# Energy & Urban Metabolism

Z Smith

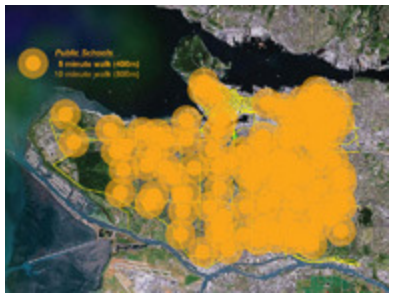
Eskew+Dumez+Ripple

ARCHITECTURE
ENVIRONMENTS
URBAN DESIGN

# Themes

- High-performing standalone buildings: a start
- Buildings aren't static objects
  - Occupants matter: feedback & control
  - Buildings can participate in urban ecosystems during
    - Construction
    - Operation
    - Deconstruction
- One building's "waste" is another's "food"






# Vancouver

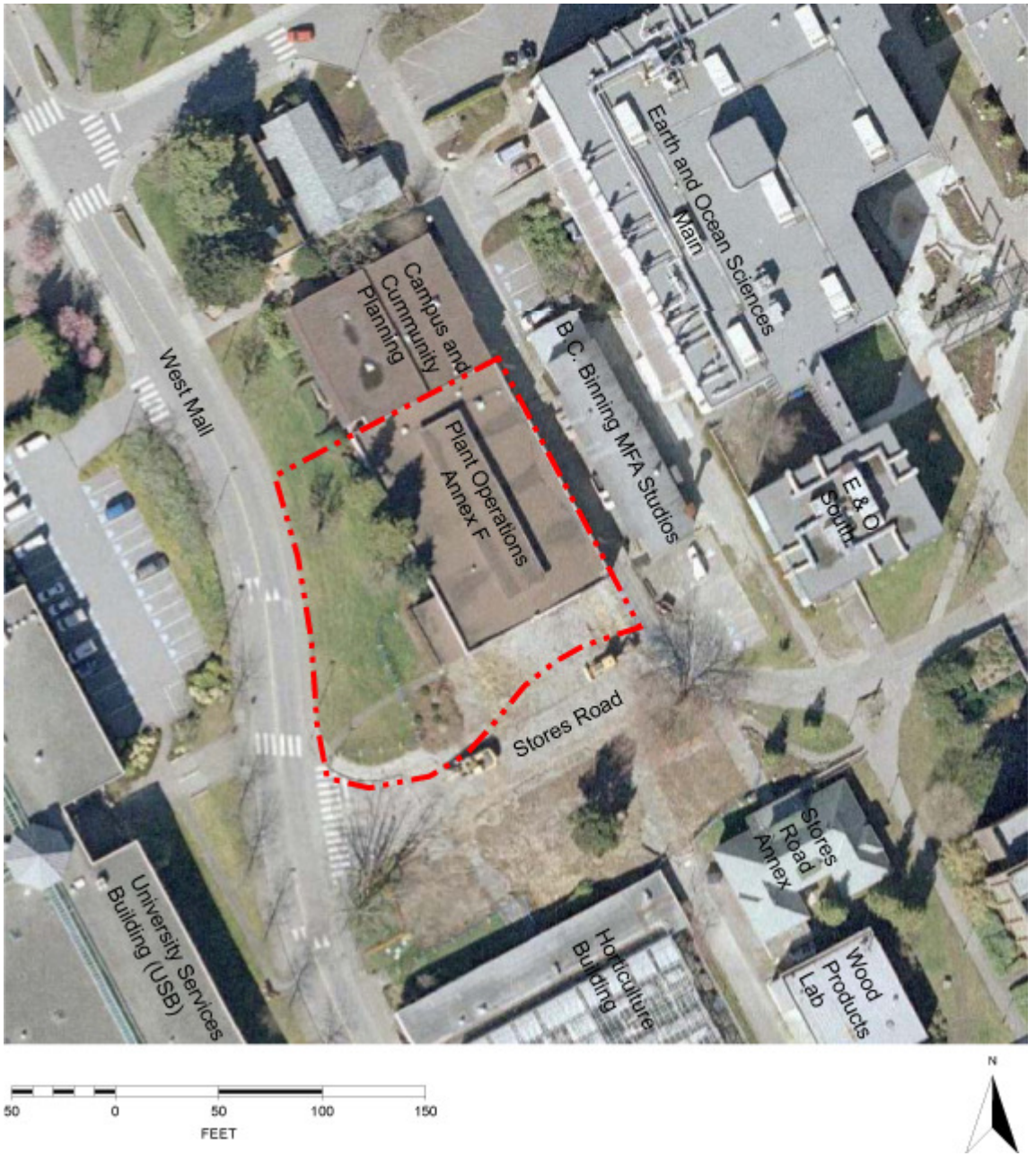
BUSBY
PERKINS
+ WILL

# CIRS

- A living laboratory to accelerate sustainability
- A healthy place to work
- Net zero energy
- Carbon negative operation
- Low Carbon construction
- Net zero water use
- Net gain in landscaped area
- Non toxic materials
- *Cost no more than typical university construction*

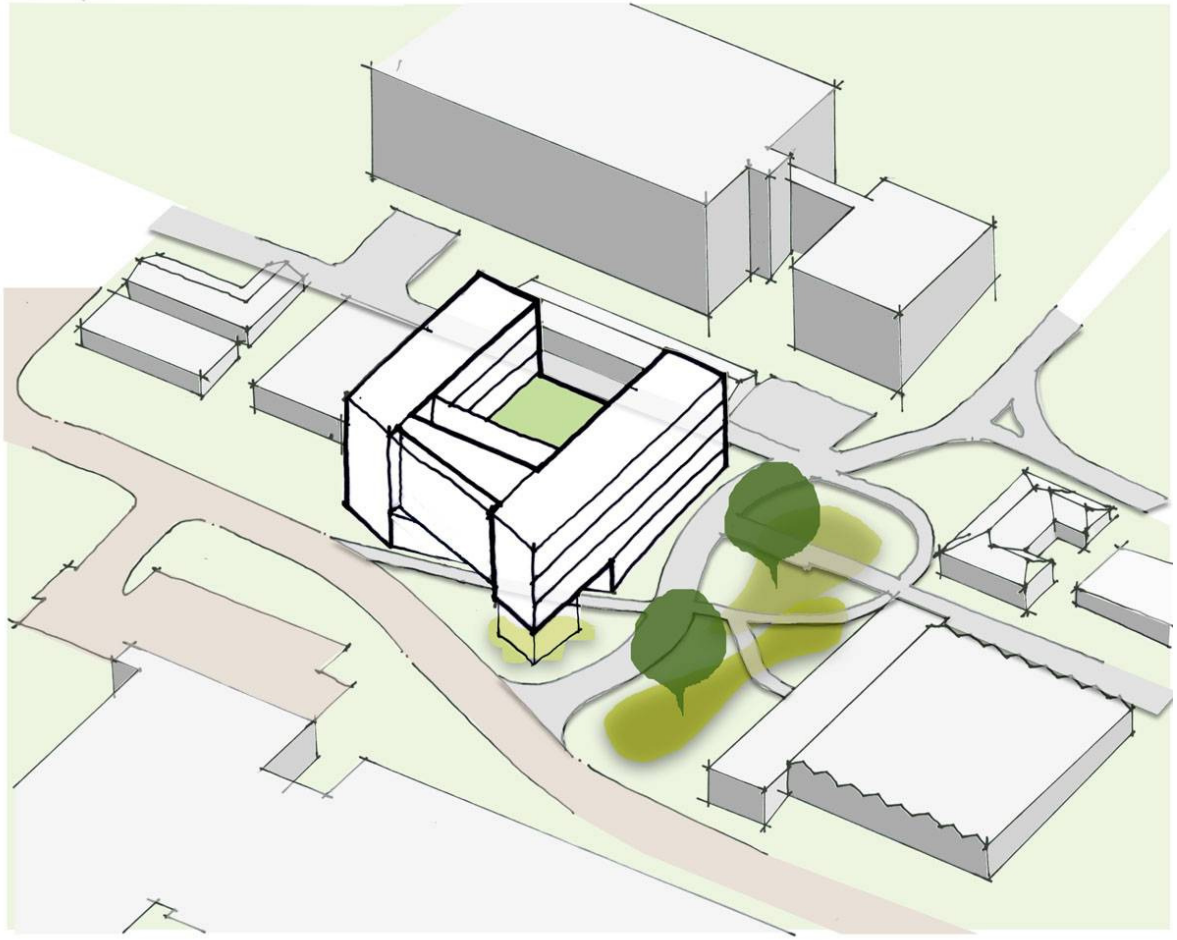

UNIVERSITY
OF
BRITISH COLUMBIA
CIRS SITE
WOOD

Deconstructing existing building on site;
Function replaced in basement of new building



# Massing

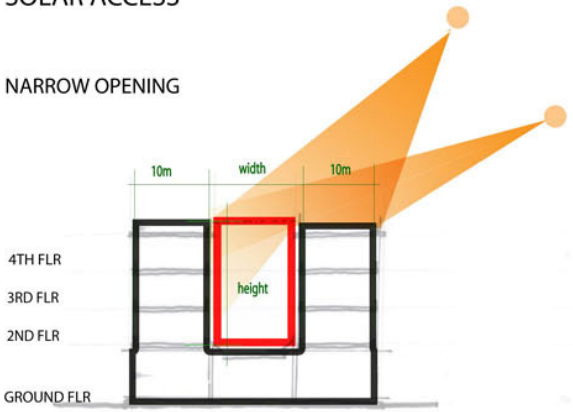
- Daylighting
  - Narrow office bars
  - Orient them
    E-W for easiest glare control
- Wood Structure
  - Try not to place office spaces over assembly spaces
- Make the most of the site
  - preserve path
  - engage Sustainability Street landscape



