Sustainable Development at the University of Regina

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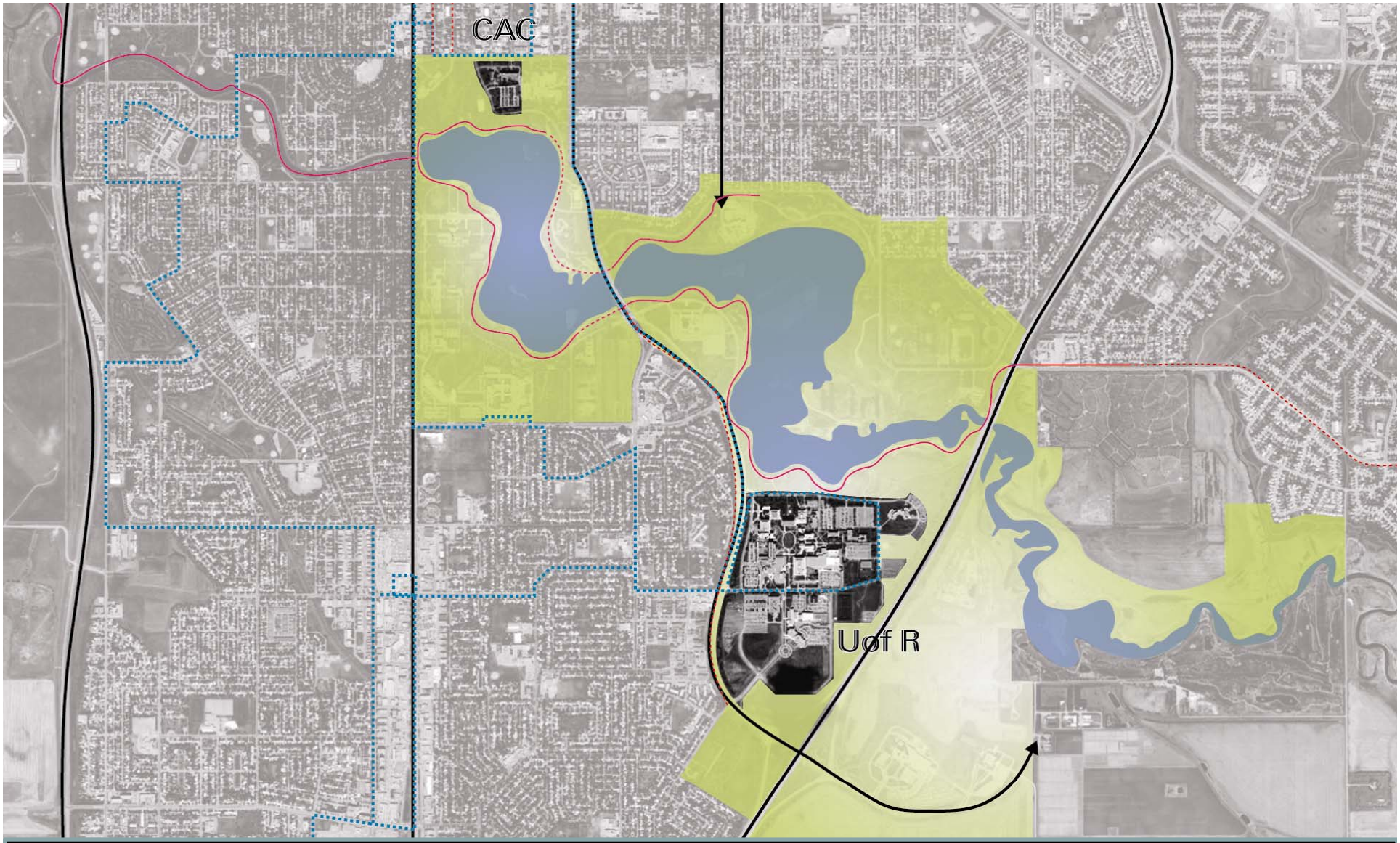
University of Regina

Overview

- Our discussion today will include:
  - Prominent research initiatives at the U of R.
  - Examples of leadership in sustainable design, construction and retrofit of facilities that house this research.
  - Plans for the future.

Campus in a Park



University of Regina

Campus in a Park

- Student Population – 12600
- 1200 staff
- 2.4 million square feet

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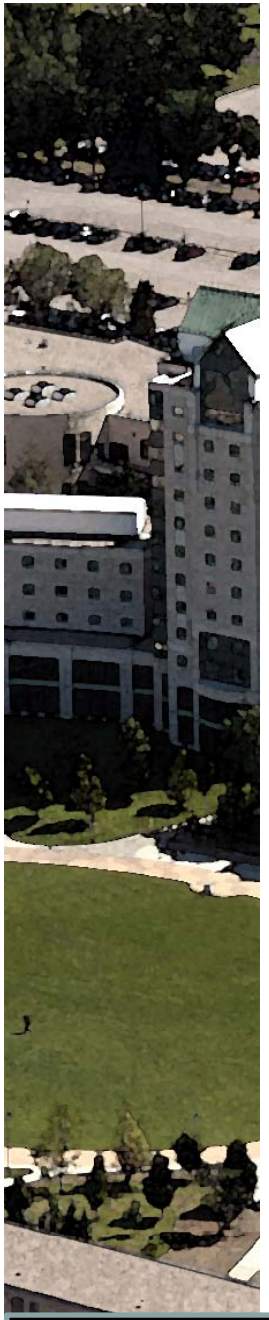


