GeoExchange BC

Geoexchange for BC Public Sector Organizations

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Chair of the Board, GeoExchange BC

Carbon Neutral Government Symposium

December 3, 2014

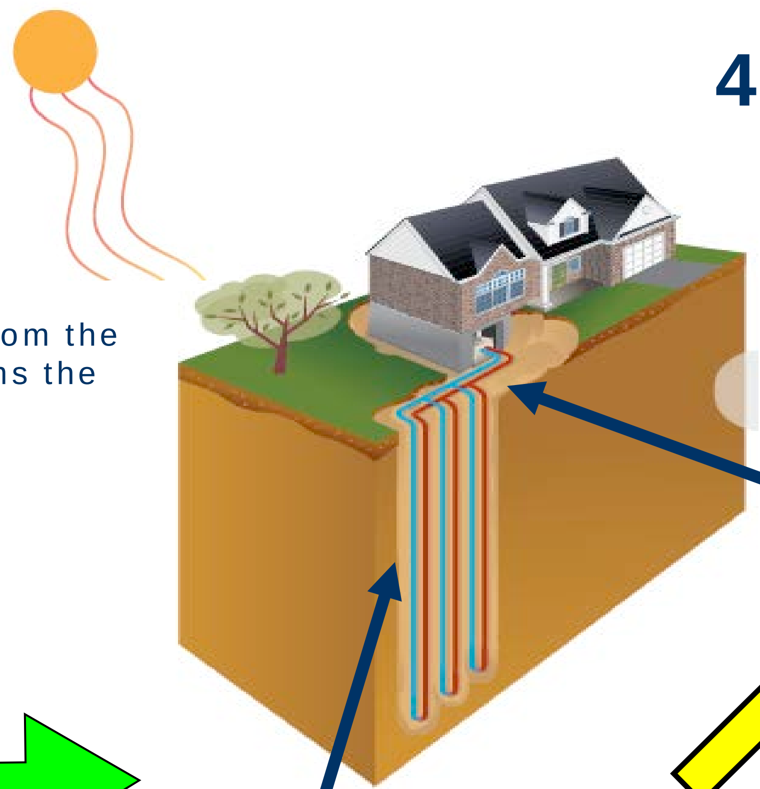
WHO WE ARE

- Non-profit industry association
  - Private and public interests
  - Designers, installers, utilities, developers, municipalities, and government agencies
- Incubated 2002 - joint initiative BC Hydro and GVRD
- Evolved to non-profit association status in 2004
- Governed by volunteer elected directors who lead a series of activity-based committees

What We Do

- Provide leadership for geoexchange in BC
- Improve recognition of technology – merits **and** limitations
- Promote best-practices – unique BC settings
- Promote improvement of geox reliability and reputation
- Help build capacity to meet new code and regulation requirements (e.g., MoE, Building Code)
- Work with government, utilities, and other stakeholders