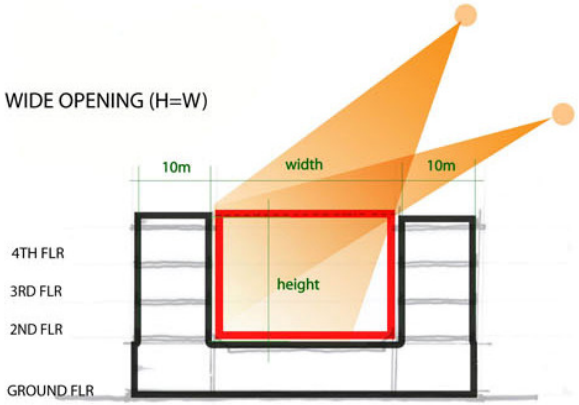
# BUILDING MASSING IMPLICATIONS

## SOLAR ACCESS

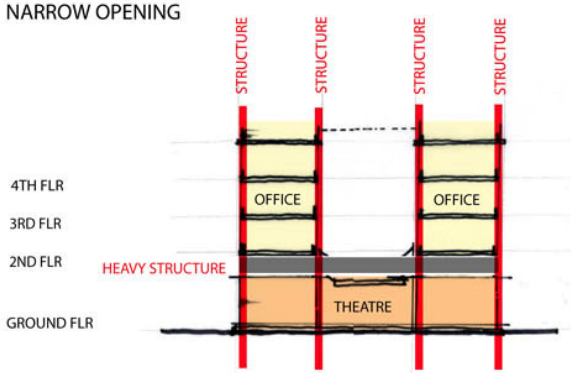
### NARROW OPENING




### WIDE OPENING (H=W)




### NARROW OPENING

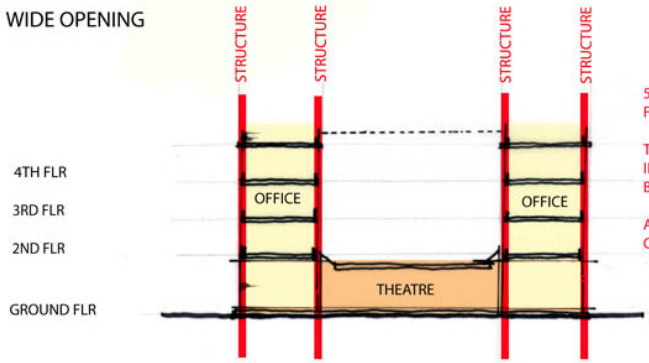



STRUCTURE OBSTRUCTS
500 SEAT THEATRE SPACE

REQUIRES HEAVY BEAM
SUPPORTS TO KEEP
THEATRE UNOBSTRUCTED

CODE RESTRICTIVE IF
BUILDING STRUCTURE IS
ALL COMBUSTIBLE
CONSTRUCTION

### WIDE OPENING



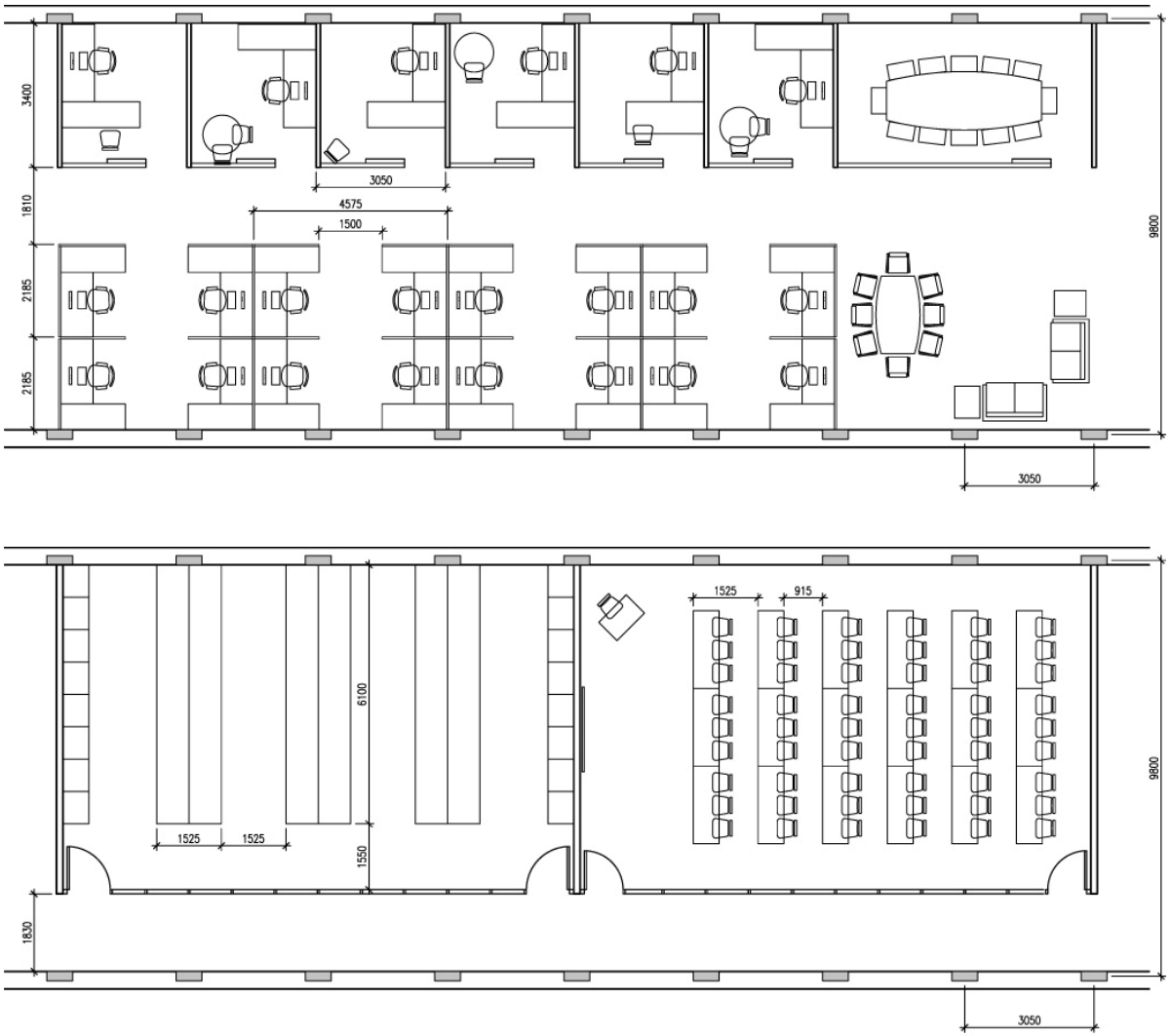

500 SEAT THEATRE SPACE
FITS BETWEEN OFFICE BARS

THEATRE STRUCTURE IS
INDEPENDENT FROM OFFICE
BARS

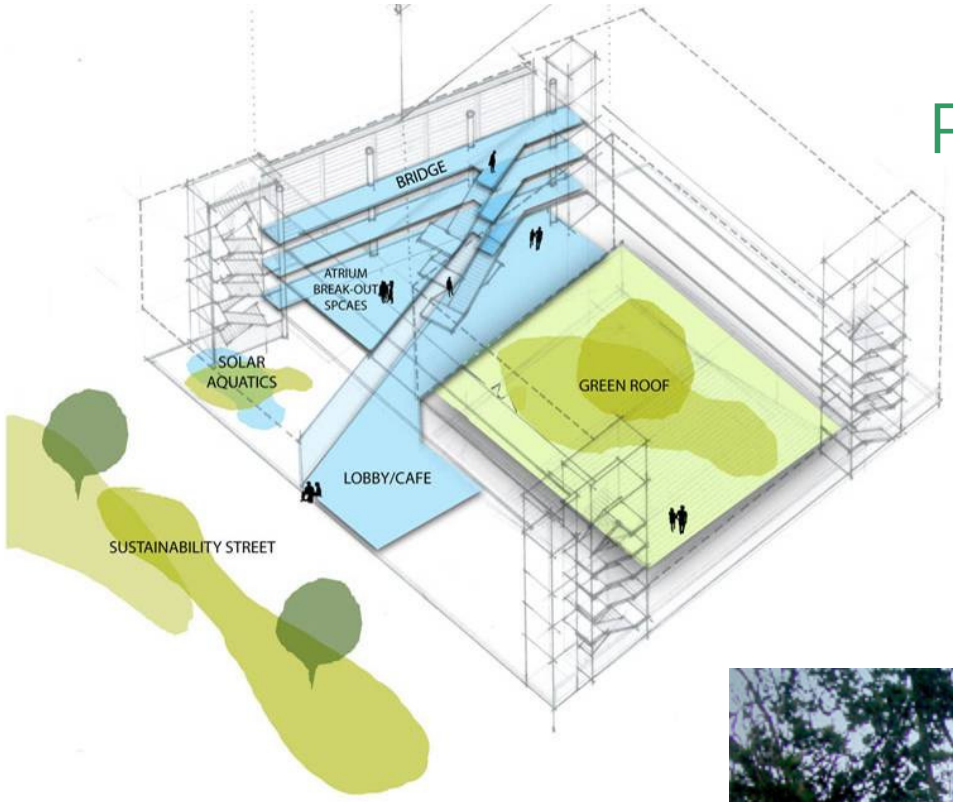
ALL COMBUSTIBLE
CONSTRUCTION IS POSSIBLE

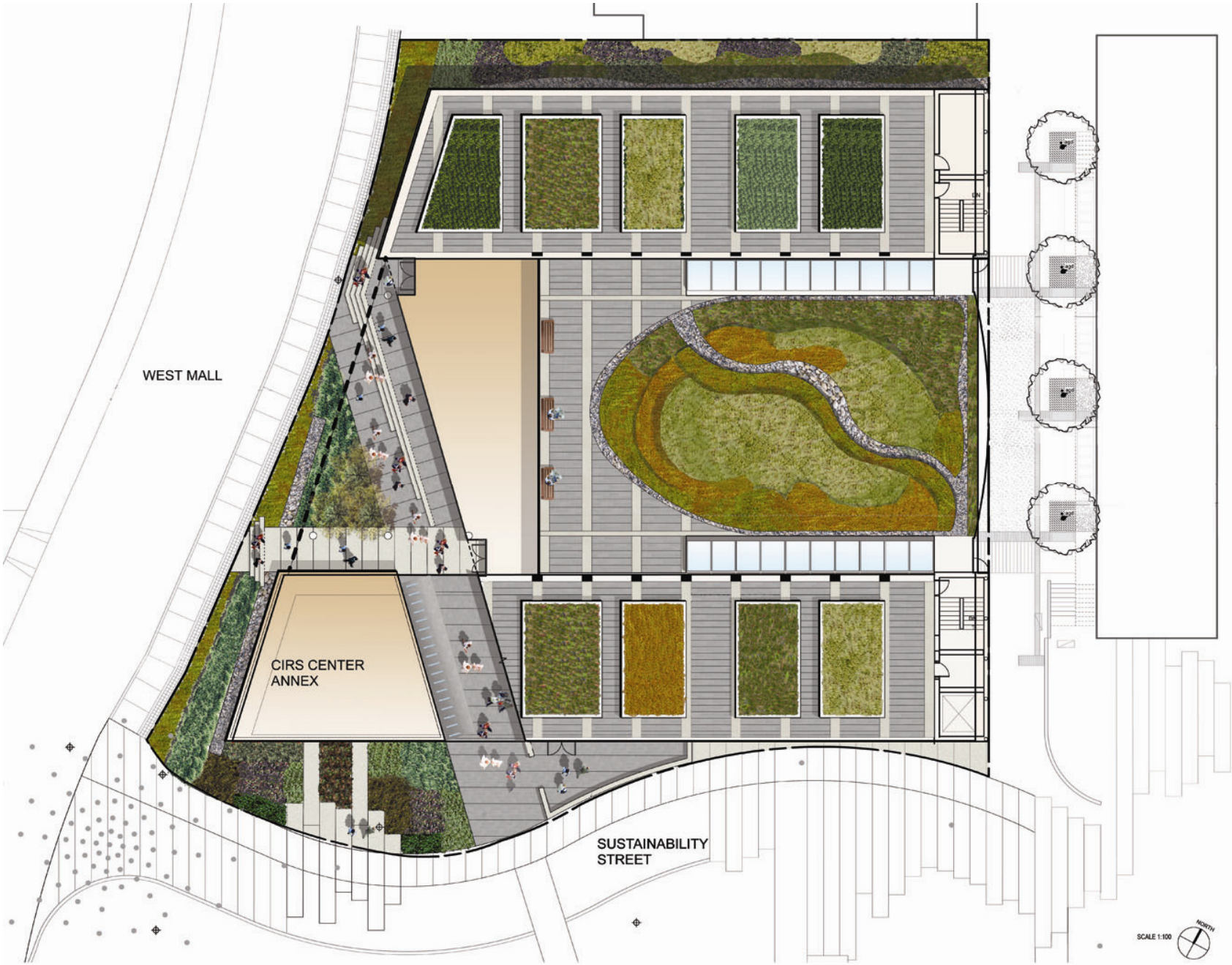
# Narrow floor plates

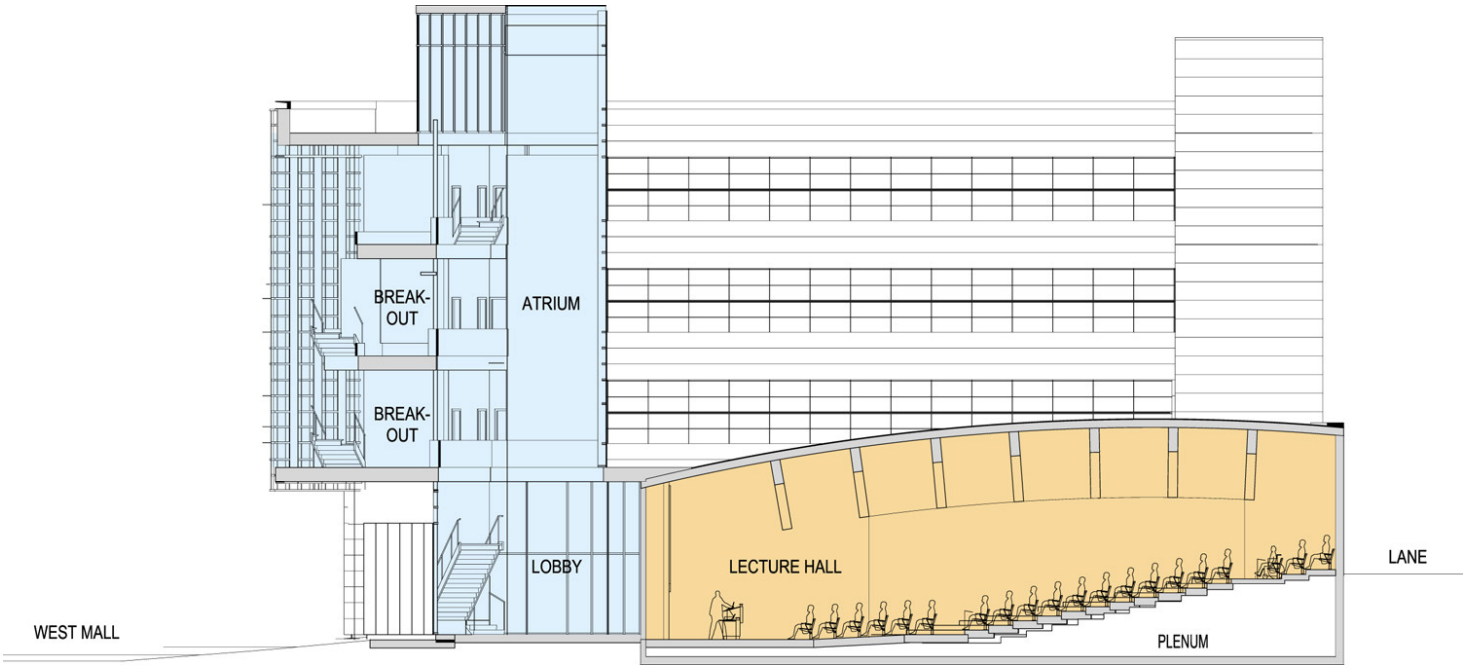
- Everyone has access to light and views
- Easy natural ventilation