Specialized Programs

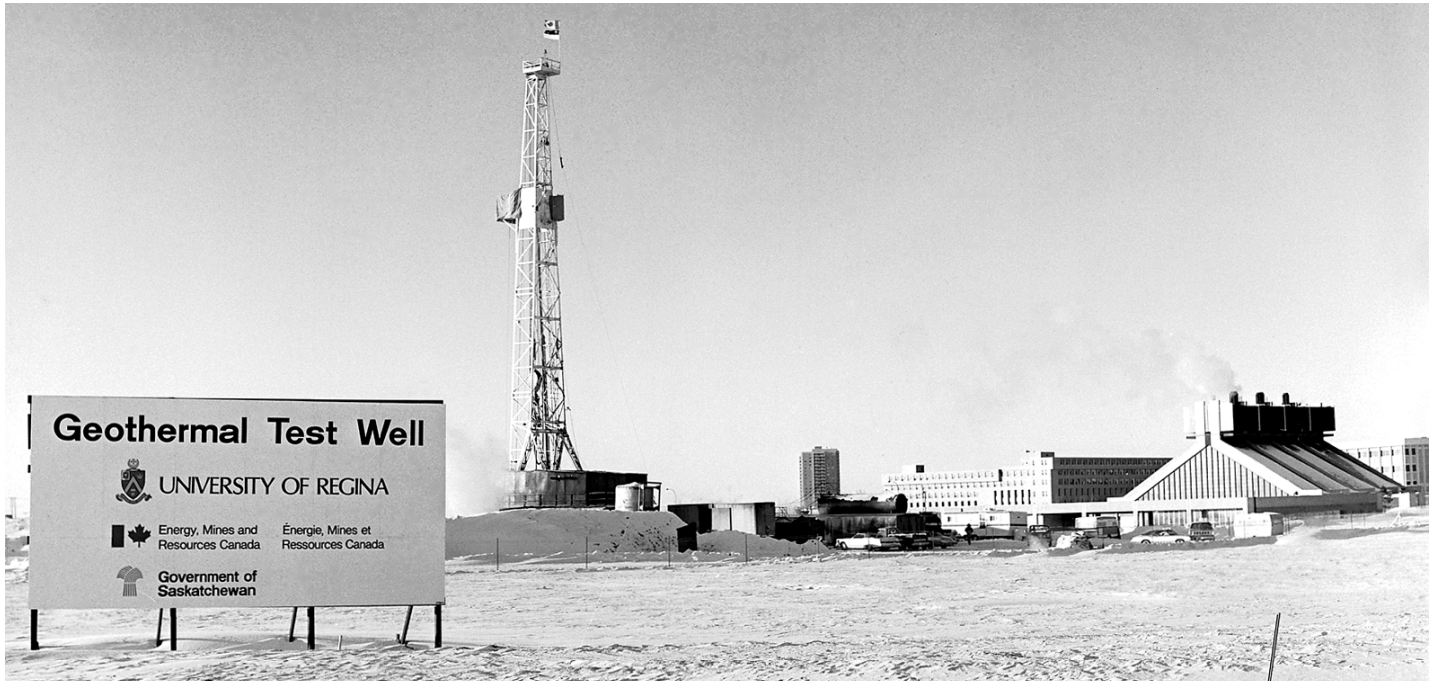
- Journalism
- Social Work
- Petroleum Engineering
- Media Production
- Actuarial Science
- Software Systems
- Education
- Police Studies
- Health Studies
- Public Policy

Our Strategic Emphasis

- Energy and Environment
- Health
- Culture and Heritage
- Informatics
- Public Safety, Security and Social Justice

Going Green - Historical Campus Research

- 1979 – Regina Geothermal Project
  - Wellhead temperature of 140 Deg F
  - Potential of 16 million Btu/hr
  - Technical and funding issues stopped the project



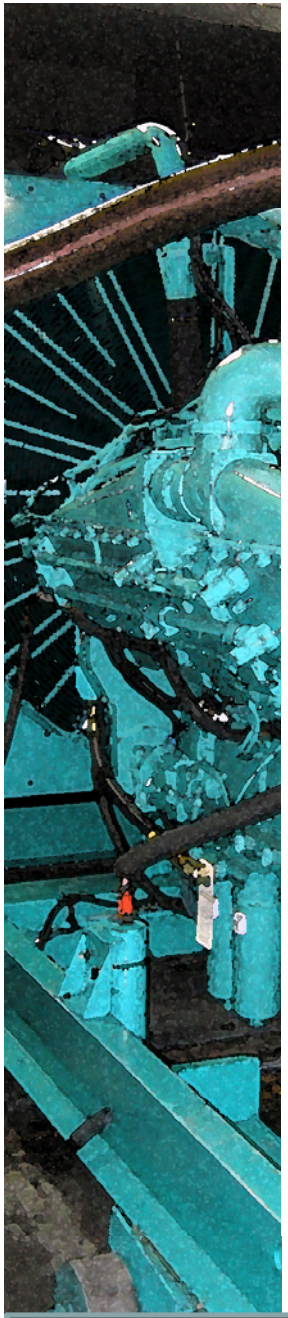
Going Green - Current Campus Research

- 2000 - The International Test Centre For Carbon Dioxide Capture
- Saskatchewan firsts:
  - Infrastructure to evaluate climate changes & technology
  - World leader in CO2 Capture & Storage (CCS)
  - Instrumental in developing federal provincial climate change discussions
  - Prairie Adaptation Network (model for PARC & the Canadian Impacts & Adaptation Research Network)