Geoexchange Fundamentals



4 Geothermal heat pump transfers heat to the conditioned space

1 Energy from the sun warms the ground

3 Loop piping carries heat into the building

2 Heat exchange piping absorbs heat from the ground

Heat transfer process reversed for cooling

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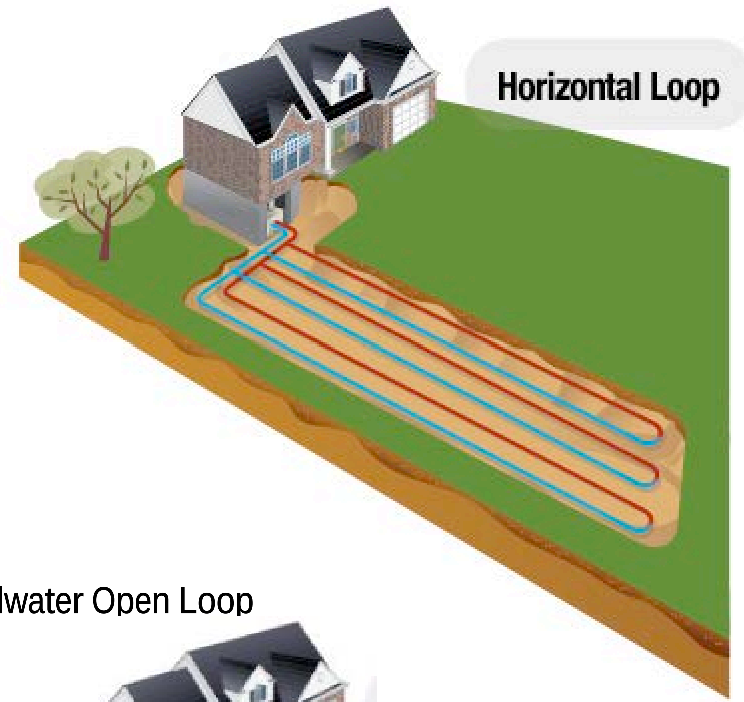
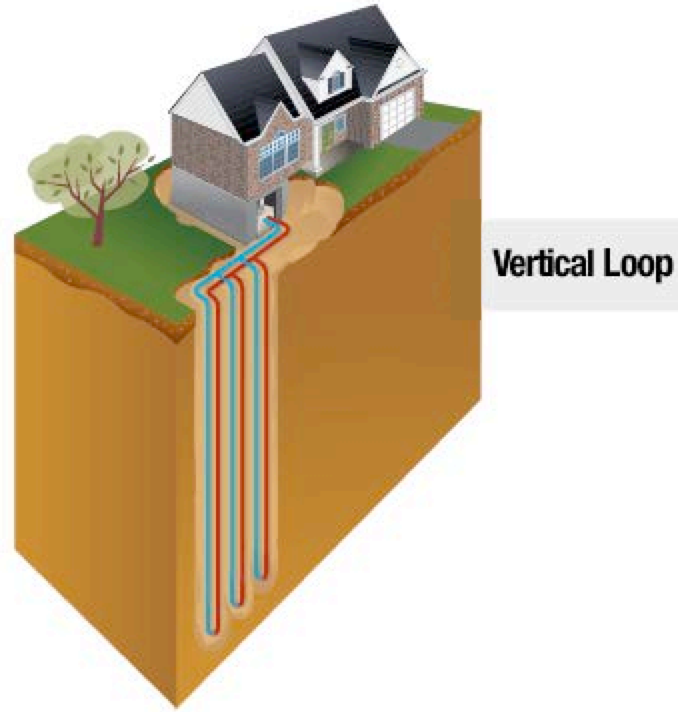
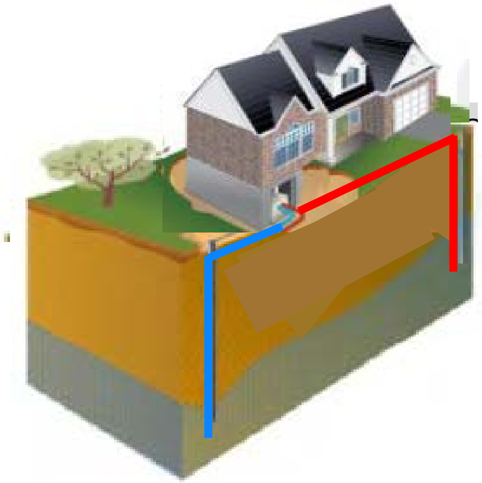
Ground Heat Exchange options