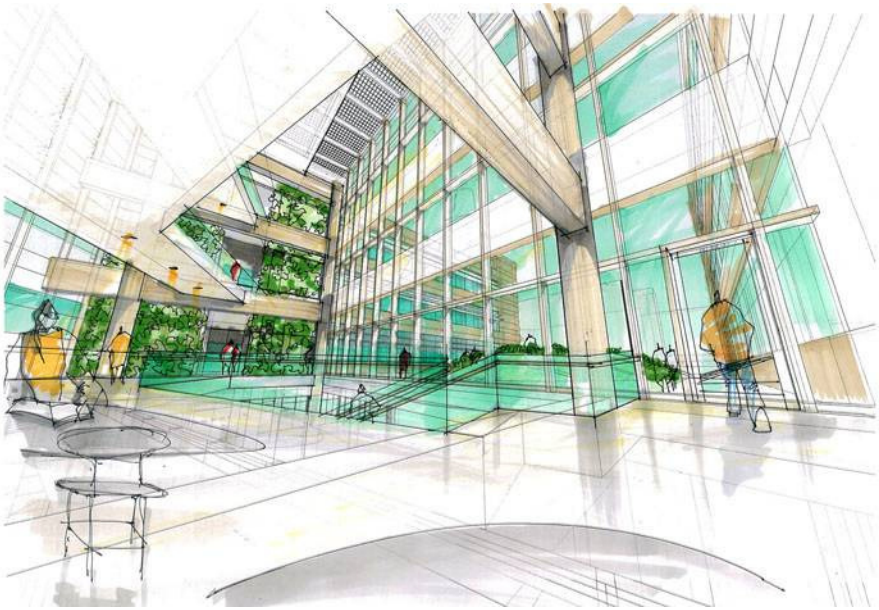


# Public space / green space





WEST MALL
CIRS CENTER
ANNEX
SUSTAINABILITY
STREET
SCALE 1:100
NORTH



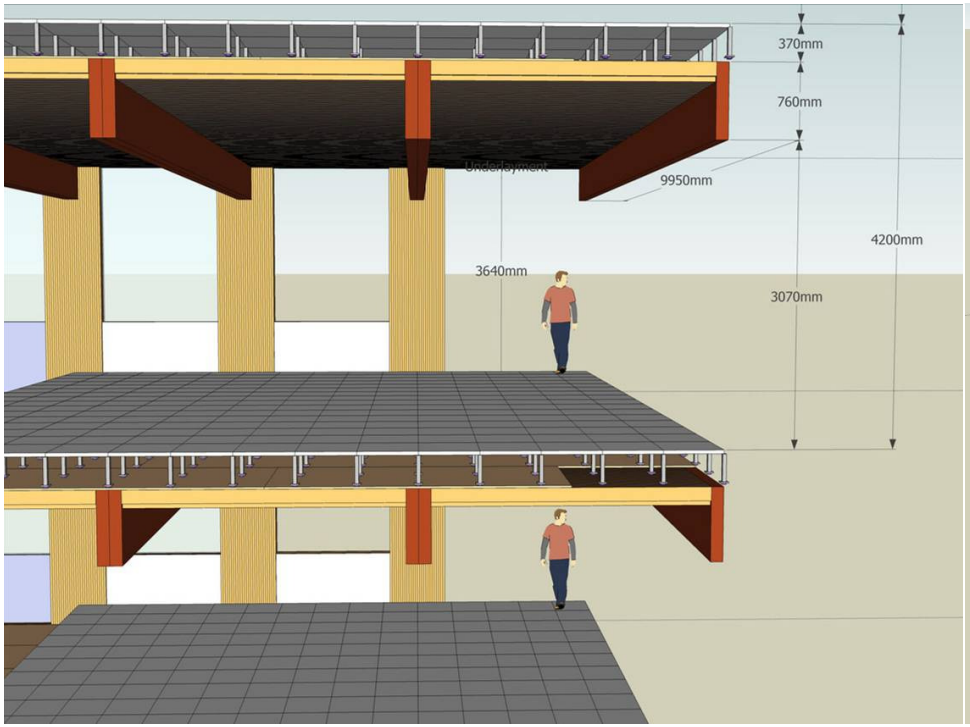



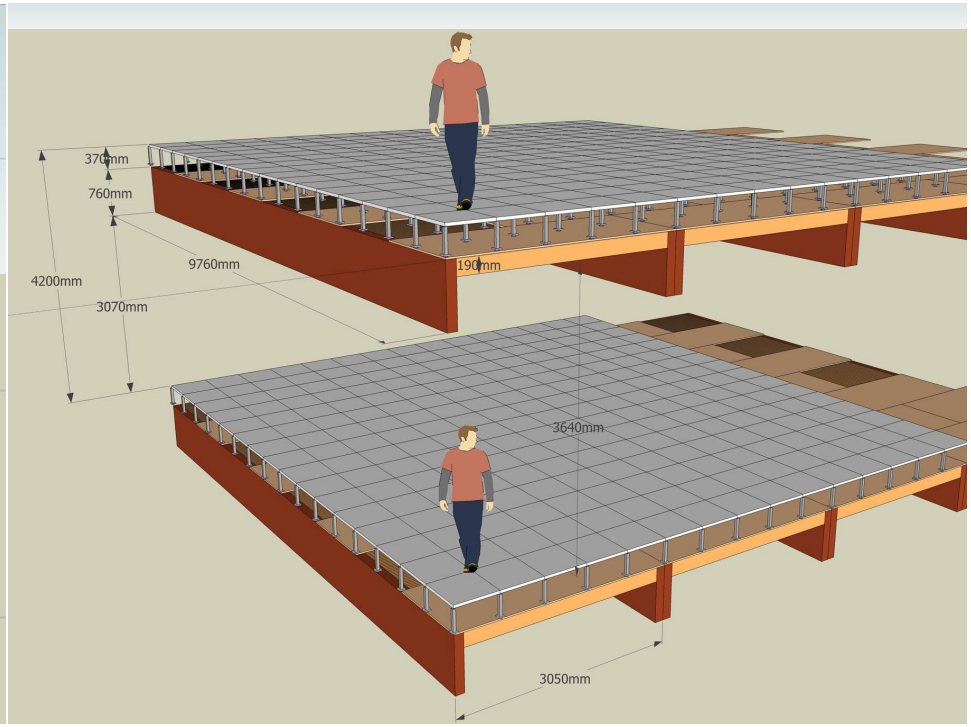
View from Level 2 Break-out Area

View from Courtyard / Auditorium Roof

# Structure: Wood

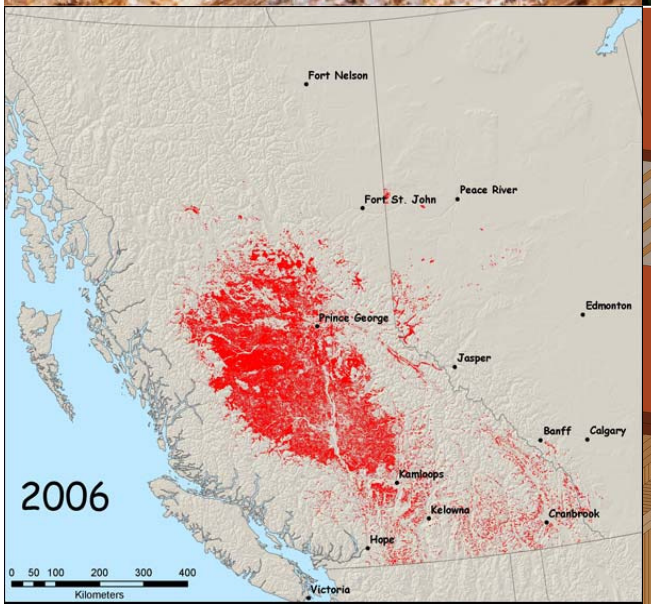
- Glulam moment frame
- Solid wood floor slabs
- Shear in perimeter walls

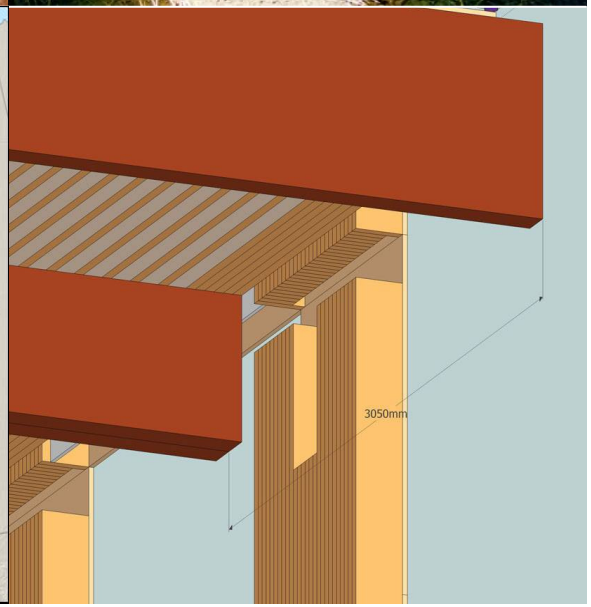


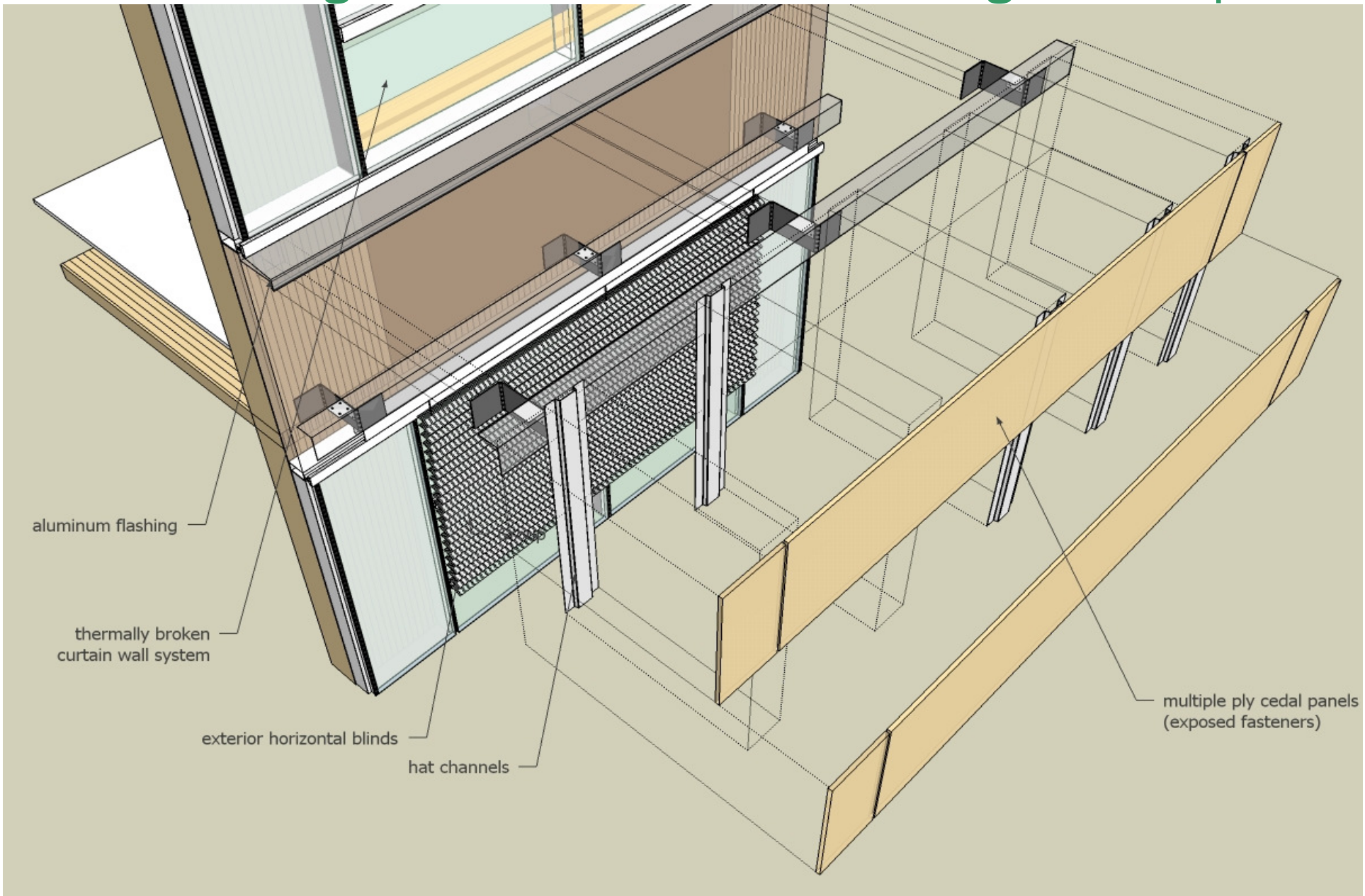
# Why wood?

- The building material made by the sun
- The building material that sequesters carbon
- There's a lot of it in BC—a lot of it dead, thanks to the pine beetle
- Low embodied energy