Creating and Environment for Success

- 10880 heating degree days, 262 cooling degree days
- 300 days of sunshine

- Design conditions:
  - Summer: 32 C, 29% RH
  - Winter: -40 C, 50 %RH



Utility Stats

Total utility budget;
$5.0 million

Electrical:

- Rates:
  - $.0455/kWh
  - $5.251/kVA
- Power purchased at 72 kV
- Distributed at 25 kV
- Essential power also distributed at 25 kV.
- First Sask. purchaser of Green Power

Utility Stats

Natural Gas:

- Rate: $7.00/GJ
- Direct purchase of natural gas.
- Purchasing strategies include gas storage and interruptible service.

- Central Heating Plant capacity:
  - 150,000 pph steam
  - 4800 tons cooling

Going Green - Campus Planning

The University intends to provide community leadership in responsible and effective environmental action through sustainable developments that are land, energy and waste efficient.

University of Regina
Campus Plan for Long Range Development

Going Green - Campus Planning

- 1990 Cogeneration Feasibility
- 1994 Central Plant Linear Infrastructure Capacity Analysis and Utilities Review
- 1996 Chilled Water System Study and Master Plan development
- 1998 Electrical Systems Planning Study
- 2005 Campus Energy Audit
- Ongoing sustainable design and commissioning practices

Going Green - Results!

- During a 10 year period when our campus area grew by 76%, our energy usage grew by less than 10%.
- Unit utility costs in 2009 were $1.60/sq.ft. This is roughly the same as our unit cost paid in 1994, despite inflationary increases such as 267% in natural gas.

Chilled Water Plant

- Phased Replacement and Enhancement
- Phase 1 - 1998
  - Modified the plant to primary/secondary with variable flow secondary circuit
  - Increased plant capacity from 2000 to 3400 TR
  - Installed cooling towers and secondary pumps for ultimate 4800 TR plant capacity
  - Installed extensive metering
  - Replaced cooling plant controls
  - Upgraded plant electrical systems

Chilled Water Plant

- Phase 2 - 2000
  - Improved Chilled Water Flow Controls
    - Replaced over-sized control valves
    - Improved valve authority and rangeability
    - Installed automatic flow control valves
    - Established guidelines for new installations with high ΔT's
  - Resulted in an overall improvement to the plant ΔT from 8.5 ˚F to 12 ˚F

Chilled Water System

- Phase 3 - 2004
  - Installed third chiller increasing plant to ultimate 4800 ton capacity
- 2007 - New Lab Building – Heat Recovery/Free Cooling

Chilled Water System

- Overall Results
  - Increased plant capacity from 2000 TR to 4800 TR
  - Building Improvements resulted in a consistent ΔT of 12°F (from 8.5°F).
  - All-in annual plant efficiency of < 0.7 kw/ton (from 1.2 kw/ton).

2005 Canada Summer Games

- City of Regina selected as host site in July 2001
- The University of Regina campus was selected to host:
  - The Athlete's Village
  - The administrative, social and cultural center for the games
  - The site for Basketball, Volleyball, and Cycling

New Facilities

- New Residences
  - The Residences and the Dr. Lloyd Barber Academic Green

- New Sporting Facilities
  - The Center for Kinesiology, Health and Sport (CKHS) and Artificial Turf Field

Tree Relocation Project

- More than 500 mature trees were relocated from the building sites and distributed around the campus and neighboring affiliate colleges

Center for Kinesiology Health and Sport

- 265,000 gross ft2
- Construction Cost $26,800,000
- New Three-court Gymnasium capable of seating 2000 spectators
- Elevated 4-lane running track
- Fitness and Lifestyle Areas
- Lecture Theatres, Labs and Classroom Spaces

CKHS Sustainability Initiatives

- Focused on:
  - Optimized Energy Performance
  - Water Use Reduction
  - Additional Commissioning
  - Carbon Dioxide Monitoring
  - Indoor pollutant and source control
  - Occupancy Sensors for ventilation and lighting control

Energy Modeling

	Electricity (MJ)	Natural Gas (MJ)	Total (MJ)
Reference	7,911,645	18,339,498	26,251,143
Proposed	6,158,044	9,904,012	16,062,056
Savings	1,753,601	8,435,486	10,189,087

	Electricity (kWh)	Natural Gas (m^3)	Energy Cost ($)
Reference	2,197,679	489,706	$192,448
Proposed	1,710,568	264,460	$130,268
Savings	487,111	225,247	$62,180

