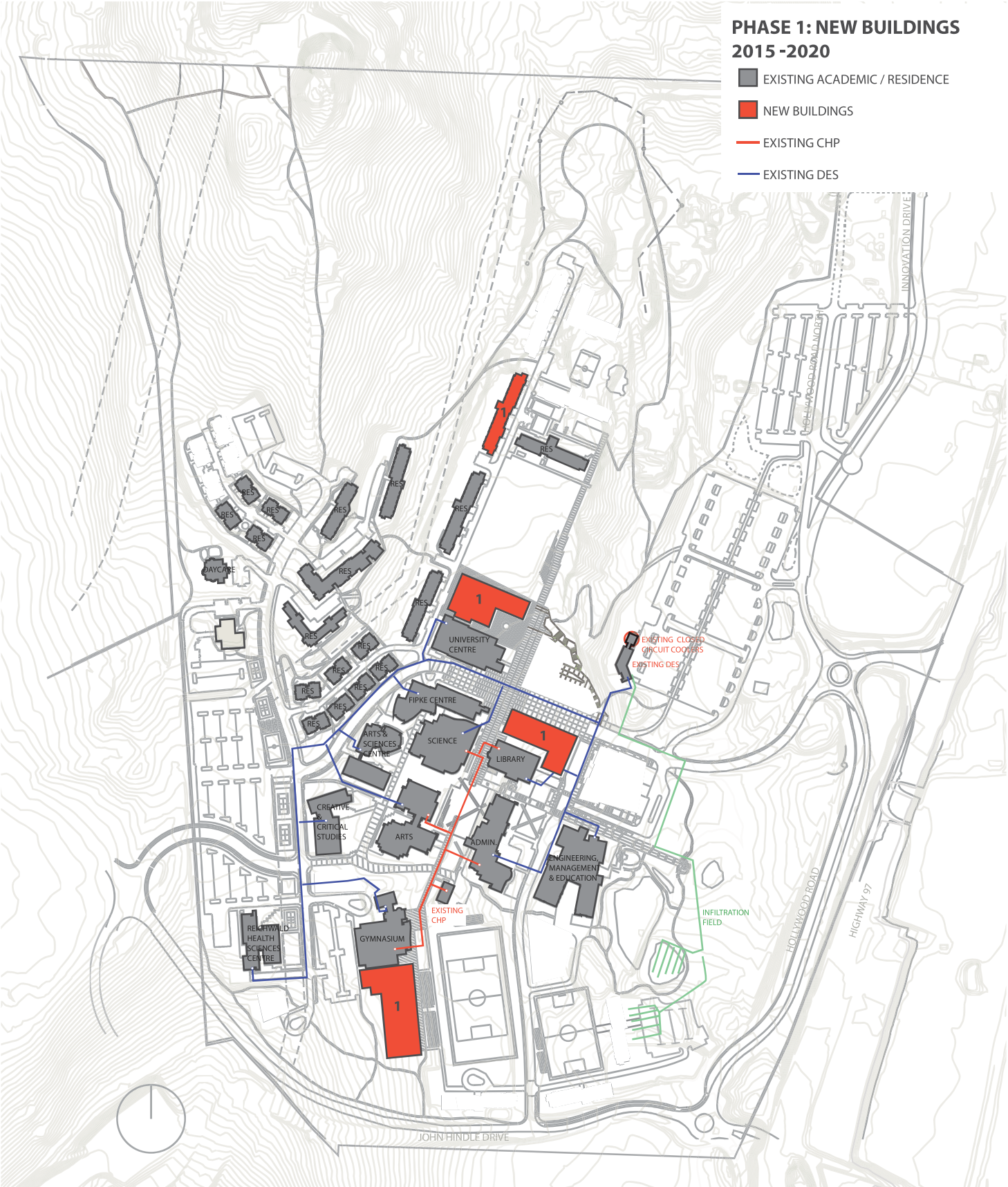


FIGURE 11: EXPECTED DEVELOPMENT PHASE 1: NEW BUILDINGS 2015-2020.







FIGURE 13: EXPECTED DEVELOPMENT PHASE 3: NEW BUILDINGS 2025-2030



## 2.3 ECONOMIC MODELLING

A Class C cost analysis was performed to provide an assessment of the capital project and life-cycle costs for each of the suggested performance measures. Each measure's capital costing includes allowances for direct and indirect costs. Indirect costs include general contractor's general requirements and profit, an allowance for design fees, and a construction contingency. An allowance of 40% has been included for indirect costs for retrofit works and 30% for new construction.

The economic model used a life-cycle cost analysis over a study period of 15 years and applied criteria, such as, Net Present Cost and payback period, to provide useful information for decision making, i.e. for selecting certain measures above others. UBC indicated that a 10-year payback is required for measures implemented in buildings and a payback within the life of the component for infrastructure works.