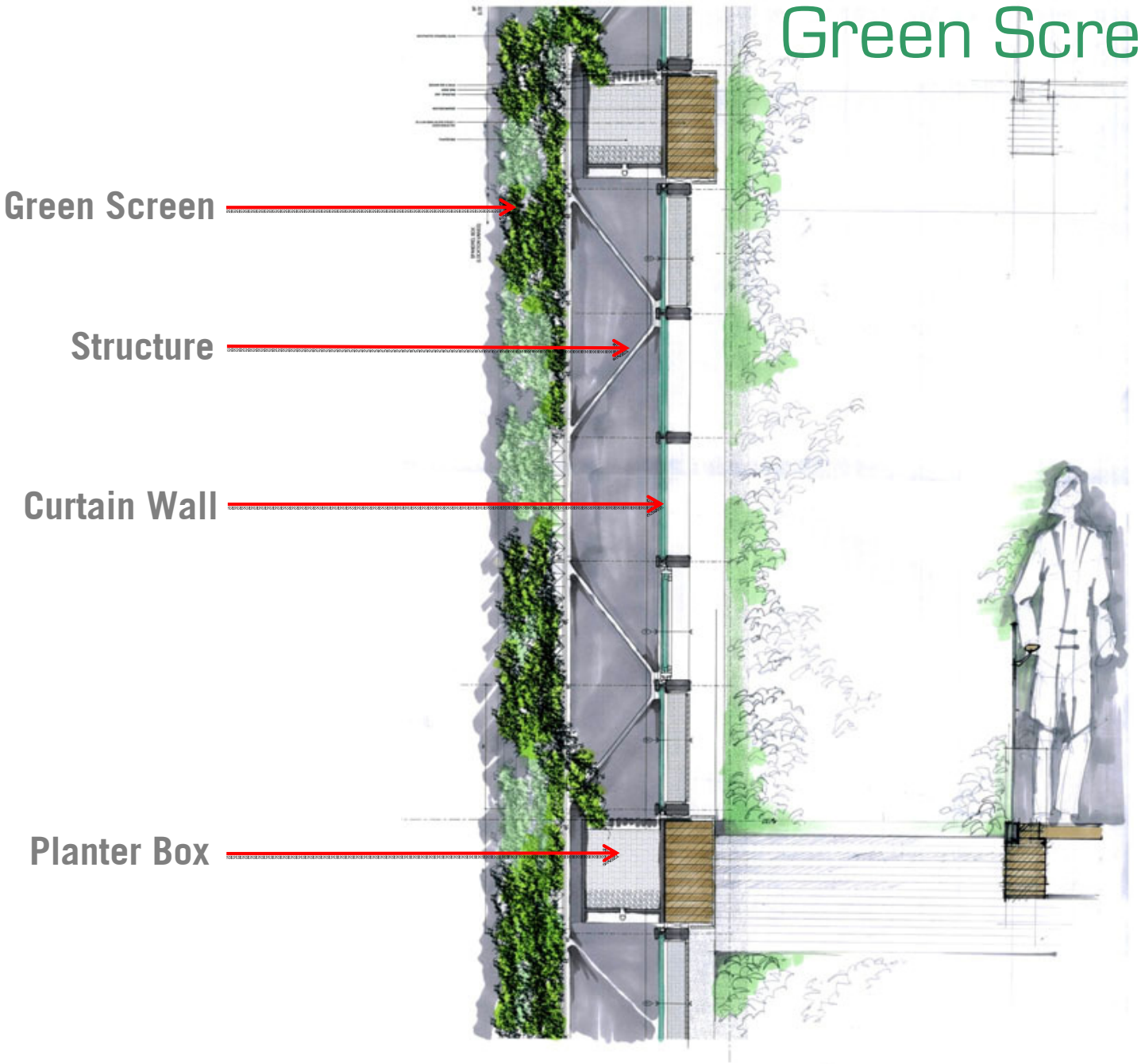



# High Performance Building Envelope

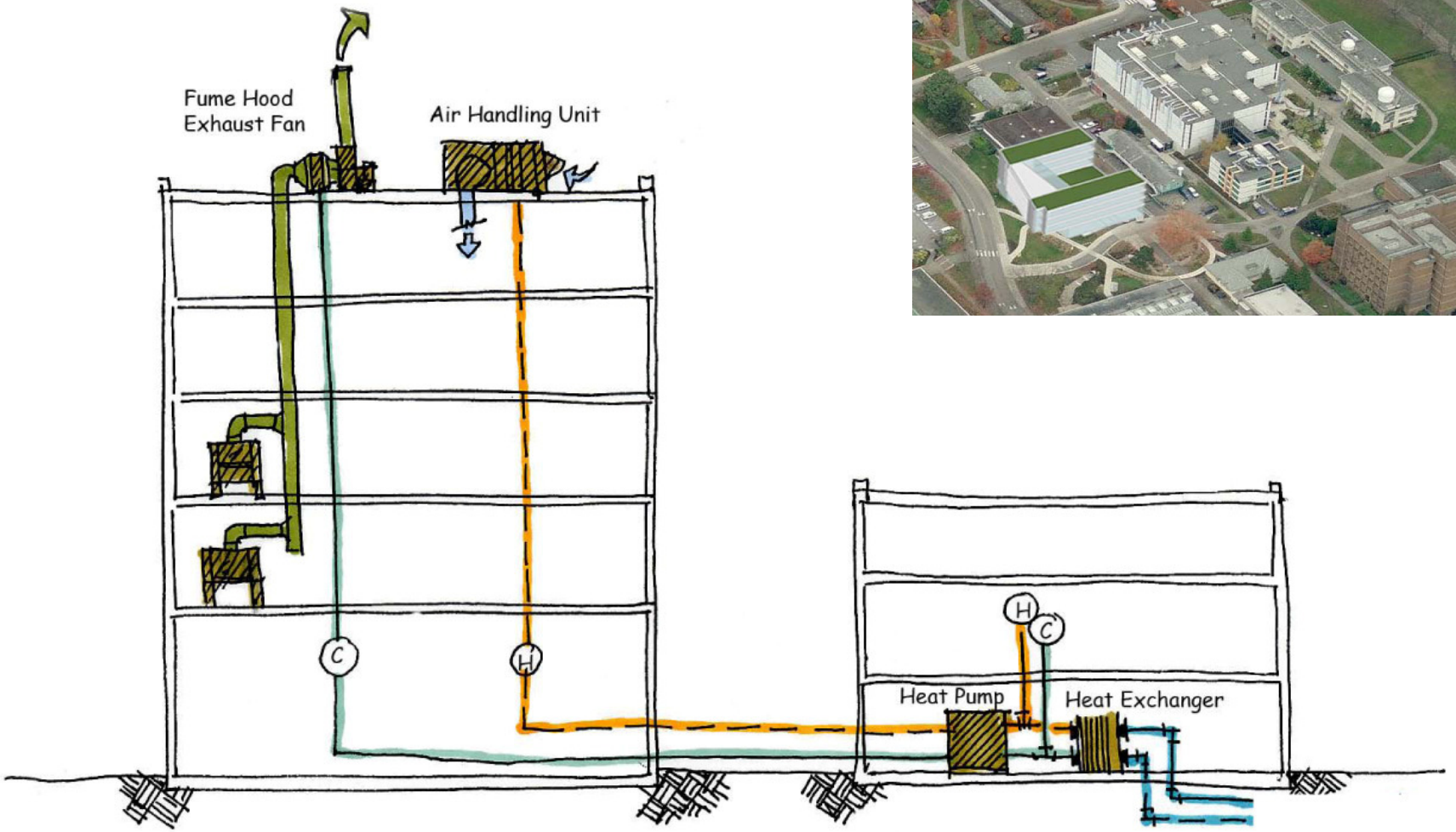


# Reflecting Seasonal Change

# Green Screen



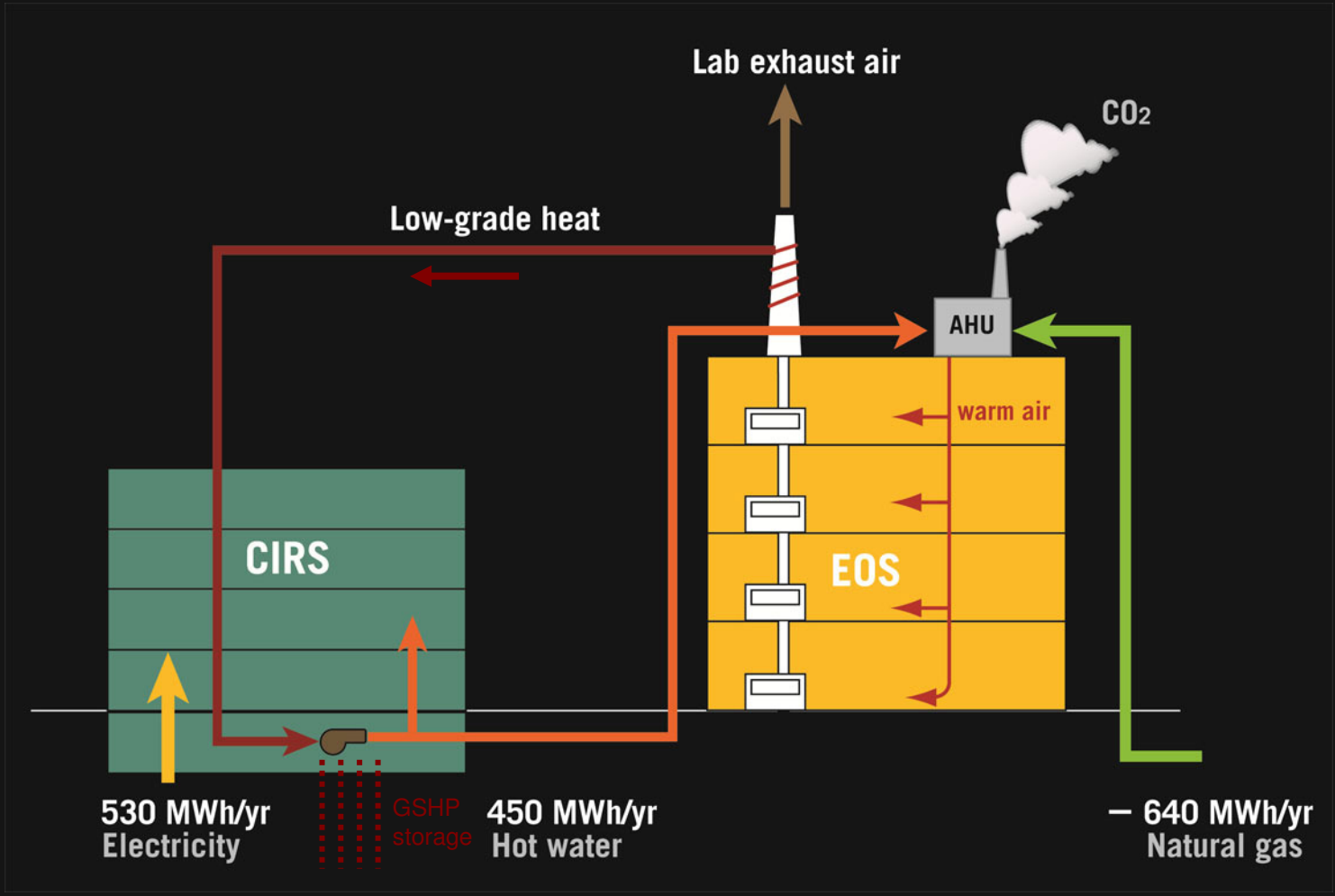
# Energy strategy: A net-zero intervention



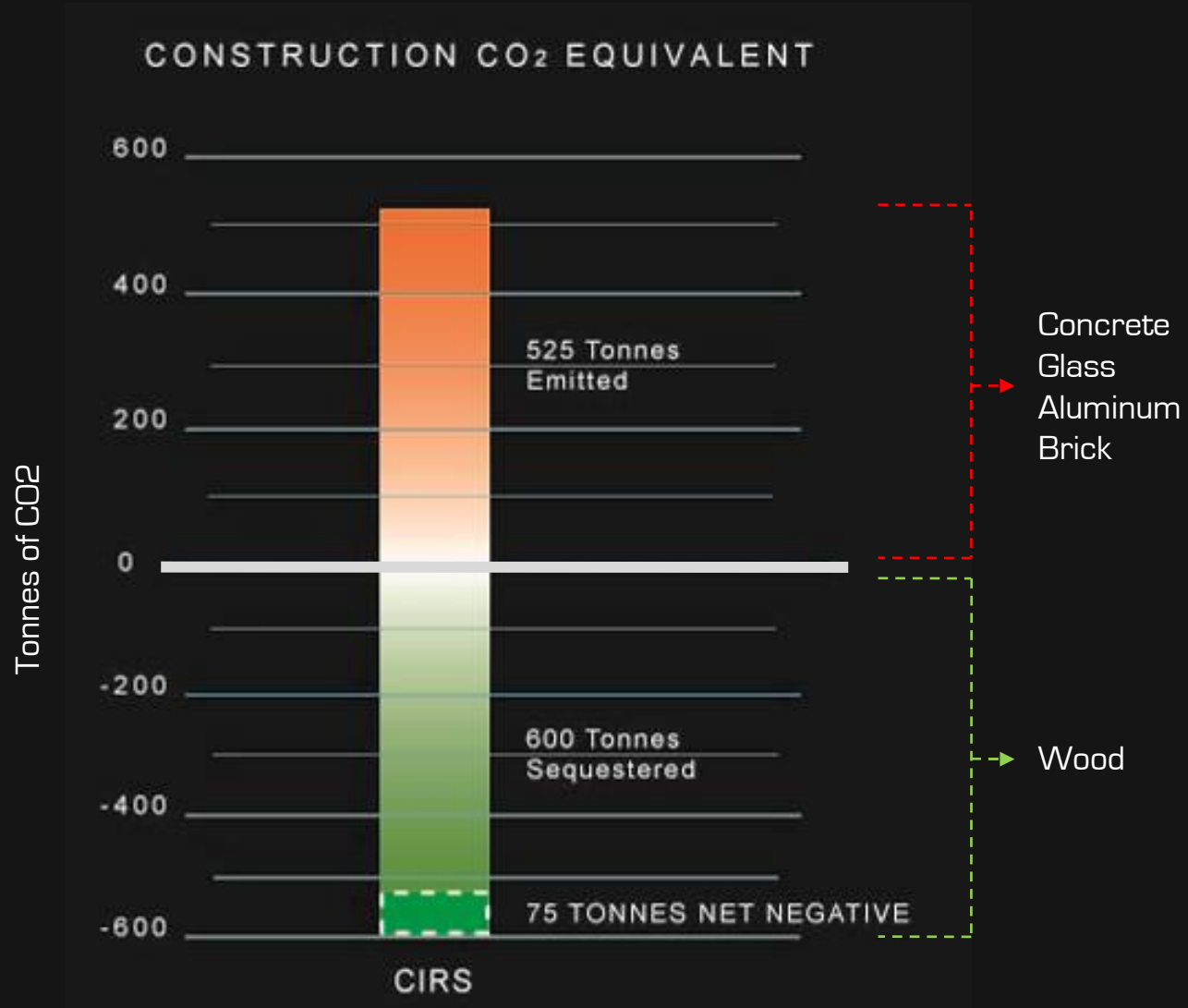
# Energy Strategy: A Carbon-Negative Intervention

*As a result of building CIRS, the university...*

- *gets a new 60,000 SF building*
- *their campus CO2 emissions will drop 70 tons per year*
- *their campus energy consumption will drop 110MWh/yr*



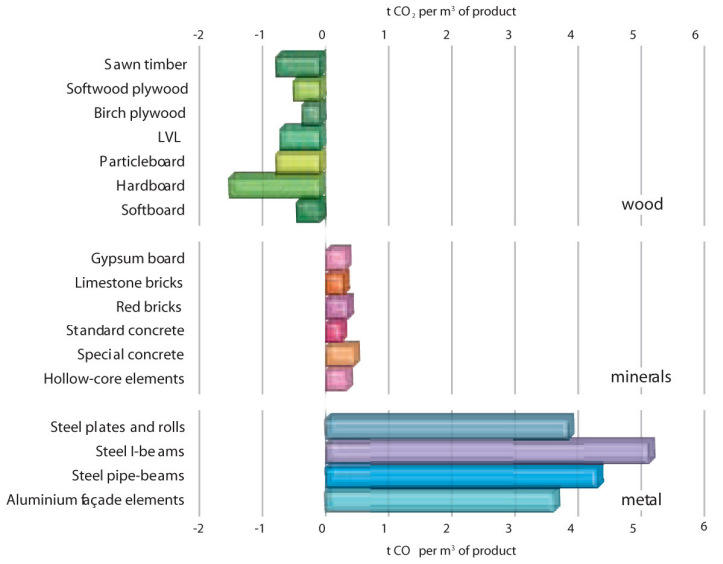
# Carbon Neutral Construction



# Energy strategy: A net-zero intervention

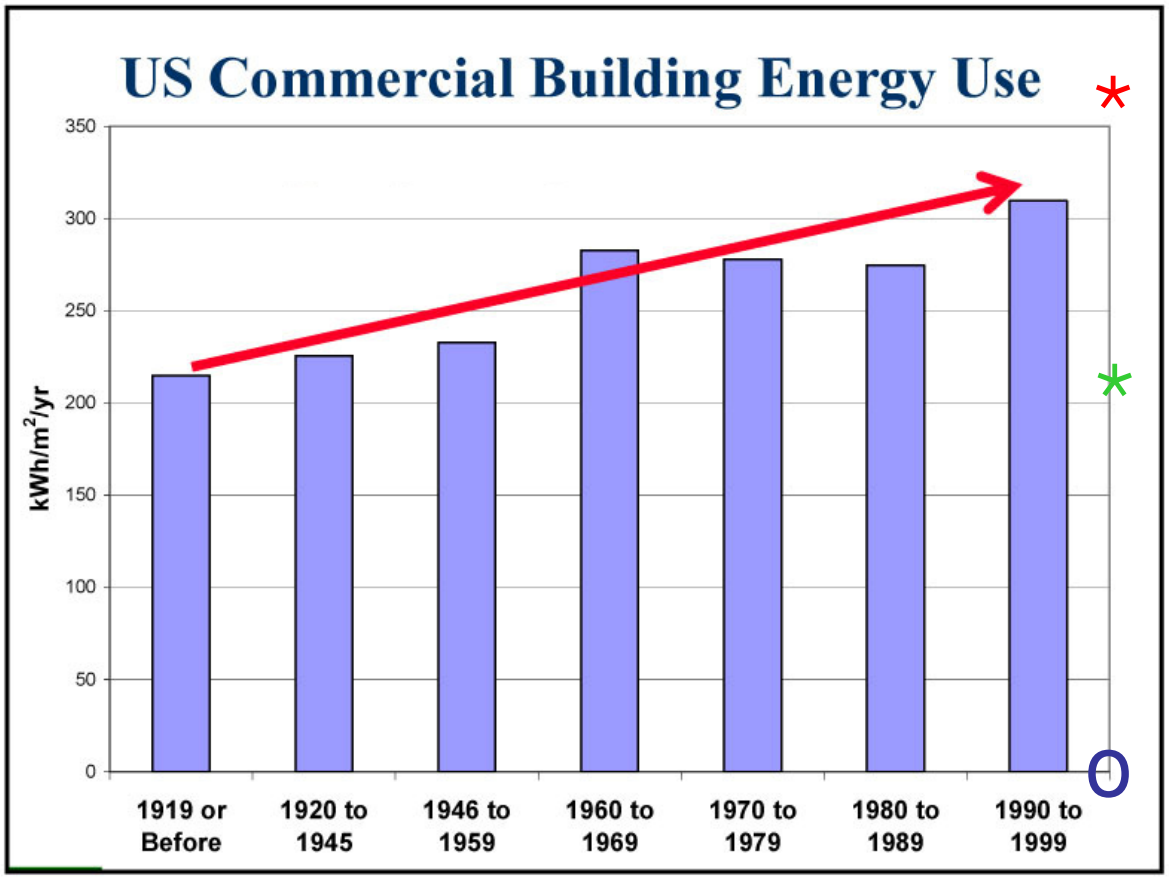
- Energy—net zero
  - CIRS uses 306 MWh/yr electricity, including EOS intervention
  - CIRS exports 311 MWh/yr heat to EOS, reducing natural gas use
- $CO_2$ –net negative
  - UBC will emit 50 tonnes/yr less $CO_2$ after building CIRS than before
  - The construction of CIRS has associated emissions of ~1000 tonnes $CO_2$
  - The wood used in building CIRS sequesters ~500 tonnes $CO_2$ eq.

| CIRS Alternative | CIRS Energy Use kWh/m²/year | Energy Sent to EOS kWh/m²/year |
|---|---|---|
| Lab Exhaust HR | 67 | 68 |
| GSHP | 70 | 0 |
| ASHRAE Reference | 201 | 0 |




**LCA CO2 per m3 of material, including carbon sink effect of wood**
*Building Information Foundation RTS (Finland)*

# *Achieving* better energy performance




*Energy use vs. decade of construction, Source: J. Straube, quoting DOE*

Lewis Center,
Oberlin College
2000

o Goal: energy neutral

* Energy use w/ PV

* Energy use without PV array

*source; J. Scofield, Oberlin*

# The gap between prediction & performance

- Buildings *predicted* to use less energy *tend* to, but…
  - Variation in design accounts for only 1/3 of the variation in actual energy use
  - What is responsible for the other 2/3?