University of Regina's Centre for Kinesiology, Health and Sport building is 38.8 % better than the MNECB reference building

Annual reduction of 467,685 kilograms of carbon dioxide emissions

Actual Energy Performance

- The Residences use similar mechanical systems and had similar attention paid to envelope and lighting design and other energy optimization features.
- The combined total increase in building area for the campus for the two projects was 36%.
- The increase in energy use for the campus after occupancy of the two buildings was less than 5%
  - Steam Consumption increased 1.77%
  - Electrical Energy Consumption increased 6.51%
  - Electrical Demand increased 4.49%

What Worked

- Project Partnering
  - University Physical Plant
  - Stakeholders
  - Architects
  - Engineers
  - Construction Manager
- University's acceptance of risk and risk management
- Disassociation of Design and CM fees from construction costs
- Project Management
- Low Construction Costs ($102/GSF for the Residence, $101/GSF for the Kinesiology).

Construction Owners of America Association 2005 Project Leadership Award Recipient

Lessons Learned

- Ask for performance guarantees on critical energy recovery products
  - Performance of the cross flow air-to-air heat exchangers has been sub-par
- Push harder for buy-in by the lighting design team to optimize lighting energy performance
  - Even with extensive efforts some light levels appear to be higher than necessary
- Look at further reductions in mechanical systems energy

Research and Innovation Centre

- Complete December, 2009
- 160 seat state of the art teaching theatre
- Dry bench lab space
- Wet bench research lab space
- Teaching lab space
- Central Service areas and floor support (NMR, isolated floor labs, etc.)
- Research integrated into facility
  - Green Roof
  - Grey Water Recovery

Research and Innovation Centre
Sustainable Goals

- Produce a flexible laboratory environment
- Provide a flexible building that will respond to the changing needs of research both in terms of discipline and building longevity
- Beat CBIP Energy reduction requirement of 35-40%
- High performing envelope
- Sustainable Showcase
- Utilize Labs 21 as a benchmark for the design

Research and Innovation Centre
Labs 21 Environmental Performance Criteria

- A rating system for use by laboratory building project stakeholders to assess the environmental performance of laboratory facilities. To facilitate widespread use and to avoid "re-inventing the wheel" this effort builds on the U.S. Green Building Council (USGBC) LEED™ Rating System 2.0

EPC 2.0 Project Checklist

EPC credits and prerequisites (additions/modifications to LEED) are highlighted

Click on links to see full text for each credit and prerequisite

Yes	?	No				
0	0	0	**Sustainable Sites**		16	Responsibility
Y			Prereq 1	**Erosion & Sedimentation Control**	Required	CM/A
1			Credit 1	**Site Selection**	1	A
	1		Credit 2	**Urban Redevelopment**	1	O
		1	Credit 3	**Brownfield Redevelopment**	1	
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1	O/A
	1		Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1	O/A
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1	
		1	Credit 4.4	**Alternative Transportation**, Parking Capacity	1	
	1		Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1	O/A
		1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1	
	1		Credit 6.1	**Stormwater Management**, Rate or Quantity	1	M
		1	Credit 6.2	**Stormwater Management**, Treatment	1	
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1	A
1			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1	A
1			Credit 8	**Light Pollution Reduction**	1	E/A
	1		Credit 9.1	Safety and Risk Management, Air Effluent	1	M
1			Credit 9.2	Safety and Risk Management, Water Effluent	1	M
Yes	?	No				
0	0	0	**Water Efficiency**		7	
Y			Prereq 1	Laboratory Equipment Water Use	Required	M
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1	A/O/LS/M
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1	A/O/LS/M
	1		Credit 2	**Innovative Wastewater Technologies**	1	M/O
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1	M
	1		Credit 3.2	**Water Use Reduction**, 30% Reduction	1	M
1			Credit 4.1	Process Water Efficiency, Document Baseline	1	M
	1		Credit 4.2	Process Water Efficiency, 20% Reduction	1	M
Yes	?	No				
0	0	0	**Energy & Atmosphere**		25	
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required	CM/M/O/E/A
Y			Prereq 2	Minimum Energy Performance	Required	M
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required	M
Y			Prereq 4	Assess Minimum Ventilation Requirements	Required	M
1			Credit 1.1	Optimize Energy Performance, 5%	1	M
1			Credit 1.2	Optimize Energy Performance, 10%	1	M
1			Credit 1.3	Optimize Energy Performance, 15%	1	M
1			Credit 1.4	Optimize Energy Performance, 20%	1	M
1			Credit 1.5	Optimize Energy Performance, 25%	1	M
	1		Credit 1.6	Optimize Energy Performance, 30%	1	M
	1		Credit 1.7	Optimize Energy Performance, 35%	1	M
		1	Credit 1.8	Optimize Energy Performance, 40%	1	
		1	Credit 1.9	Optimize Energy Performance, 45%	1	
		1	Credit 1.10	Optimize Energy Performance, 50%	1	

Research and Innovation Centre Envelope

- Maximize daylighting
- External shading
- Integrated design of insulation requirements and mechanical heating & cooling