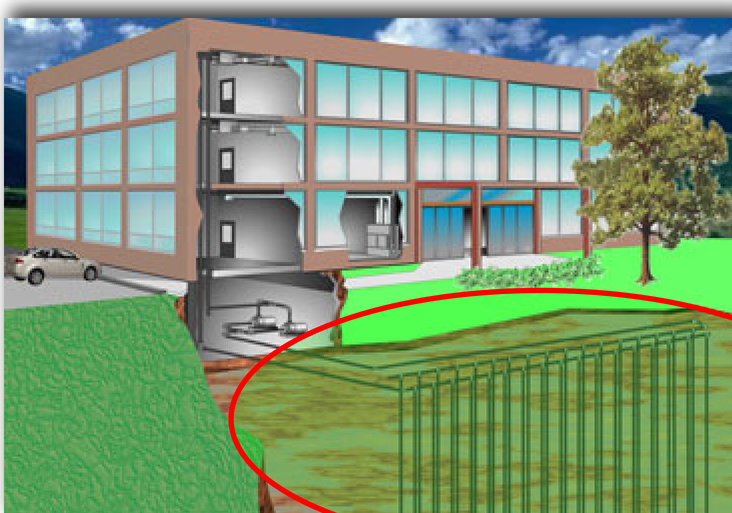


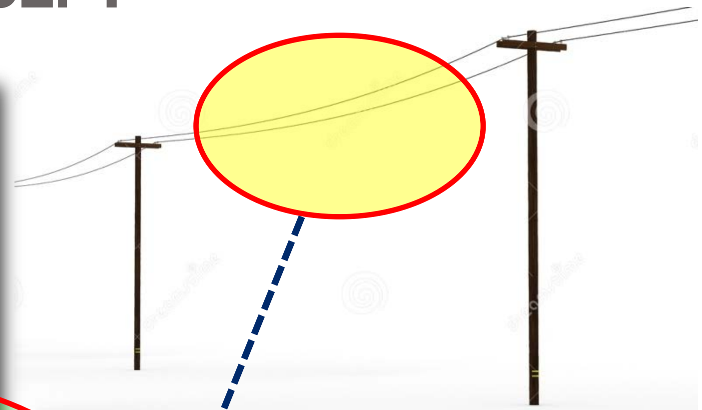
Groundwater Open Loop



Common Types of Ground Heat Exchangers (GHX's)

COP Leveraging Concept





2.6 units
Renewable heat
absorbed from ground

+

1 unit
electricity
from utility

=

3.6 units
Heat Delivered to
Building

$$\textbf{Coefficient of Performance} = \frac{\textbf{Heat delivered (3.6 units)}}{\textbf{Electricity used (1.0 unit)}} = \textbf{3.6}$$

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GHG Reduction Potential

Assume Building with:

- 500 kW peak heating load
- 2,000 equivalent annual full load hrs
- Located in BC Hydro service area

Then:

- Annual Heat demand = 1 million kWh/yr
- Converts to 3600 GJ/yr

Gas-Fired Boiler Base Case

- Assume AFUE = 90%
- Nat Gas input = 4000 GJ (3600 GJ output)
- 49.99 kgCO_2e/GJ emission factor

200 tons CO_2e

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- Assume heating seasonal system COP = 3.6
- Heat harnessed from ground = 2,600 GJ
- Compressor heat = 1,000 GJ (drawing on BC Hydro electricity)
- 4.0 kgCO_2e/GJ emission factor for BC Hydro electricity

4.0 tons CO_2e

98% Reduction from Base Case

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Geoexchange BC Guideline Set

- Comprehensive 5-volume guideline for BC
- First volume in 2004 - latest this year – 10 years in the making
- Meet a clear need for solutions for BC ground and climate settings
- Intended for larger commercial or institutional applications
- Dozens of BC authors and reviewers - wealth of "lessons-learned" experience
- *Best-in-Class* resource guide – truly unique to address challenges and opportunities in BC
- Although BC focused, received international recognition

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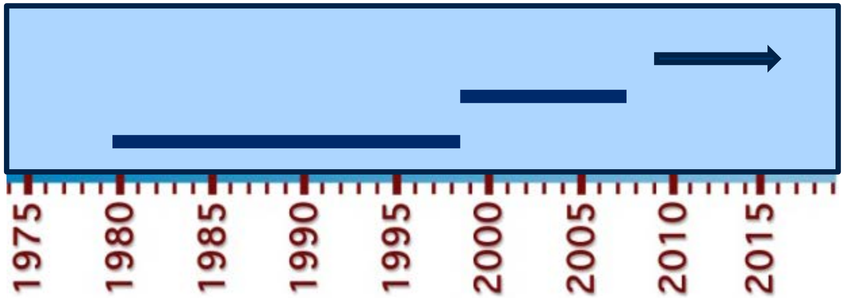
HISTORICAL PESPECTIVE