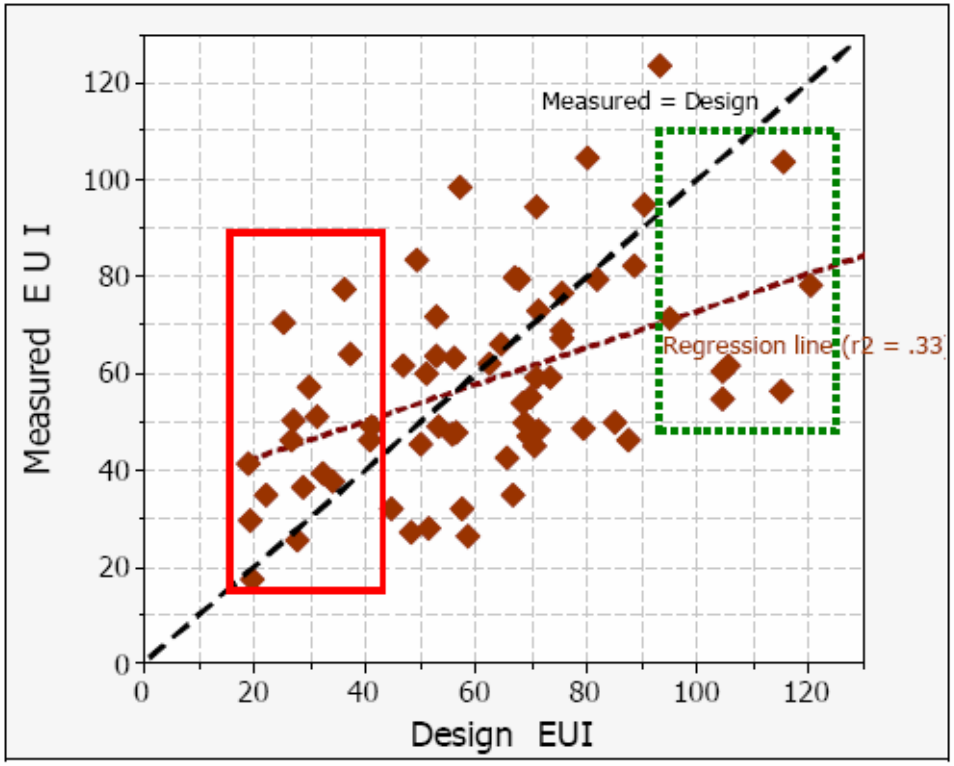
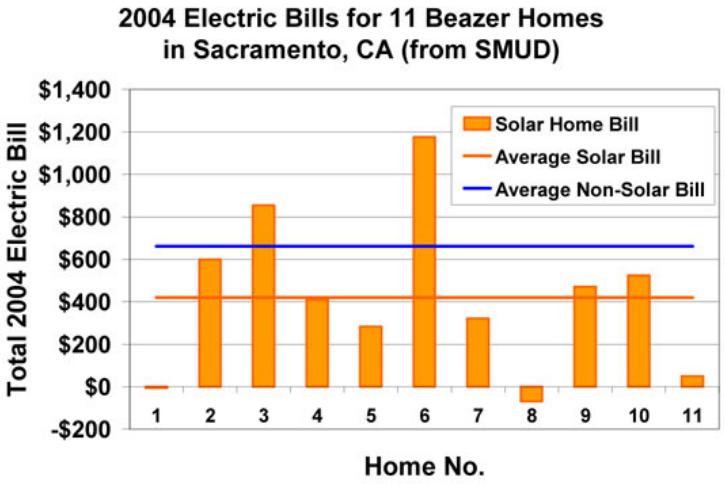
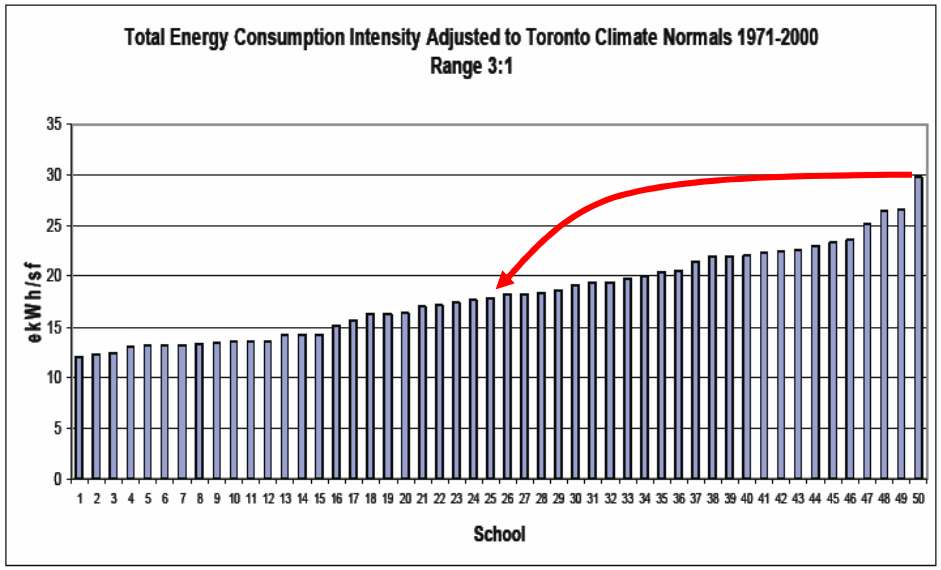



**Figure 21: Measured versus Design EUIs (kBtu/sf)**

Source: New Buildings Institute study of 100 LEED certified buildings

# People matter



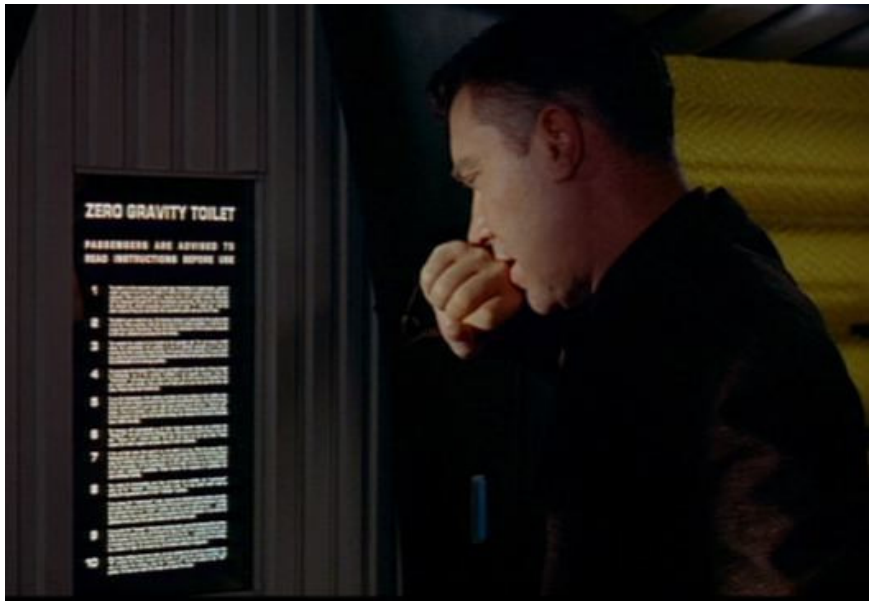




50 schools built around the same time,
with similar designs & budgets

Source: Toronto and Region Conservation Authority

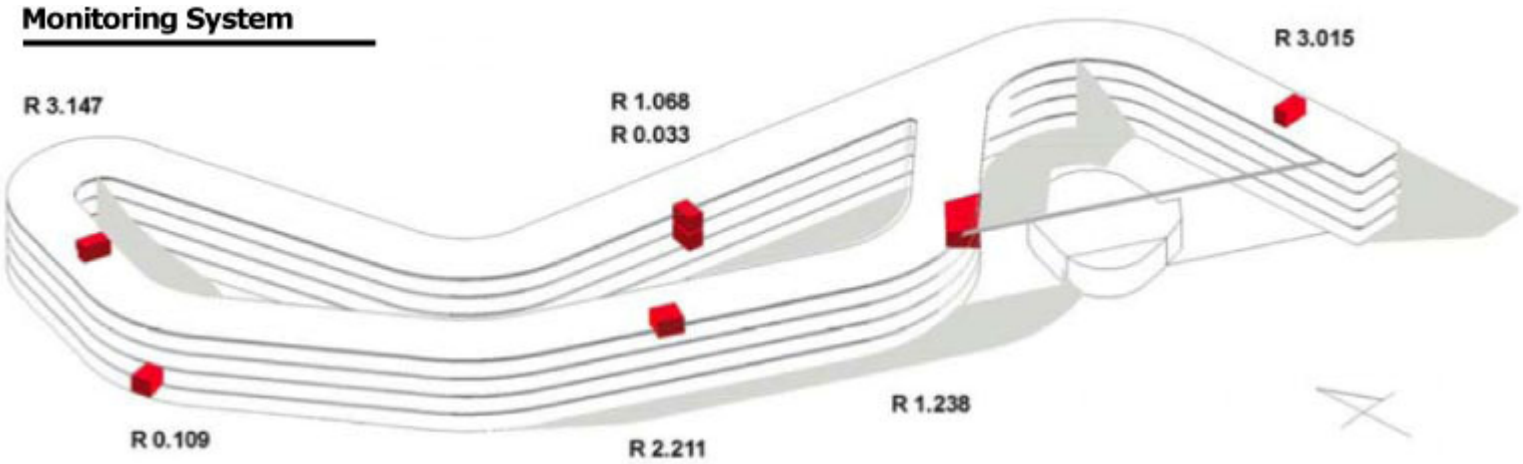
# Complexity matters

- Building form: Deep floor plates require more complex systems
- Complex systems can be harder for organizations to maintain & operate
- Building and systems need to be legible to users



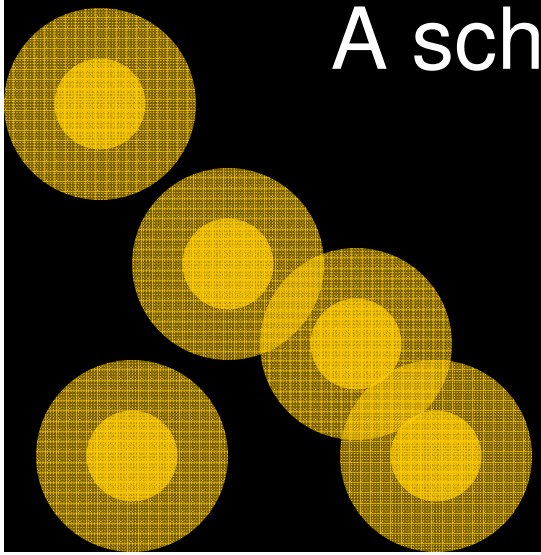
# Feedback matters

- UBA Dessau
  - Predicted use: 55 kWh/m$^2$/yr
  - Actual use: 75 kWh/m$^2$/yr
    (typical office building: 300 kWh/m$^2$/yr)
- CIRS
  - Sensors everywhere
  - Building learns from inhabitants,
    inhabitants learn from the building

# Neighbourhood amenity & energy centres for EcoDensity

## A schools-centred opportunity for locating amenities



Presented to Vancouver City Council 4 March 2008—Z Smith

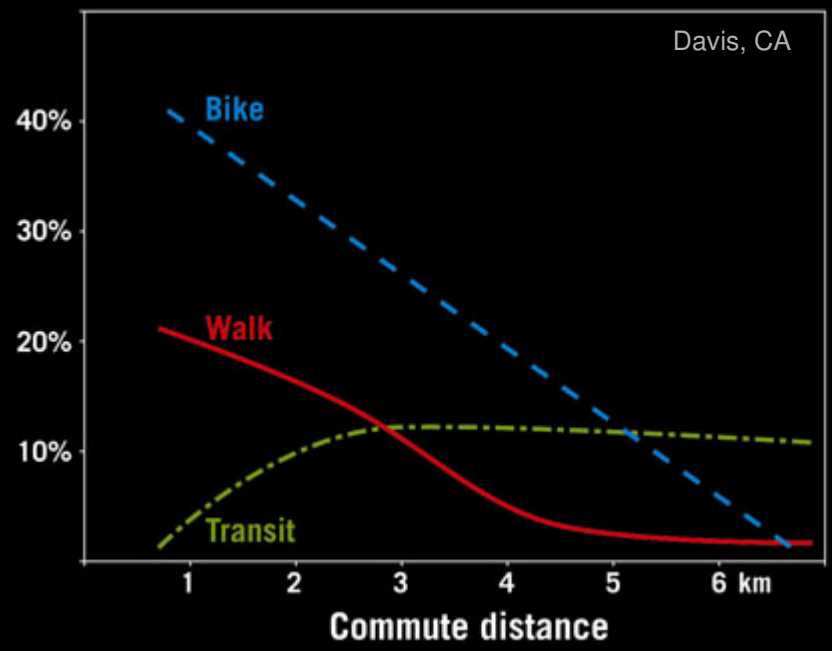
# EcoDensity / Eco-Intensity

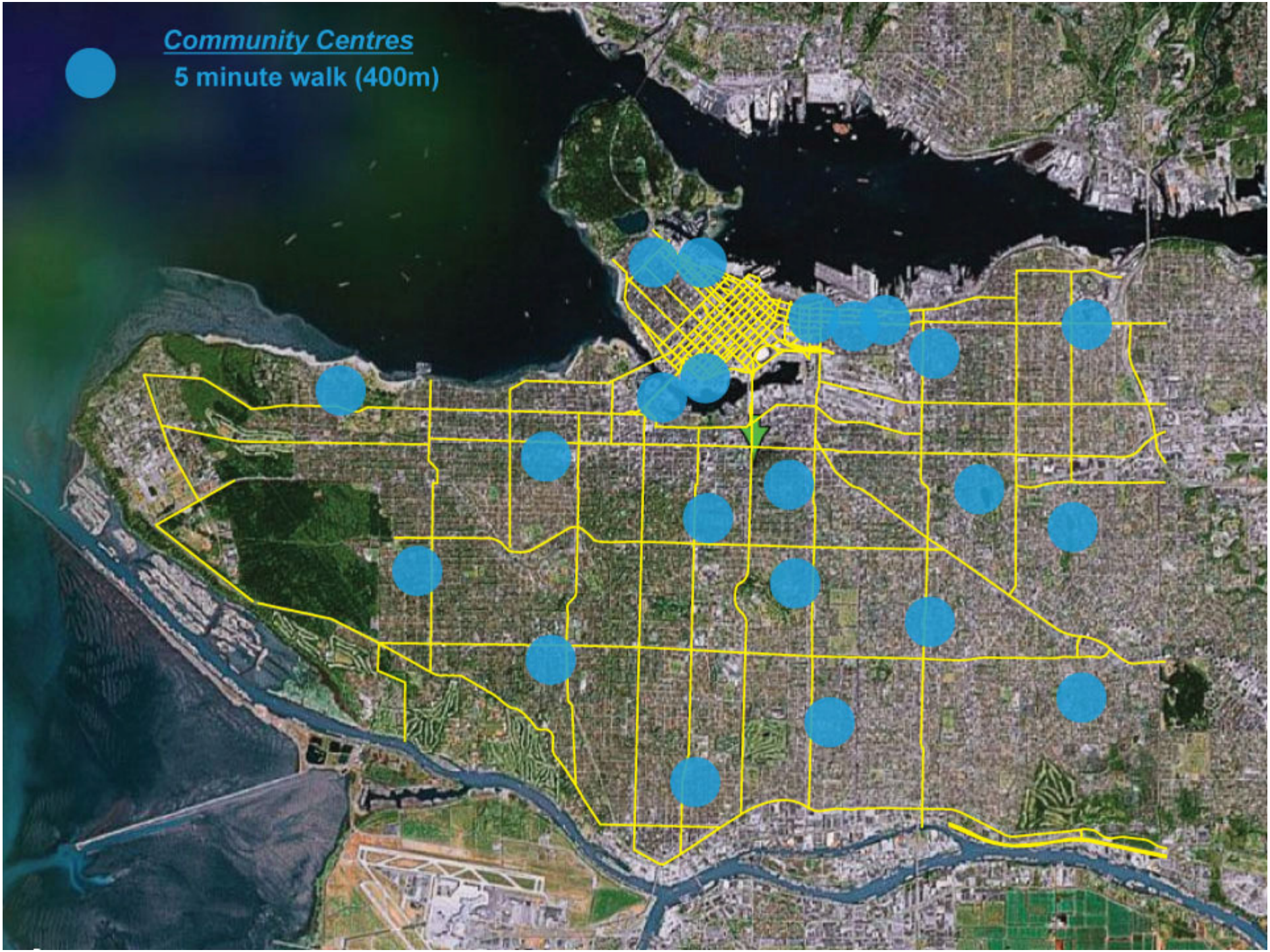
- Not just putting more buildings on a piece of land…
- Getting more *use* out of a piece of land and existing buildings
- Providing live, work and recreation opportunities that *enhance* civic life