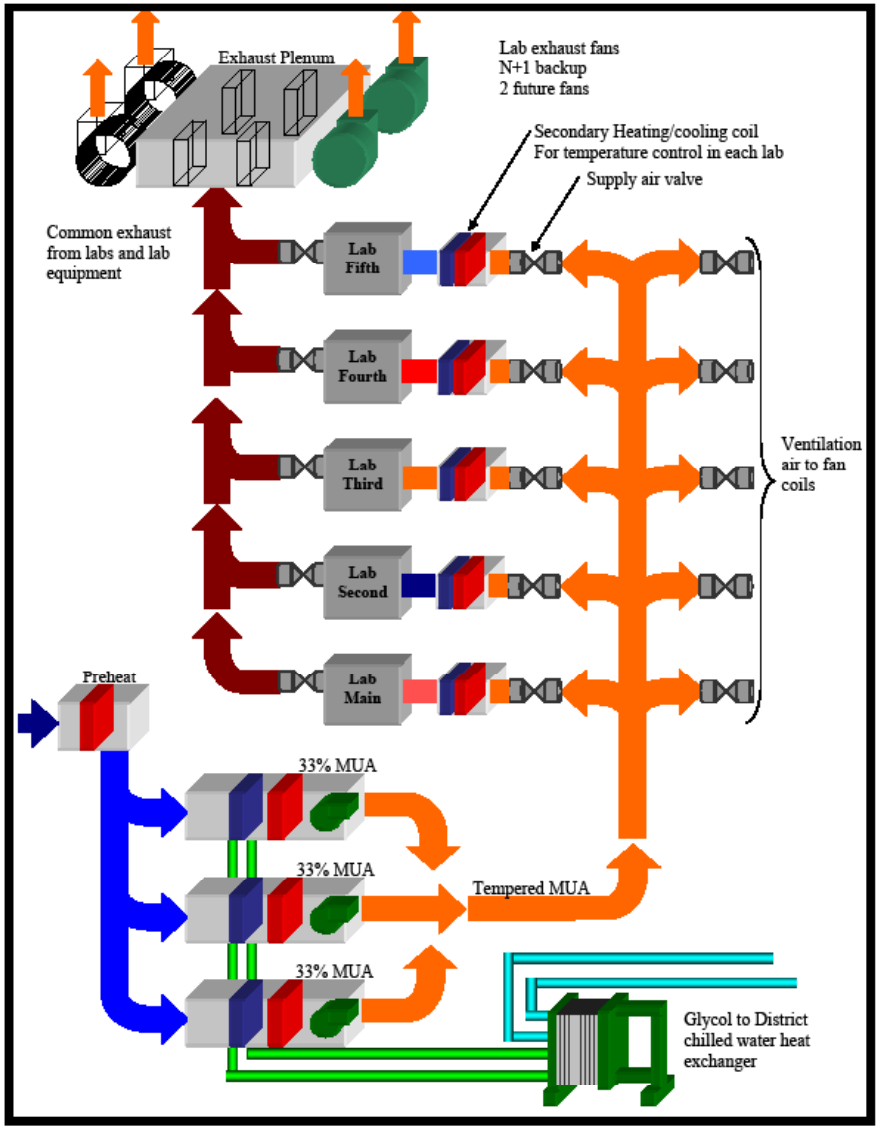
Research and Innovation Centre
Wind Tunnel Analysis

- Reduction in power consumption resulting from wind dispersion analysis
- Achieved safe dispersion through regular style stacks and centrifugal fans

Research and Innovation Centre

Mechanical System

- Steam, chilled water from Central Plant
- Variable Flow pumping
- Variable Air Volume
- Manifold Exhaust
- Once thru supply
- Terminal heating & cooling
- No reheat/recool