- ***Geoexchange 1.0 Era* (1980 - 1999)**
  - Early adopters, “cottage industry”, trial & error approach
  - Dedicated and committed independent innovators
- ***Geoexchange 2.0 Era* (2000 - 2008)**
  - Very rapid (unsustainable) industry expansion with sharp rise in energy costs and new interest in GHG emissions
  - Latest Fad - over-promised and under-delivered – many poor performing systems
- ***Geoexchange 3.0 Era* (2009 - Present)**
  - Market correction, low natural gas price cause significant contraction for all renewables (including geoexchange)
  - Higher ratio of public sector projects
  - Renewed focus on quality and performance

Actual Outcomes

- Too many poor outcomes during the *Geoexchange 2.0 Era*
- Perception of poor reliability – sometimes deserved
- Problems not the fault of the technology per se – always the fault of the way in which it is implemented
- Severe underperformance can result from:
  - Relatively small deficiencies that can be relatively easy to rectify (such as inadequate commissioning - very common)
  - Or fundamental deficiencies that may be difficult and expensive to rectify

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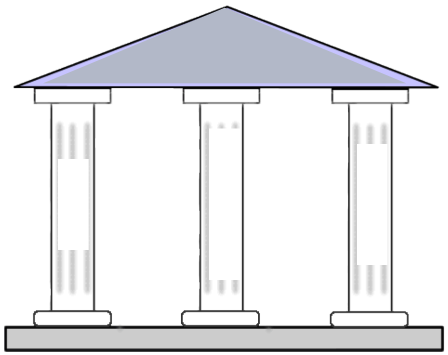
GEOEXCHANGE – MORE SUSCEPTIBLE TO POOR OUTCOMES?

- Technically, geoexchange principle is simple….
  - Complexity lies in coordinating a varied, multi-disciplined team on work scopes straddling traditional divide between mechanical and civil engineering
  - Geoexchange teams include drillers, plumbers, excavators, refrigeration mechanics, electricians, engineers, architects – with no other reason to collaborate other than geoexchange
  - Effective team leadership and thoughtful procurement strategies are crucial to manage to favourable outcomes
- Concealed work – poor workmanship can be easy to hide
- Susceptibility to high expectations – low tolerance for poor performance

Restoring Confidence



The *Geoexchange 3.0 Era* can be efficient and reliable if:

- ❖ Thoughtful attention to site suitability
- ❖ Careful selection of the type of system best-suited to the site
- ❖ Methodical design
- ❖ Careful and accountable installation
- ❖ Adequate site reviews by designer
- ❖ Appropriate QA/QC procedures during construction
- ❖ Methodical system commissioning
- ❖ Follow-up performance monitoring

GeoExchange BC Guidelines comprehensively address <u>all of these considerations</u>

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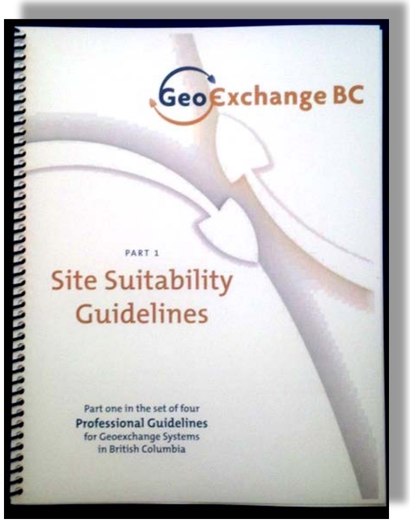
Geoexchange BC Guidelines

- Part 1 – Site Suitability
- Part 2 – Design
- Part 3 – Commissioning
- Part 4 – Procurement