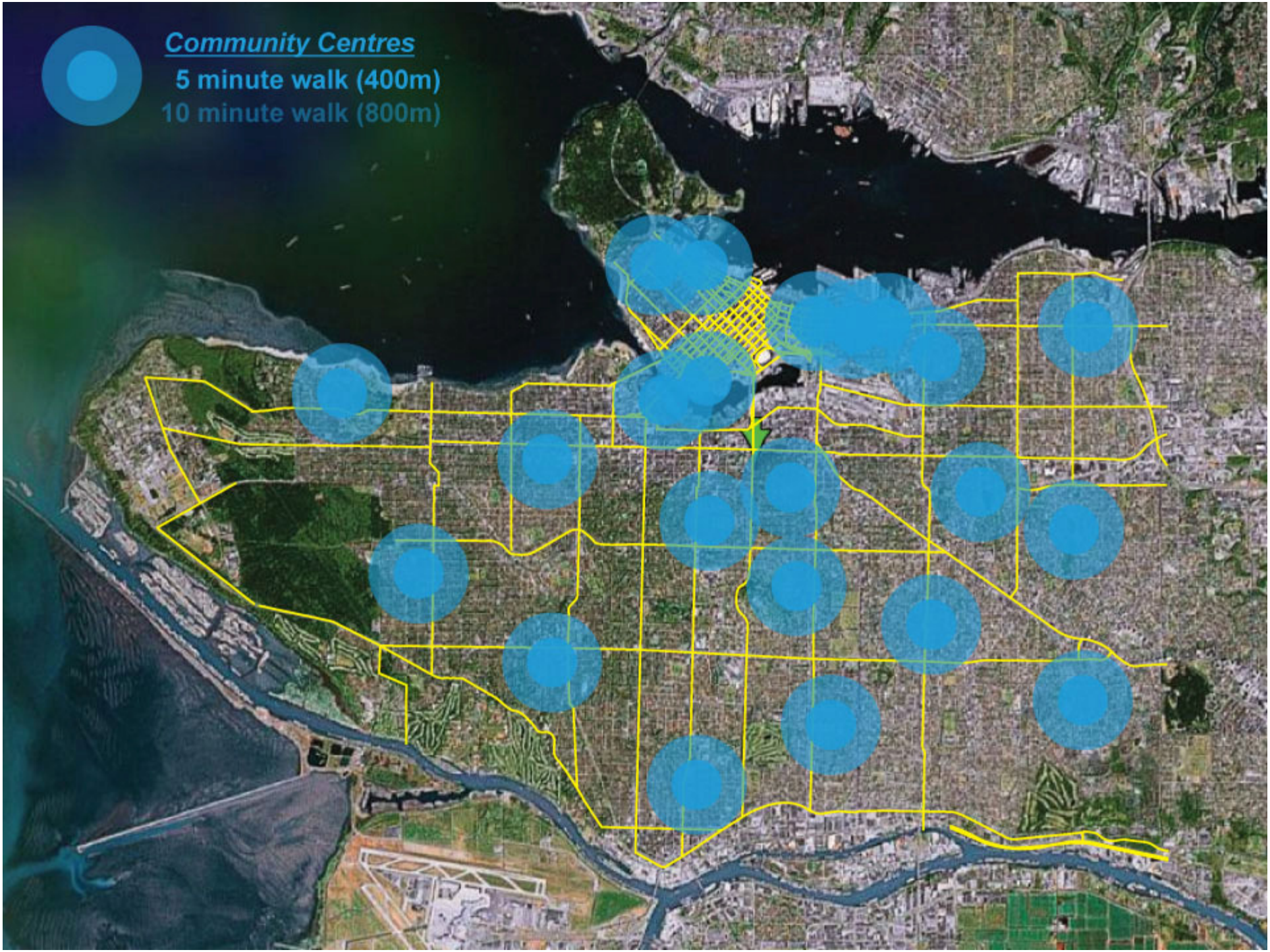
# Proposal

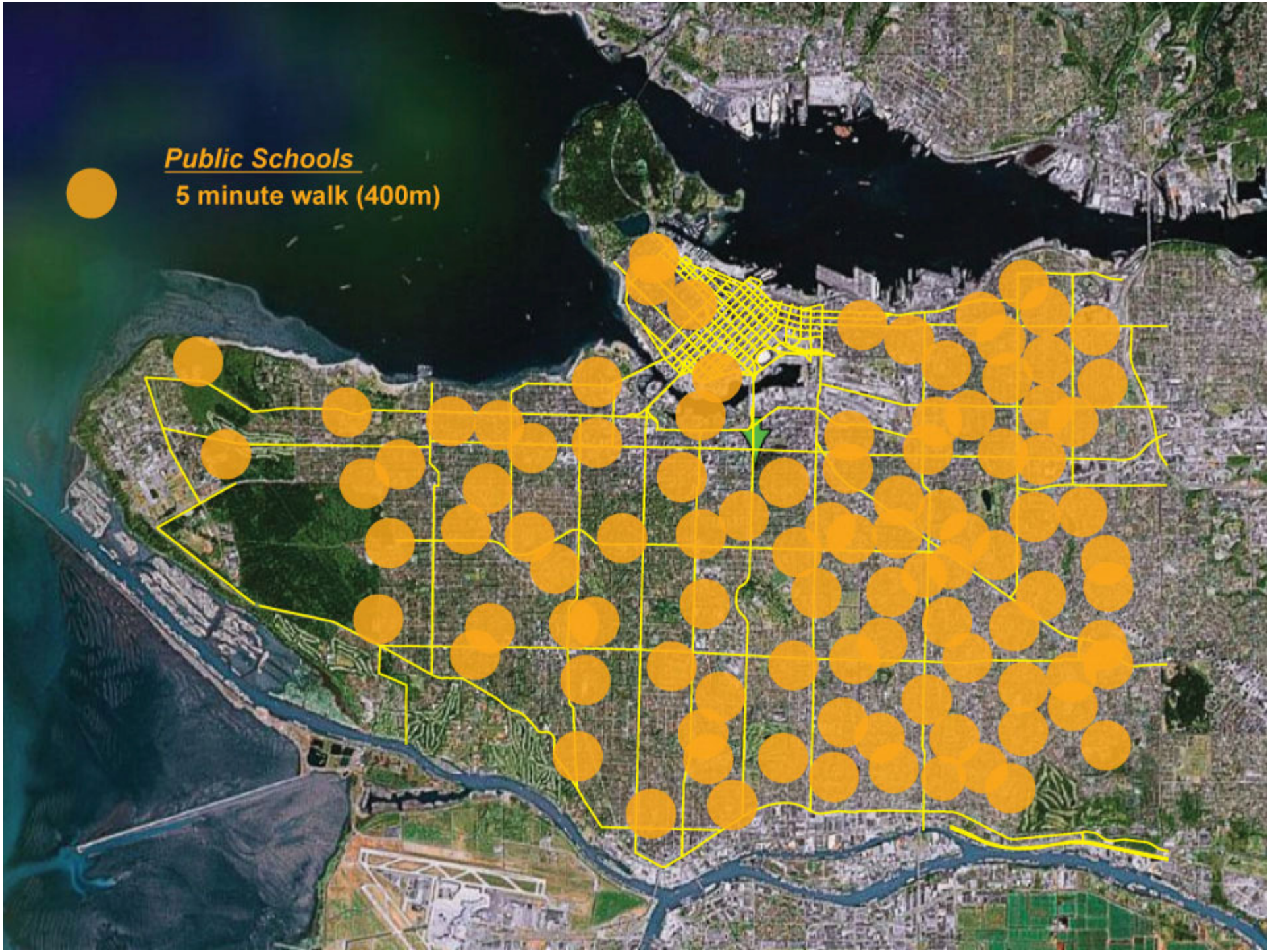
*Co-locate community amenities*
*and district energy*
*with re-developed schools*

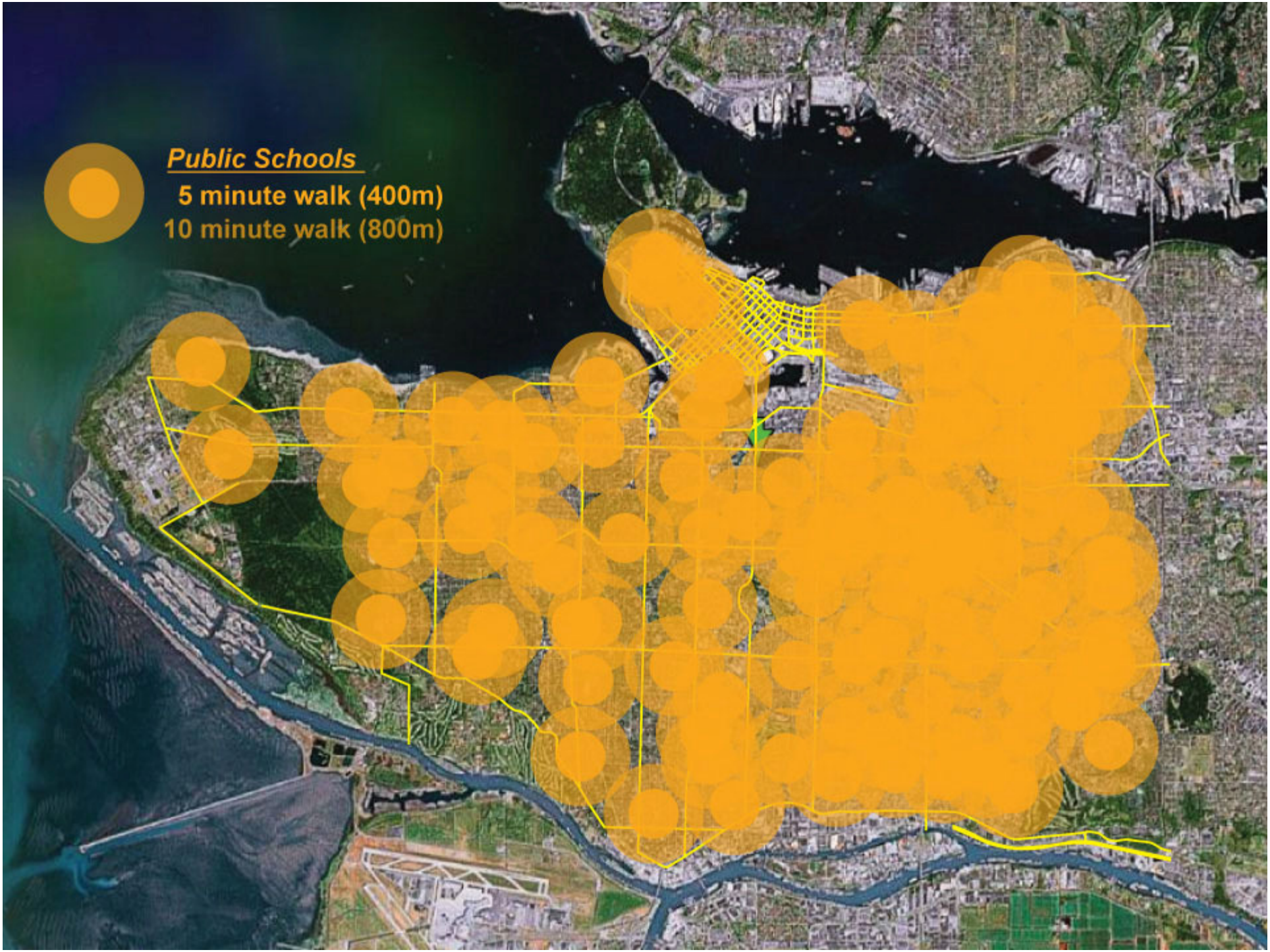
- Walking distance for everyone




Community Centres
5 minute walk (400m)


Community Centres
5 minute walk (400m)
10 minute walk (800m)


Public Schools
5 minute walk (400m)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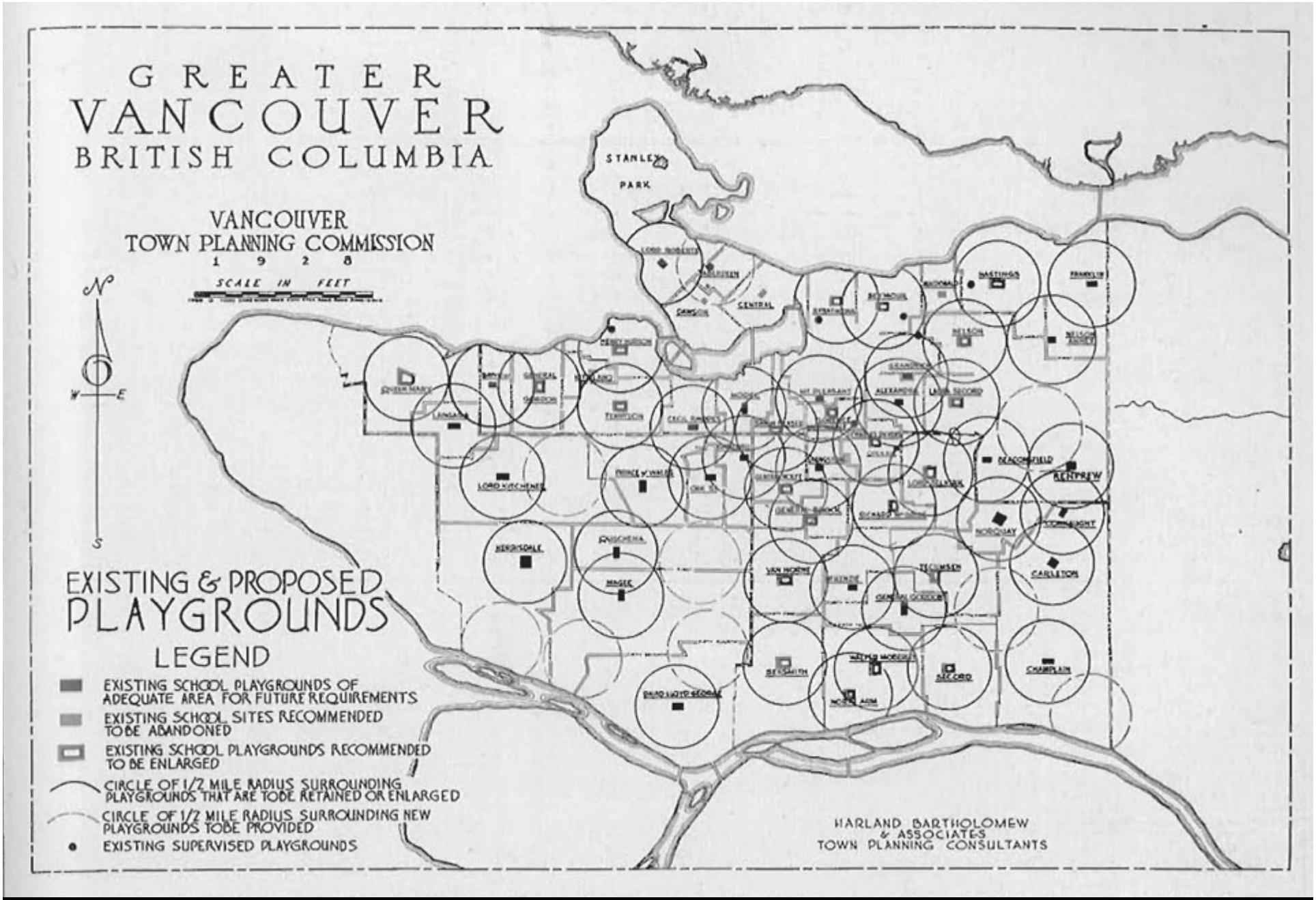
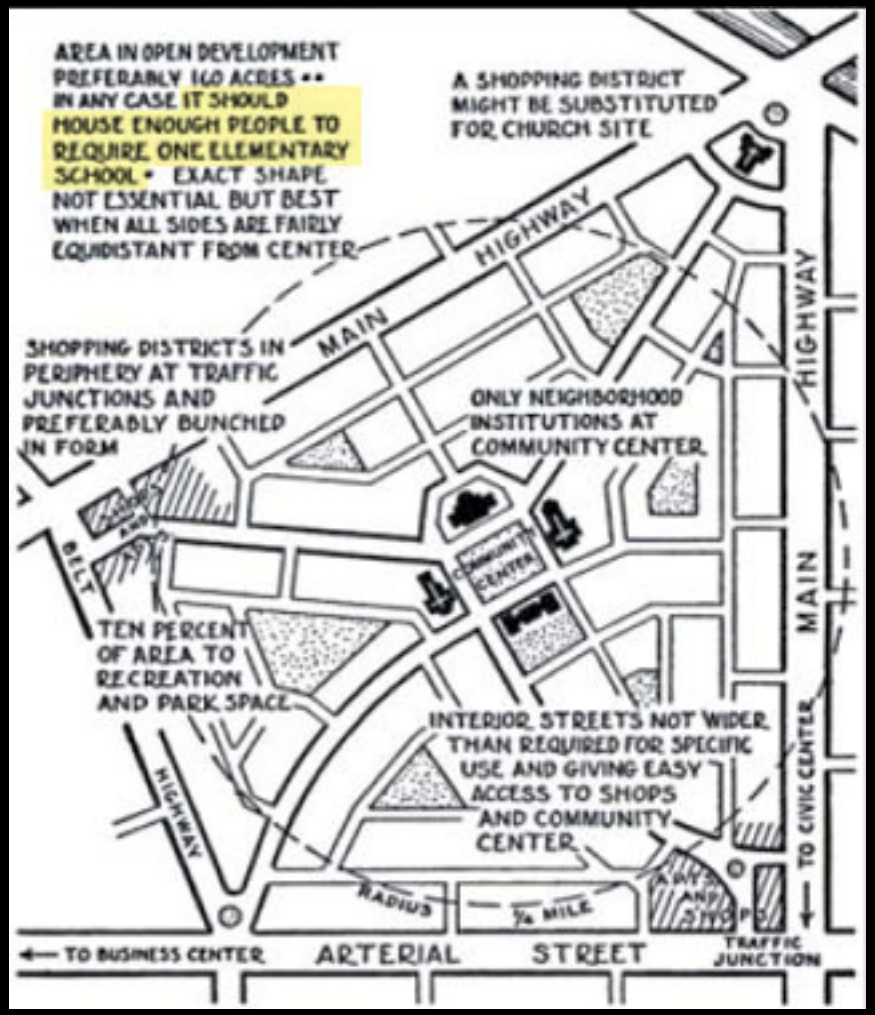