Research and Innovation Centre

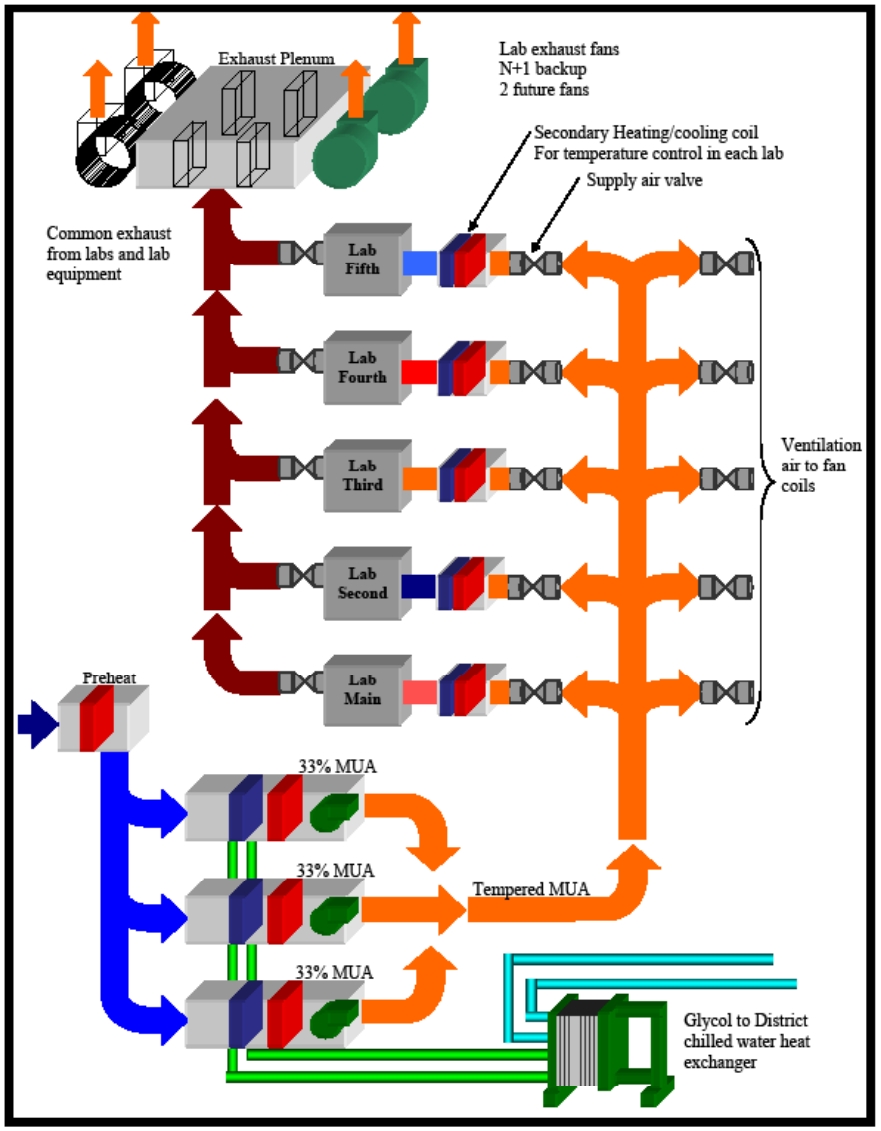
Heat Recovery

- New Lab requirement: Heat Recovery
- Central Plant requirement: Free Cooling

Research and Innovation Centre

Heat Recovery

- Utilize heat presently rejected through cooling towers to heat the outside air for the new Lab
- Reduce motor power required for cooling tower operation
- Eliminate winter cooling tower operation
- Net capital cost saving > $250,000
- Operational savings >$10,000 in RIC alone

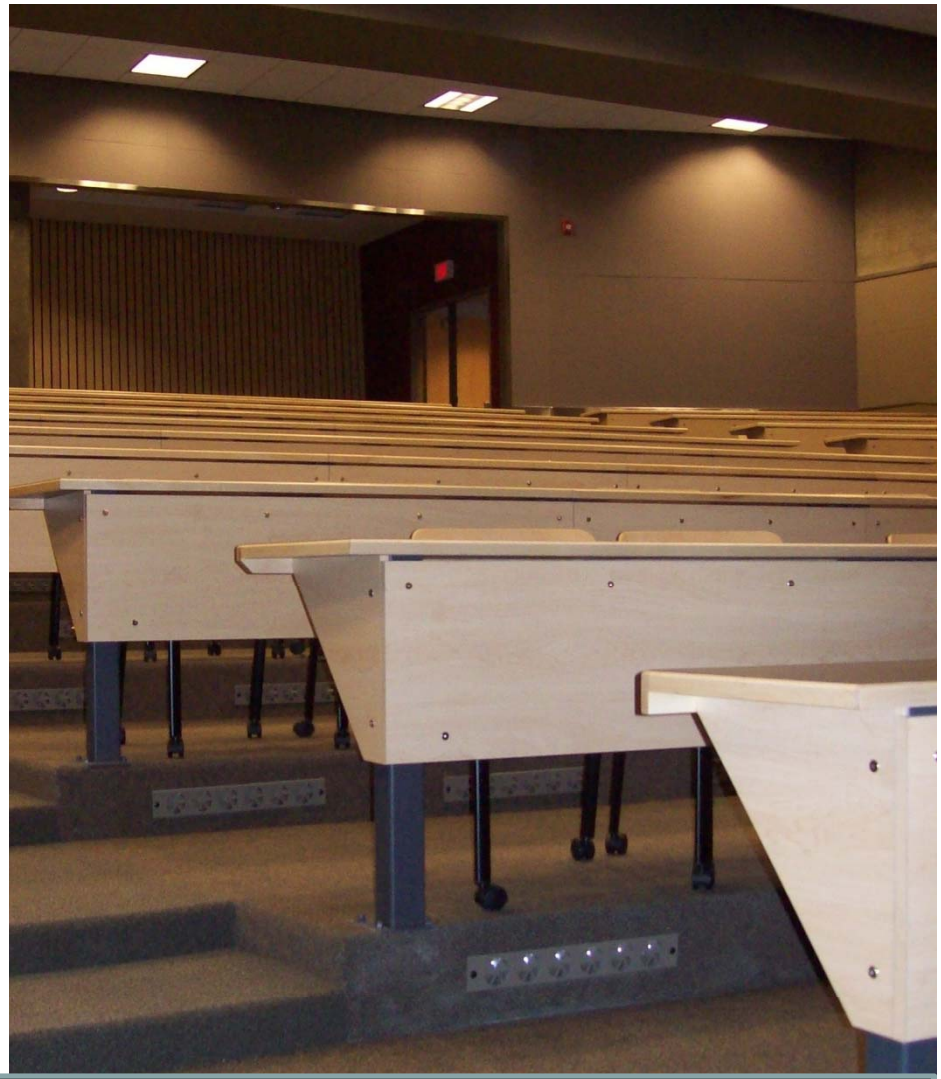


Research and Innovation Centre
Occupant Safety with Reduced Airflow Rates

- Variable air volume
- Lab occupancy sensor
  - 8 ACH occupied
  - 4 ACH unoccupied
- Fume hoods equipped with Zone Presence Sensor
  - 100 fpm face velocity
  - Reduces by 40% when not in use