- User Guide

Part 1 - Site Suitability Analysis



- Structured evaluation to assess common GHX types
- Avoid template thinking - no one-size-fits-all
- Respect geological variability that is common in BC
  - Gather sufficient information to choose best-suited GHX type
  - Gather sufficient information to adapt the specific design to take best advantage of the setting
- Reason this is important - <u>GHX cost per unit capacity can vary by a factor of 10 times !!!</u>

GeoExchange BC Part 1 *Site Suitability Guideline* describes a structured assessment method

Staged Suitability Assessment

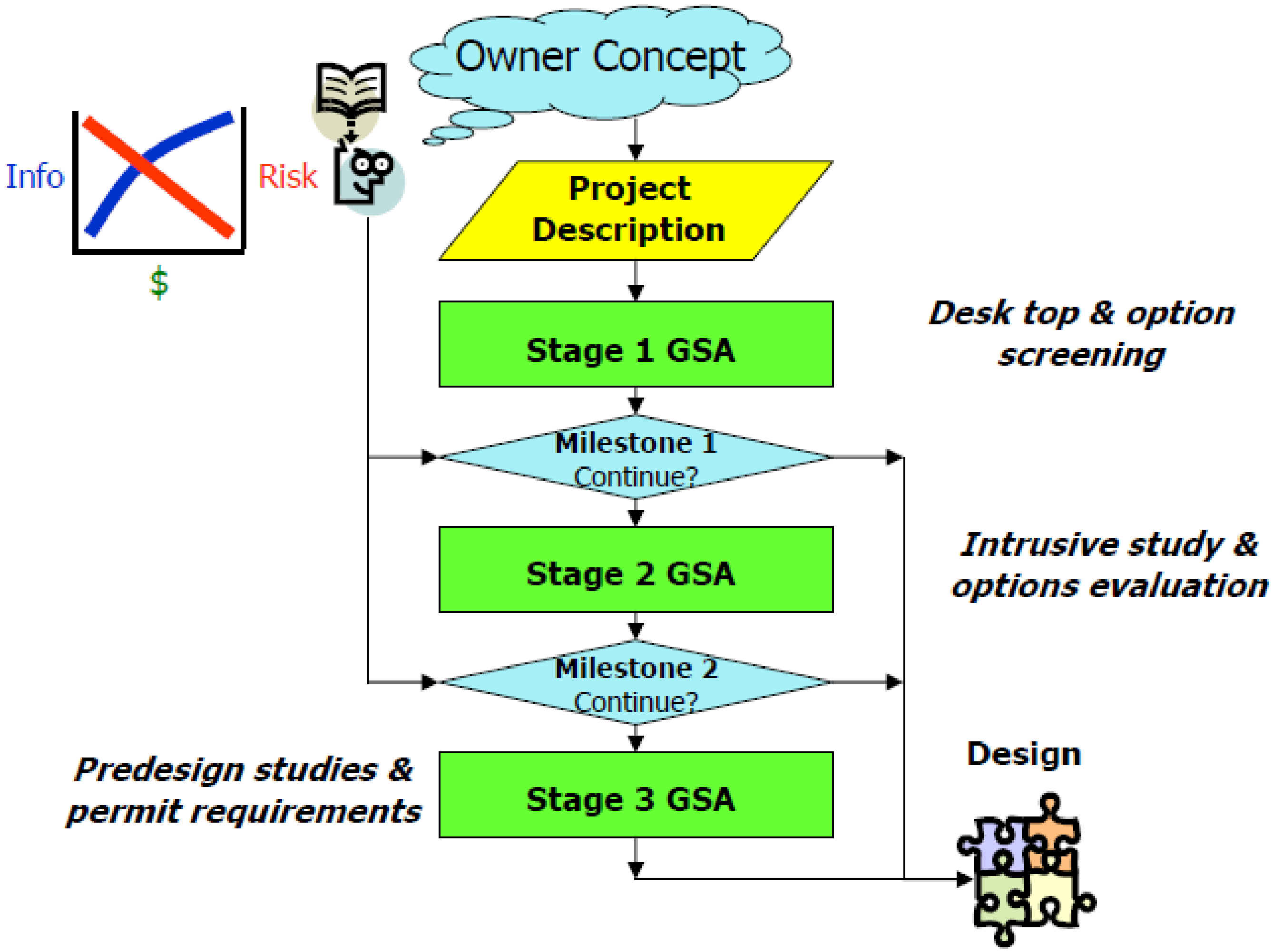
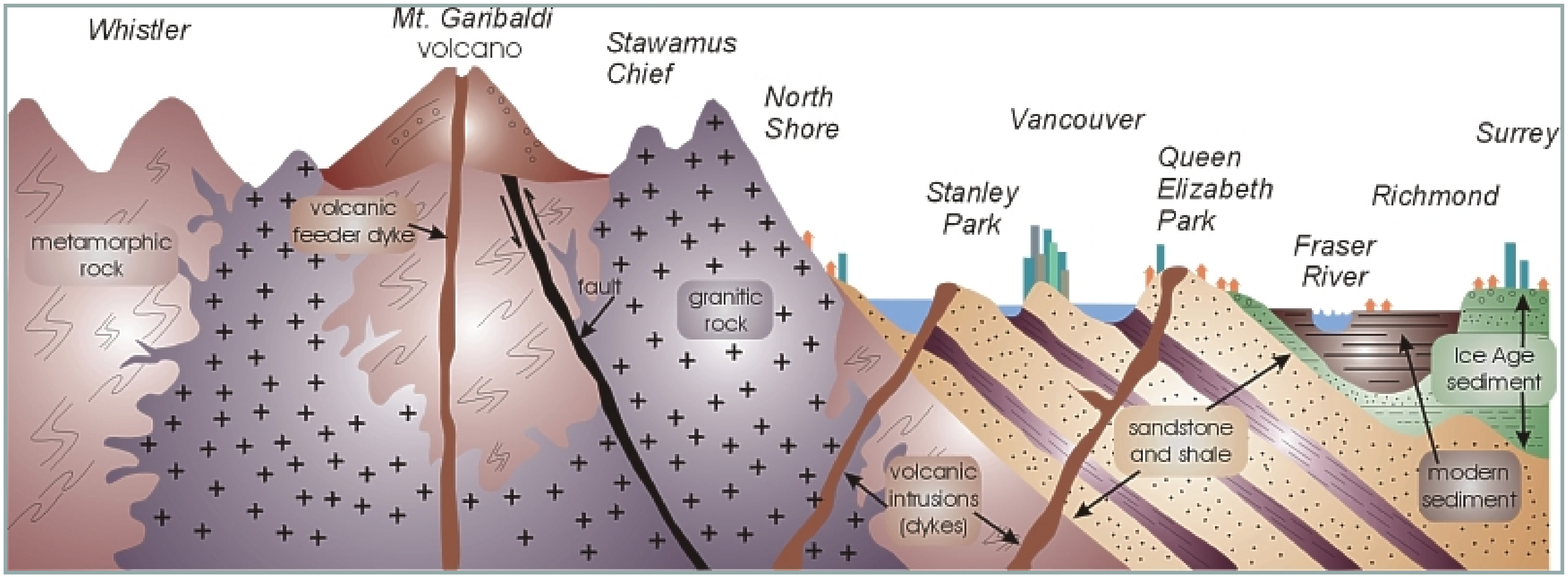