Vancouver 1928 City Plan, Harland Bartholomew



1920 New York Plan: Clarence Perry

*Why are schools so ideally located as the civic buildings you can walk to?*

- School construction boom in the 1920s
- Schools were considered the centre of neighbourhood life
- Schools placed at the centre of a ¼ mile (400m) to ½ mile (800m) walkable zone

# What Seattle is doing

*Upgrading its neighbourhood schools into neighbourhood amenity centres*

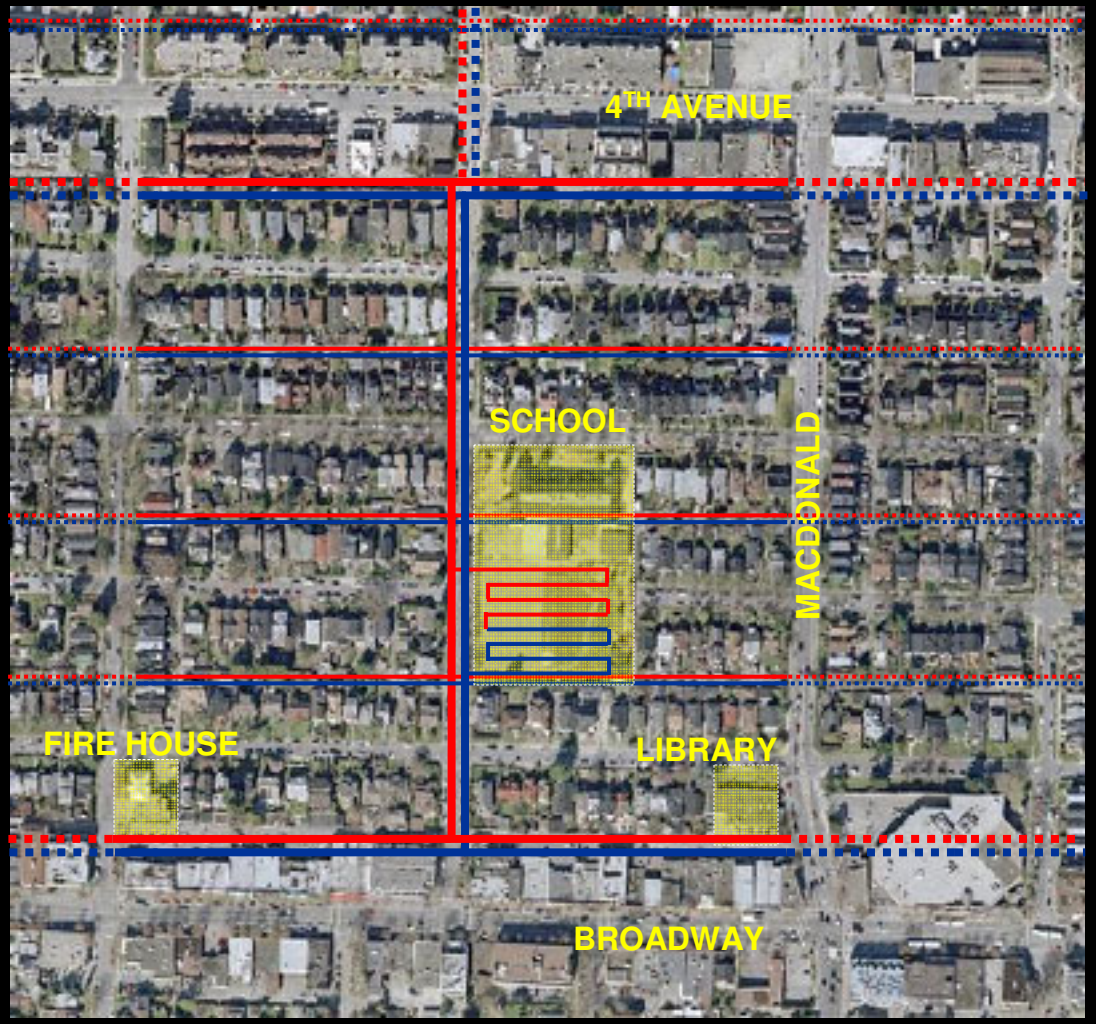
- School by day
- Gym: for the kids by day, the neighbourhood by night
- The library has a community reading room
- Day care / afterschool care is built in
- Typical project seismically upgrades a 35,000 SF heritage school, replaces gym to be post-disaster facility, and adds of amenities to a total 55,000 SF

Latona Elementary

# Schoolyards: an *energy* resource

*Neighbourhood amenity & district energy centres for Vancouver*

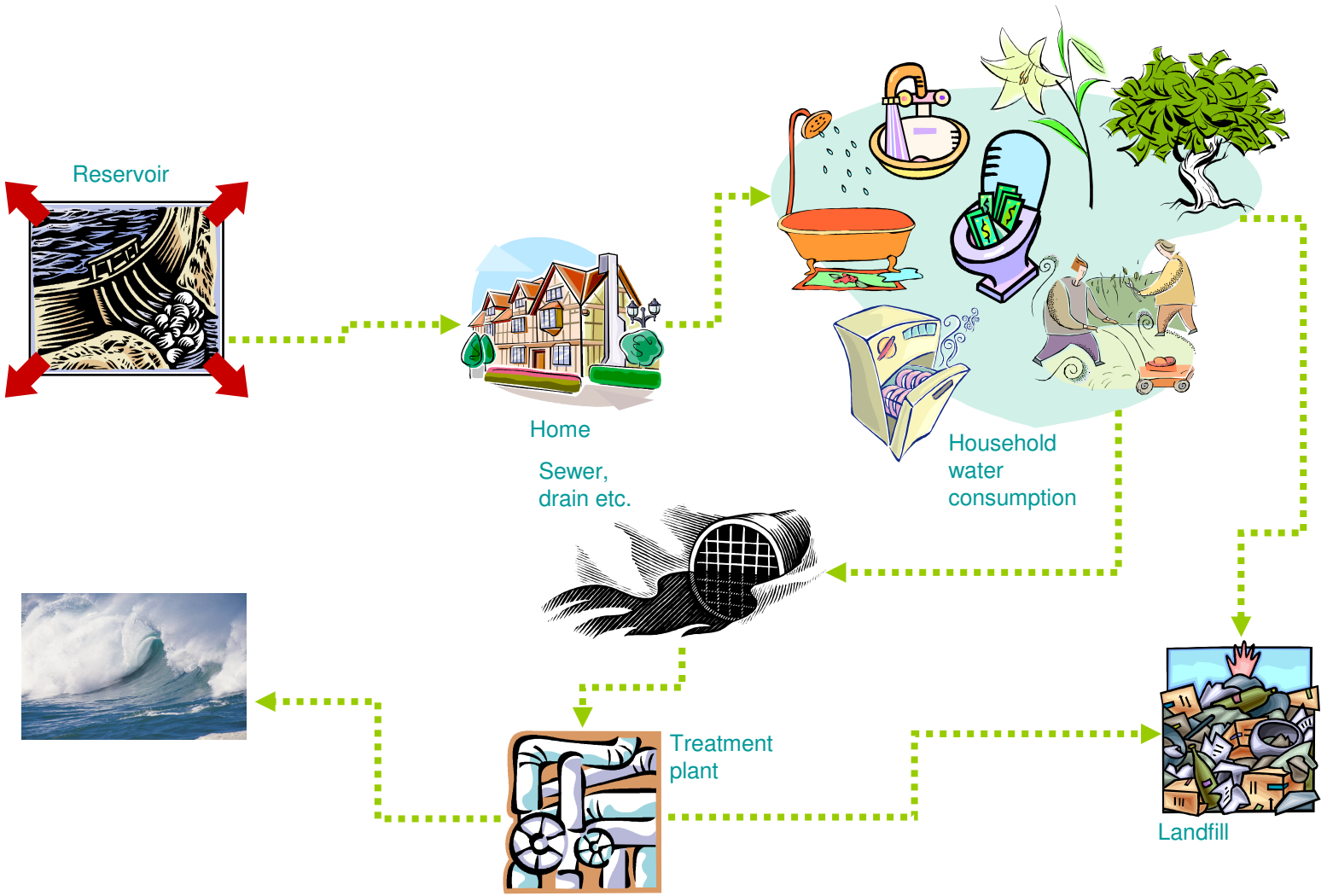
- Schools by day
- Neighbourhood amenities
  - Preschool / child care
  - Afterschool care
  - Neighbourhood gym
  - Reading rooms
  - Neighbourhood plazas
    - farmers markets
    - summer outdoor concerts
- District Energy Anchors
  - Ground source heat exchange fields under the playing fields
  - $CO_2$-free heating & cooling shared with (sold to!) nearby dense commercial & residential