Research and Innovation Centre
Displacement Ventilation

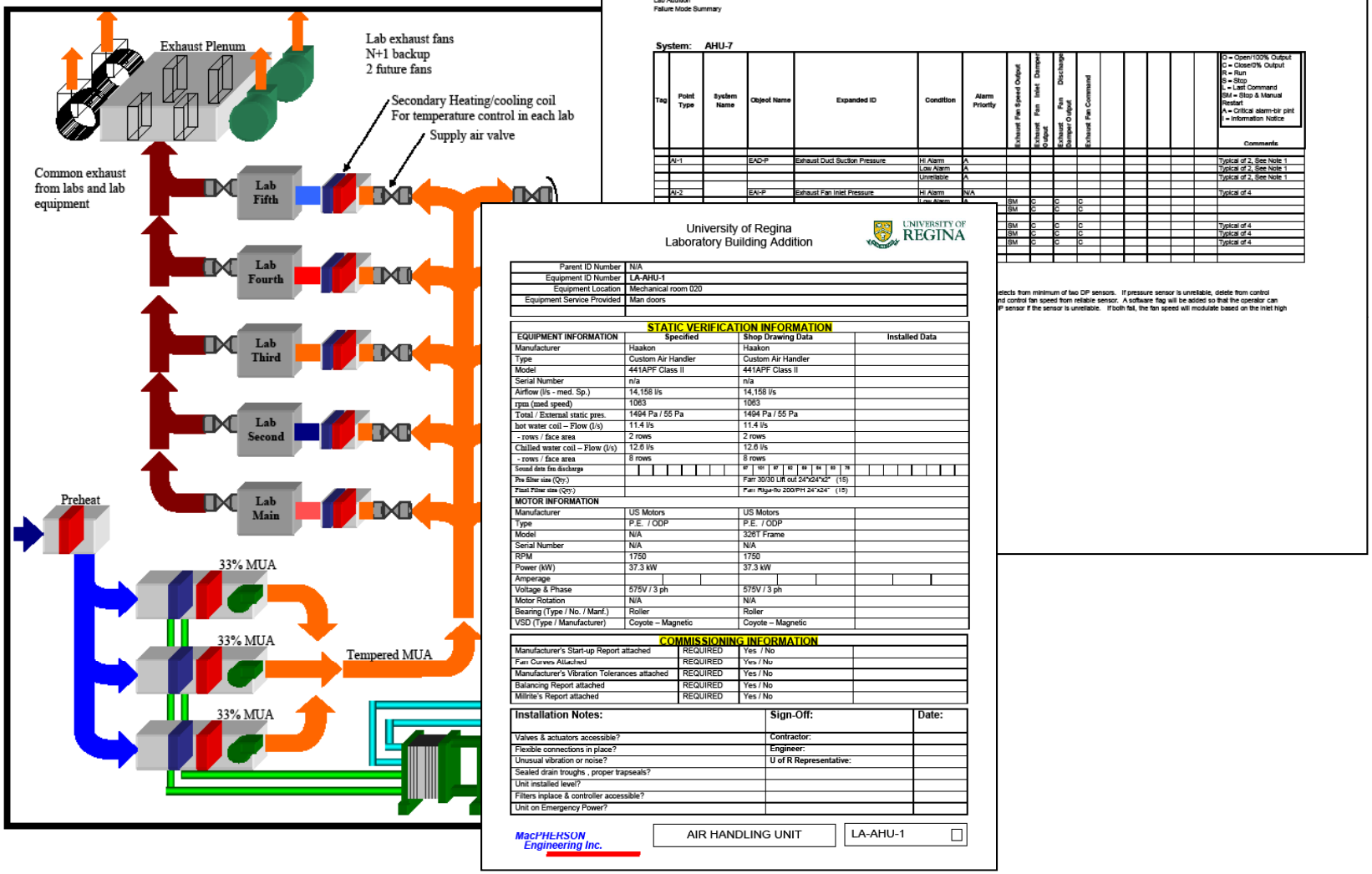
- Air supplied below seats
- Air flow rate reduced
- Cooling requirement reduced
- Noise reduced
- Energy reduced – additional 50 days of free cooling
- Ventilation rate reset based on CO2 measurement