Figure 5.1
Flow chart depicting three stage geoexchange suitability assessment process

Respect BC Geology



Whistler

Surrey

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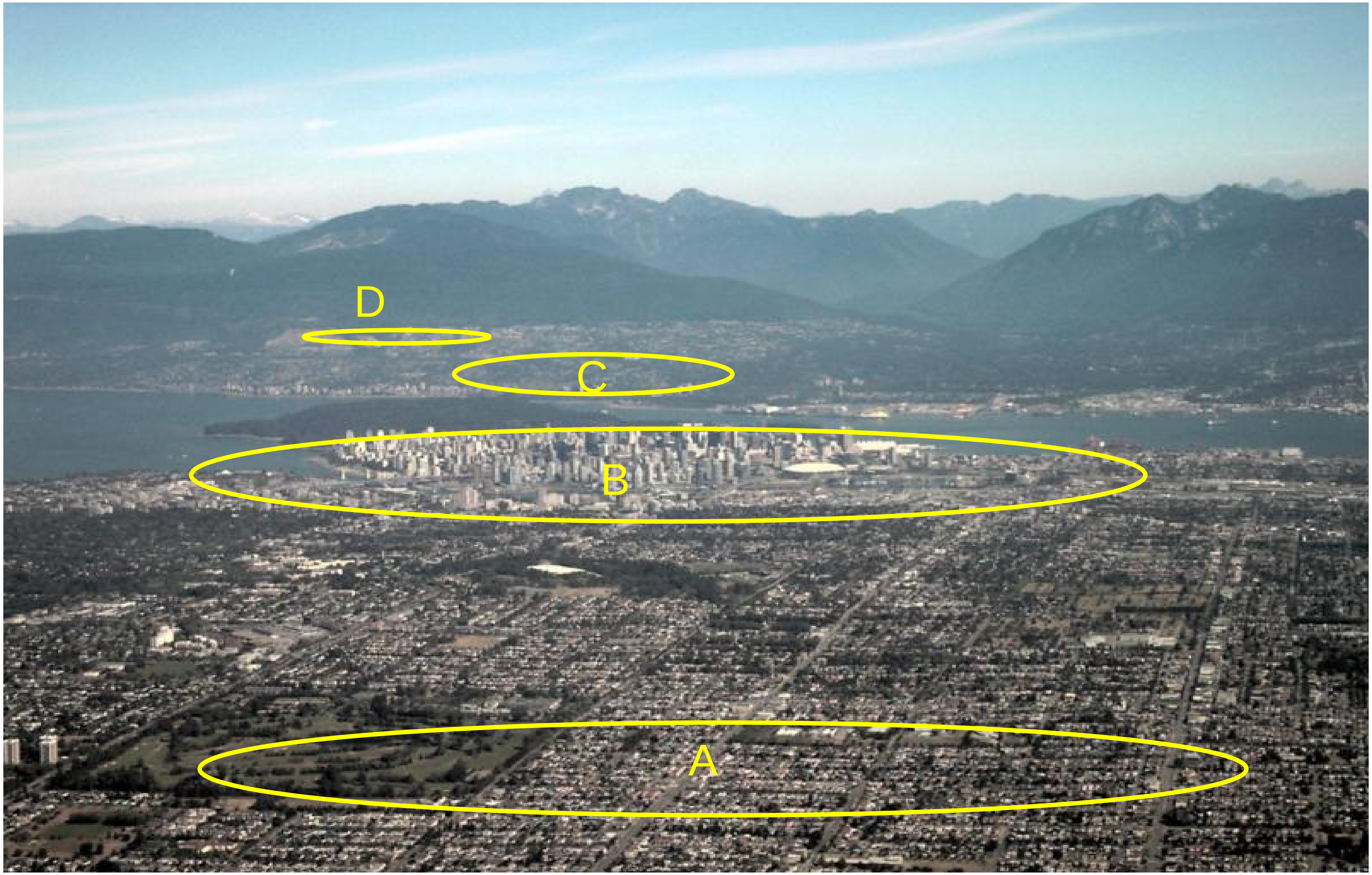
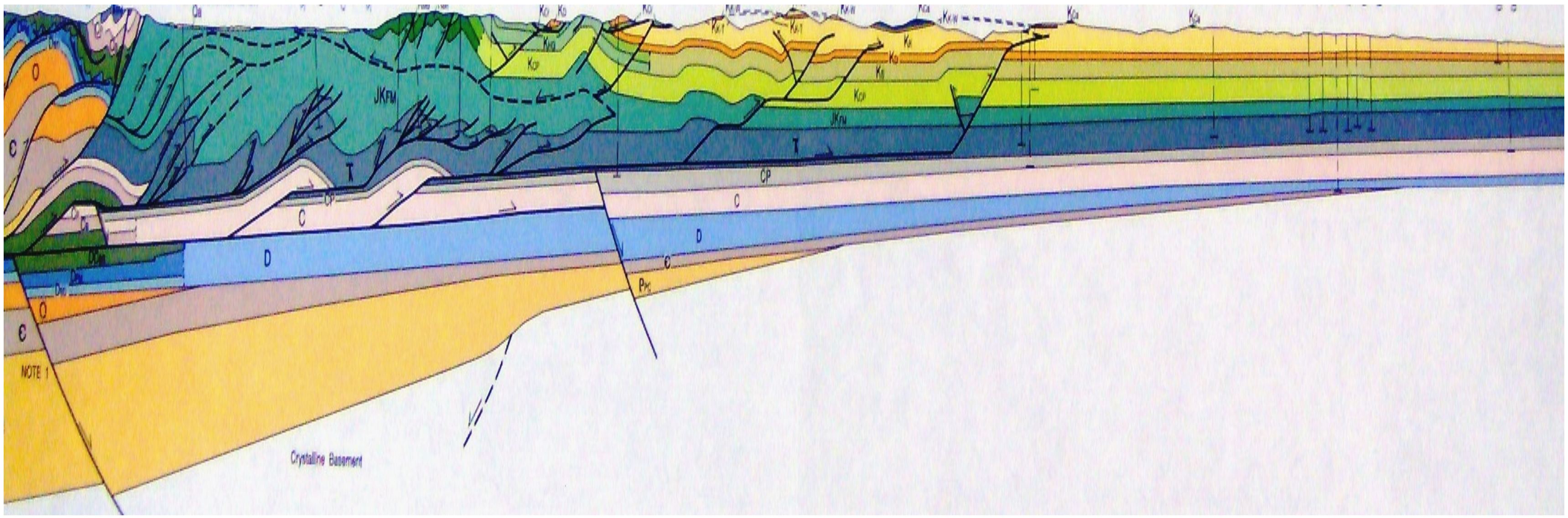
Example Settings - Vancouver