# Pilot program announced

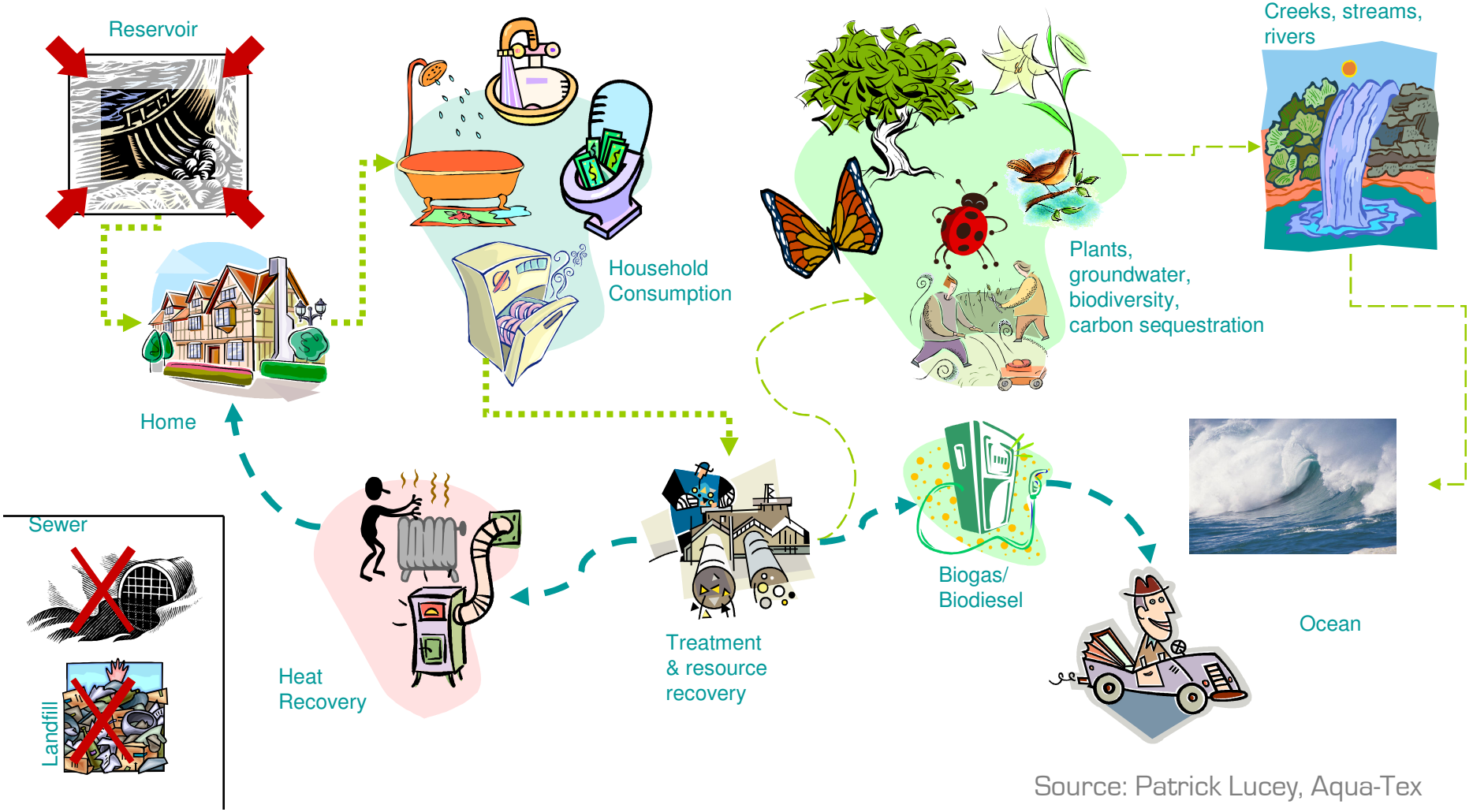
# Water Management in Cities Today

Once-through; waste is a problem




Source: Patrick Lucey, Aqua-Tex

# Tomorrow's Integrated Resource Management




Source: Patrick Lucey, Aqua-Tex

# Waste becomes fuel

Linköping, Sweden & Lille, France

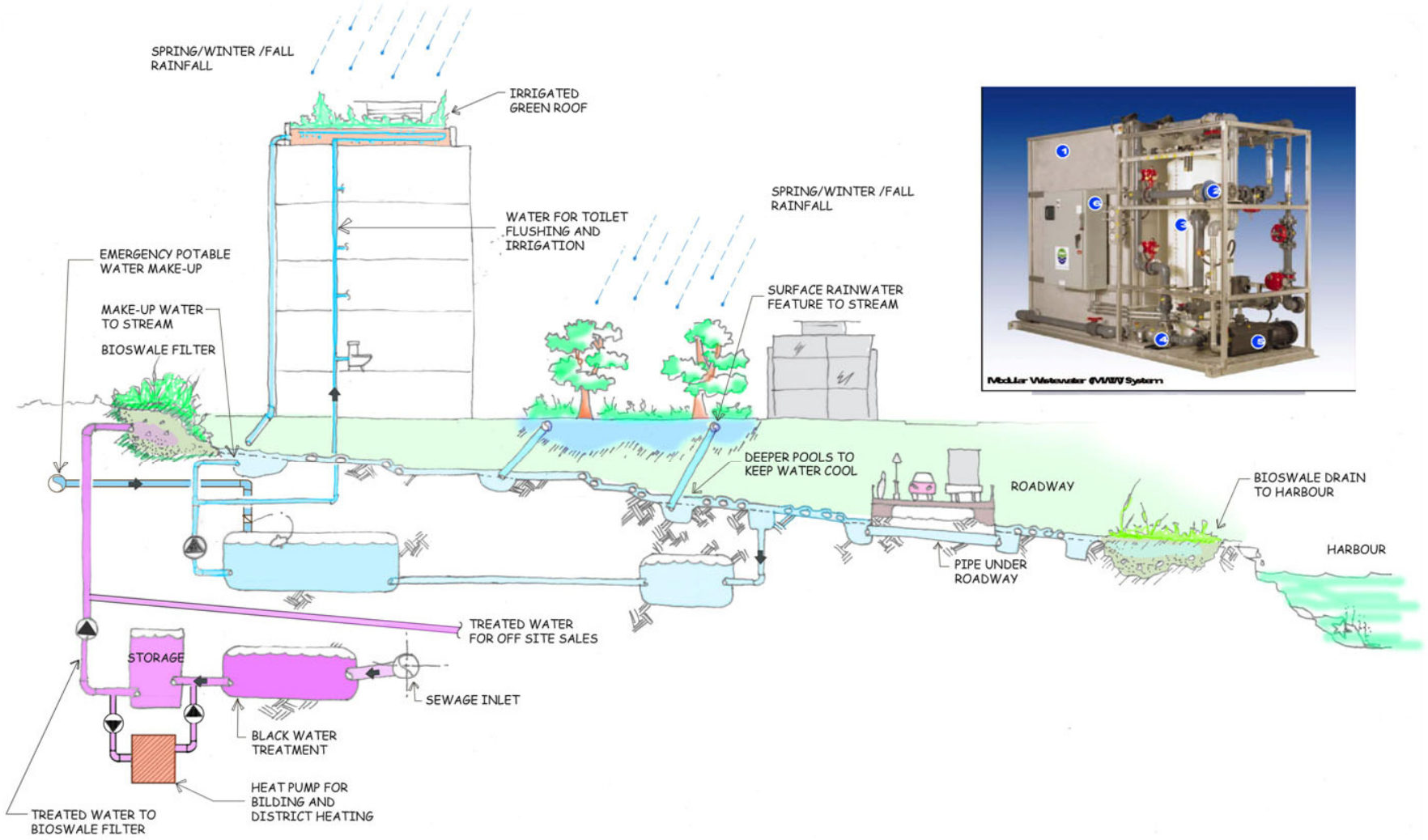


Source: Patrick Lucey, Aqua-Tex

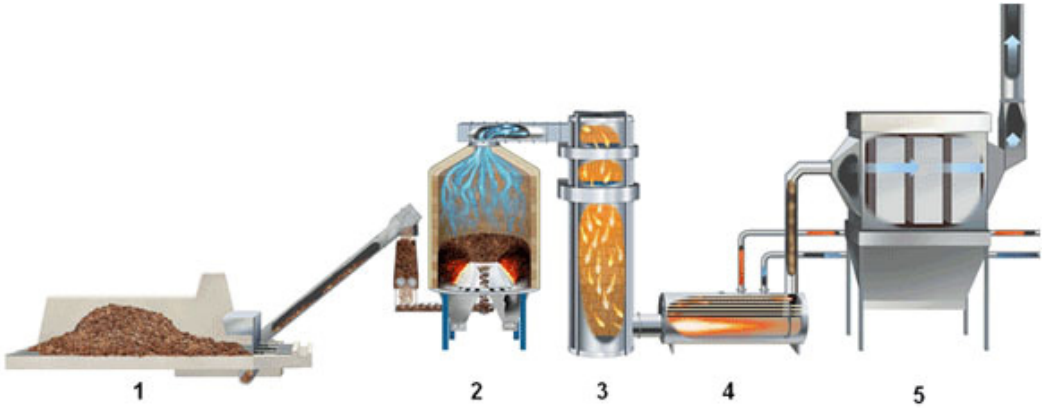
# Dockside Green

Victoria, British Columbia

# Dockside Green: Water



# Dockside Green: Energy




**1. Fuel In-Feed**
Locally sourced wood waste (including recycled clean wood construction and municipal tree trimmings) is loaded into the fuel bin and

**2. Gasifier**
Fuel enters the gasifier and goes through several stages including drying, Pyrolysis (chemical change brought about by heat), and gasification. The wood is converted into synthetic "syngas" that can be used like natural gas.

**3. Oxidizer**
The syngas is conveyed into the oxidizer where it is combusted, with the resulting flue gas directed through a boiler.

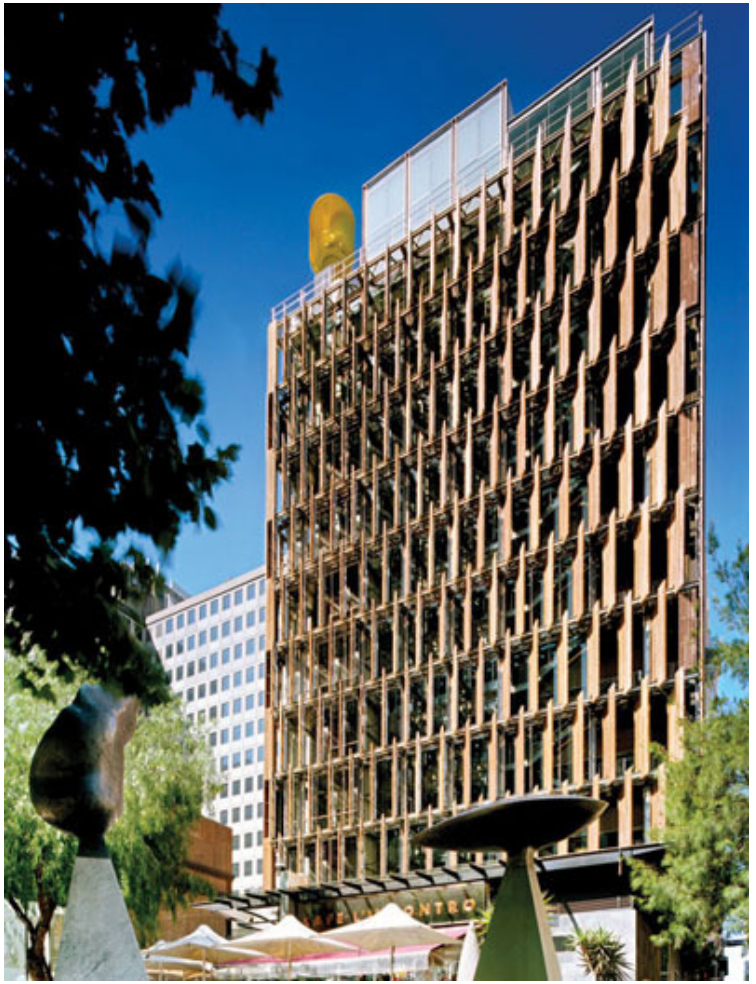
**4. Boiler**
Hot water from the boiler is transported by an underground pipe to provide heat and hot water for Dockside buildings. The cold water then returns to the boiler to start the heating process

**5. ESP**
After exiting the boiler, the flue gas is cleaned in an electrostatic precipitator (ESP) that filters out virtually all of the remaining particulate matter.

# Council House 2

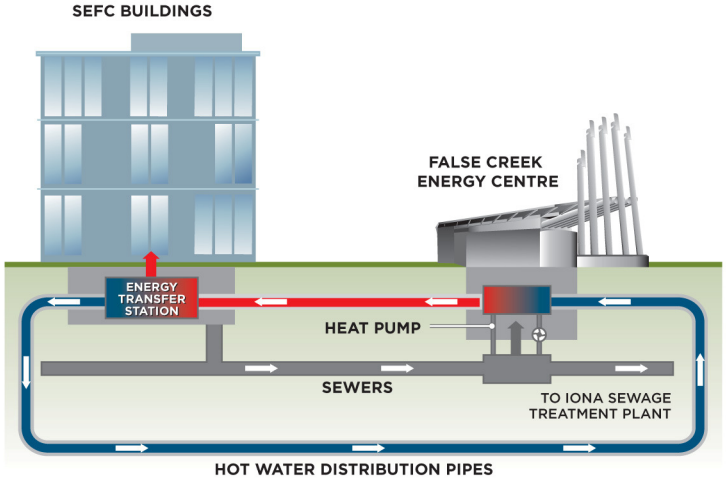
Melbourne, Australia

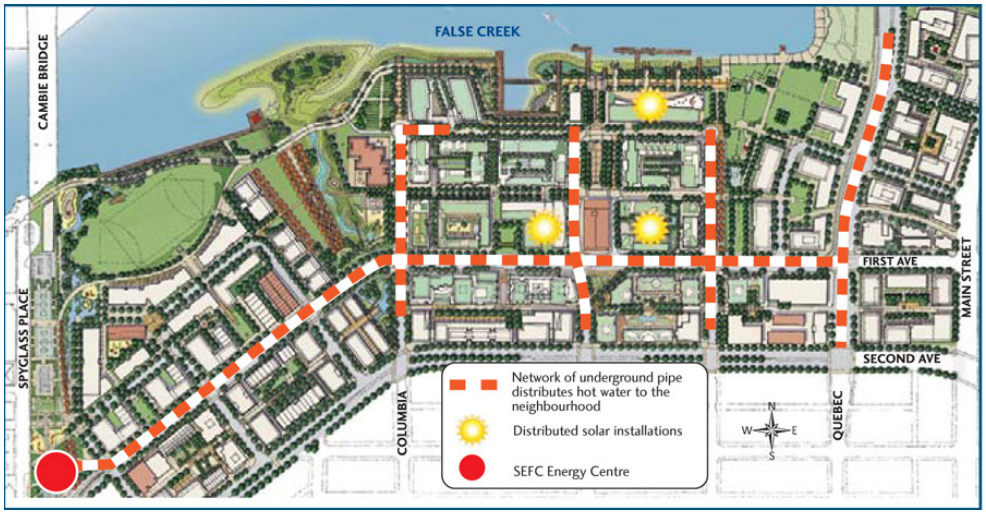
The sewer-mining system is one of CH2's more innovative sustainable strategies. Raw sewage is brought into the building directly from an adjacent sewage line (above left). From there, physical matter is filtered out and "flushed" back into the sewer system (above right). The water is then cleaned by a multistep process involving what amounts to a mini-sewage-treatment plant (bottom right). The cleaned, nonpotable water is then used throughout CH2 for flushing toilets, irrigating plants, and for make-up water in the mechanical system. Australian plumbing code, like its American counterpart, requires nonpotable water to be in lavender pipes (bottom left).
Photos © Russell Fortmeyer



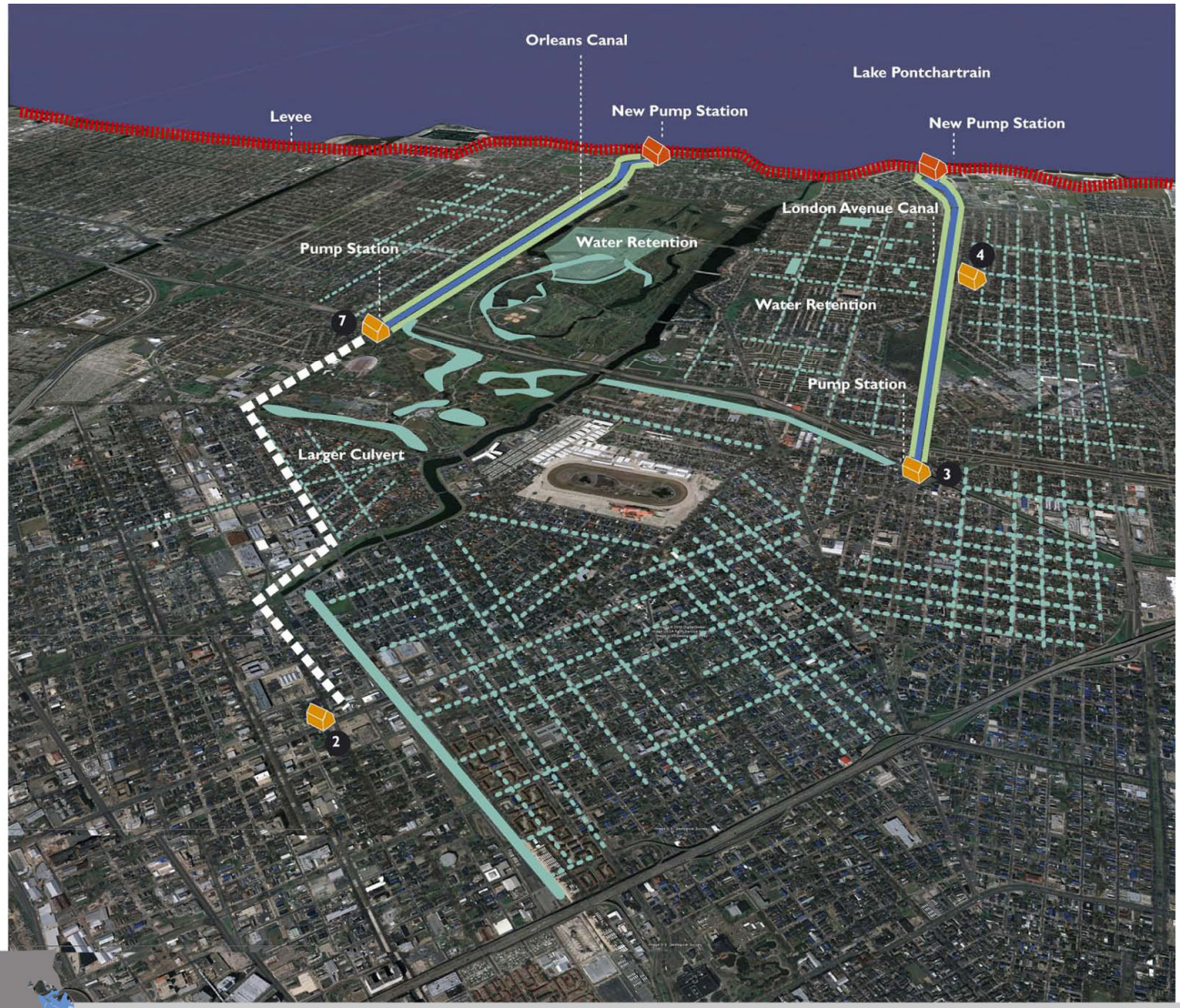
# Olympic Village

Vancouver, British Columbia



# New Orleans




**Vision**:
Instead of 'bursts' of water secreted underground, spread it, slow it down, make it an urban amenity where possible.

**Opportunity**:
What if it also acted as a distributed heat sink for heating & cooling our buildings?