Research and Innovation Centre
CBIP Results – compared to MNECB Base

	Electrical (MJ)	Natural Gas (MJ)	TOTAL (MJ)	Annual Cost
Proposed Building	7,877,156	13,291,586	21,168,742	$191 515
Reference Building	10,765,960	23,352,500	34,118,460	$256 935
Savings	2,888,804	10,060,914	12,949,718 (38%)	$65 420

Commissioning Process



Lab Addition
Failure Mode Summary

System: AHU-7

Tag	Point Type	System Name	Object Name	Expanded ID	Condition	Alarm Priority	Exhaust Fan Speed Output	Exhaust Fan Inlet Damper Output	Exhaust Fan Discharge Damper Output	Exhaust Fan Command	Comments
	AI-1		EAD-P	Exhaust Duct Suction Pressure	HI Alarm	A					Typical of 2, See Note 1
					Low Alarm	A					Typical of 2, See Note 1
					Unreliable	A					Typical of 2, See Note 1
	AI-2		EAI-P	Exhaust Fan Inlet Pressure	HI Alarm	N/A					Typical of 4
					Low Alarm	A	SM	C	C	C	
							SM	C	C	C	
							SM	C	C	C	Typical of 4
							SM	C	C	C	Typical of 4
							SM	C	C	C	Typical of 4

O = Open/100% Output
C = Close/0% Output
R = Run
S = Stop
L = Last Command
SM = Stop & Manual Restart
A = Critical alarm-blr plnt
I = Information Notice

elects from minimum of two DP sensors. If pressure sensor is unreliable, delete from control
nd control fan speed from reliable sensor. A software flag will be added so that the operator can
P sensor if the sensor is unreliable. If both fail, the fan speed will modulate based on the inlet high

University of Regina
Laboratory Building Addition

UNIVERSITY OF REGINA

Parent ID Number	N/A
Equipment ID Number	LA-AHU-1
Equipment Location	Mechanical room 020
Equipment Service Provided	Man doors

STATIC VERIFICATION INFORMATION

EQUIPMENT INFORMATION	Specified	Shop Drawing Data	Installed Data
Manufacturer	Haakon	Haakon	
Type	Custom Air Handler	Custom Air Handler	
Model	441APF Class II	441APF Class II	
Serial Number	n/a	n/a	
Airflow (l/s - med. Sp.)	14,158 l/s	14,158 l/s	
rpm (med speed)	1063	1063	
Total / External static pres.	1494 Pa / 55 Pa	1494 Pa / 55 Pa	
hot water coil – Flow (l/s)	11.4 l/s	11.4 l/s	
- rows / face area	2 rows	2 rows	
Chilled water coil – Flow (l/s)	12.6 l/s	12.6 l/s	
- rows / face area	8 rows	8 rows	
Sound data fan discharge		87 | 101 | 97 | 93 | 89 | 84 | 80 | 76	
Pre filter size (Qty)		Farr 30/30 Lift out 24"x24"x2" (15)	
Final Filter size (Qty)		Farr Rigu-Su 200/PH 24"x24" (15)	
MOTOR INFORMATION			
Manufacturer	US Motors	US Motors	
Type	P.E. / ODP	P.E. / ODP	
Model	N/A	326T Frame	
Serial Number	N/A	N/A	
RPM	1750	1750	
Power (kW)	37.3 kW	37.3 kW	
Amperage			
Voltage & Phase	575V / 3 ph	575V / 3 ph	
Motor Rotation	N/A	N/A	
Bearing (Type / No. / Manf.)	Roller	Roller	
VSD (Type / Manufacturer)	Coyote – Magnetic	Coyote – Magnetic	

COMMISSIONING INFORMATION

Manufacturer's Start-up Report attached	REQUIRED	Yes / No	
Fan Curves Attached	REQUIRED	Yes / No	
Manufacturer's Vibration Tolerances attached	REQUIRED	Yes / No	
Balancing Report attached	REQUIRED	Yes / No	
Millrite's Report attached	REQUIRED	Yes / No	

Installation Notes:	Sign-Off:	Date:
Valves & actuators accessible?	Contractor:	
Flexible connections in place?	Engineer:	
Unusual vibration or noise?	U of R Representative:	
Sealed drain troughs , proper trapseals?		
Unit installed level?		
Filters inplace & controller accessible?		
Unit on Emergency Power?		

MacPHERSON Engineering Inc.

AIR HANDLING UNIT | LA-AHU-1 ☐

Campus Energy Audit

- Potential to save 21% in energy consumption by updating systems in existing buildings
  - Building Lighting upgrades
  - Building Mechanical Systems
  - Central Plant Systems
  - Water Use Reduction
  - Building Envelope Enhancements
  - Training and Energy Awareness
- Implementation Cost: $5.6 M
- Annual savings of $880,000
- First phase ($2 million project) is complete.

- Boiler Upgrade funded by Student Union

New Project Development

- Continued Emphasis on Energy Savings and Sustainability
  - Reduced lighting and other electrical loads
  - Enhanced envelope design
- Mechanical System Design
  - Disassociating ventilation and thermal loads
  - Use of non-reheating systems
  - Increasing delta T's in hydronic systems
  - Using building thermal mass
- Energy Recovery and Re-use
  - Heat recovery
  - Use of low grade heat
- Building Energy Modeling

Questions?

Thank you!