A variety of capital costing methods were used for determining the cost of the measures suggested for this project, depending on the information provided to the cost consultant. In general, design information for the measures were conceptual, so each of the capital cost estimates reflects a number of assumptions, for example, the types of systems and the issues involved in retrofitting them in existing buildings. Assumptions for each costing analyses are included in BTY Group's *UBCO Whole Systems Infrastructure Systems and Economic Modeling* report in Appendix E, and were reviewed by the technical team and UBCO staff.

Estimates have been derived in 2015 dollars and escalated to the year in which they are assumed to be implemented. These pricing assumptions, along with the ranges to be applied for sensitivity analysis are listed in Table 7. The annual escalation rates to be applied to each of the unit rates are also listed.

For purposes of this *Infrastructure plan*, the costs and savings are presented in 5-year phases as per the technical performance analysis completed for each section. The *UBCO Whole Systems Infrastructure Systems and Economic Modelling Report's* appendices contain detailed capital cost estimates and annual life-cycle cash flows to augment these summaries.

For limitations and exclusions of the *UBCO Whole Systems Infrastructure Systems and Economic Modelling Report*, along with detailed analysis for each performance measure recommended in this plan, please see Appendix E for further details.



TABLE 7: ECONOMIC MODELING ASSUMPTIONS

ITEM	UNIT	RATE	NOTE	SENSITIVITY ANALYSIS		ESCALATION
				LOW	HIGH	
Natural Gas	GJ	\$7.91	excludes carbon tax	-30%	20%	See attached US Dept of Energy forecast
Electricity						2015: 3%; 2016: 3.25%; 2017: 2.75%; 2018: 4%; 2019 and after: 3%.
Residential (North Feeder)	kWh	\$0.0792				
Academic (South Feeder)	kWh	\$0.0735				
Use Average	kWh	\$0.0764		-10%	20%	
Water	m <sup>3</sup>	\$0.46		-10%	20%	Propose 3% p.a. (slightly ahead of inflation)
Sewer	m <sup>3</sup>	\$0.86	commercial users	-10%	20%	At same rate as water.
Storm			all retained on site			n/a
Waste Disposal			not in scope			n/a
BC Carbon tax on natural gas	GJ	\$1.49		0%	30%	0%
Carbon Offsets	Tonne	\$25		0%	30%	0%
Discount Rate		6%		5%	7%	Vary rate from 5% to 7%
Capital Cost Inflation Rate		2.5%		2%	4%	Vary rate from 2% to 4%

\* Note that BC Hydro forecast is 9%, 6%, 4%, 3.5%, 3% and inflation rate +1% for remaining years of 10-year plan.

## 2.4 EVALUATION OF PERFORMANCE MEASURES

Based on the goals and objectives established for the project, a refined set of multi-attribute evaluation criteria were established in collaboration with UBCO to assist with evaluating the performance measures beyond simply evaluating them through a single lens of financial feasibility. Integration across systems is captured in the summary matrix table (see Appendix A) as a parallel effort to communicate where synergies are maximized and where there are qualitative and quantitative benefits such as cost-savings, across systems. The four criteria are considered with equal weighting and each measure studied in this plan has been evaluated against these criteria. Appendix F summarizes the performance evaluation ranking for each of the proposed measures.

TABLE 8: SUMMARY OF UBCO PERFORMANCE EVALUATION CRITERIA

PERFORMANCE EVALUATION CRITERIA	
CRITERIA	DESCRIPTION
Contribute to meeting the following Whole Systems Infrastructure Plan goals by 2050.	<p>Goal #1 Achieve a net positive performance in operational energy and carbon.</p> <p>Goal #2 Implement a framework that supports low embodied carbon in future development.</p> <p>Goal #3 Optimize water quality, supply and security.</p> <p>Goal #4 100% diversion of stormwater from municipal systems.</p> <p>Goal #5 Strive towards full waste recovery/reuse.</p> <p>Goal #6 Enhance and/or restore the ecology These goals have been developed in support of the UBC 20 year sustainability strategy.</p>
Minimize life cycle costs	This includes minimizing costs throughout the project's lifecycle, with the potential to leverage external funding and partnership opportunities.
Ease to implement and maintain	This includes consideration of UBCO's capacity and resources to implement and maintain the performance measures on a spectrum that considers not only the easiest to implement.
Contributes to adaptability and resiliency of the campus	This includes how the measure assists the campus in adapting and responding to changes. Examples of changes could include: rate of development and land use change, utility rates, fuel switching (as fuel costs change over time, or as new technologies are developed), on-demand system loads and regional climate (i.e., water shortages).

## 2.5 ROADMAP AND IMPLEMENTATION

As a final step, the recommendations for achieving the sustainability goals for the Okanagan Campus form a long-term roadmap for optimizing its performance. In addition, actions recommended for immediate implementation within the next five years are summarized within the study (see Part 1).