Again - Respect BC Geology

Pine Pass Area

Dawson Creek Area

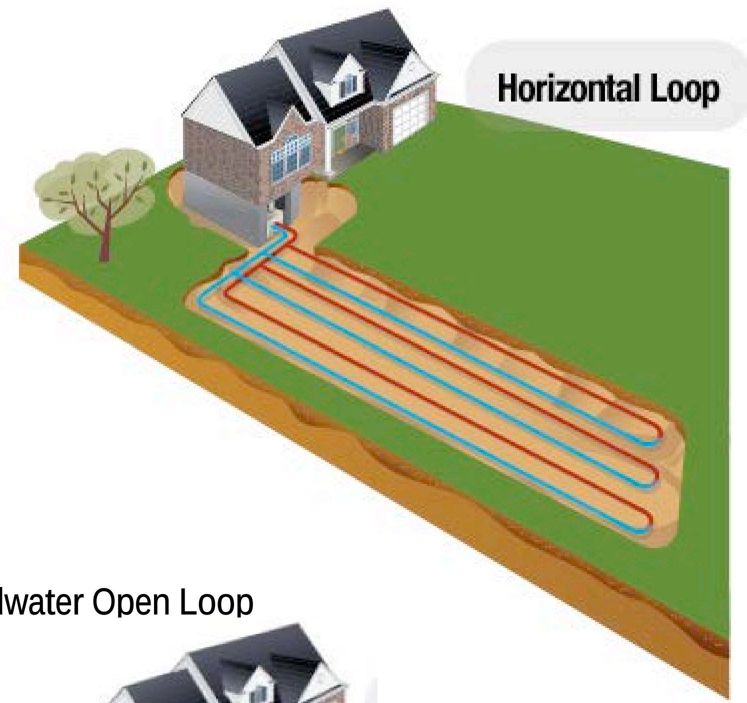


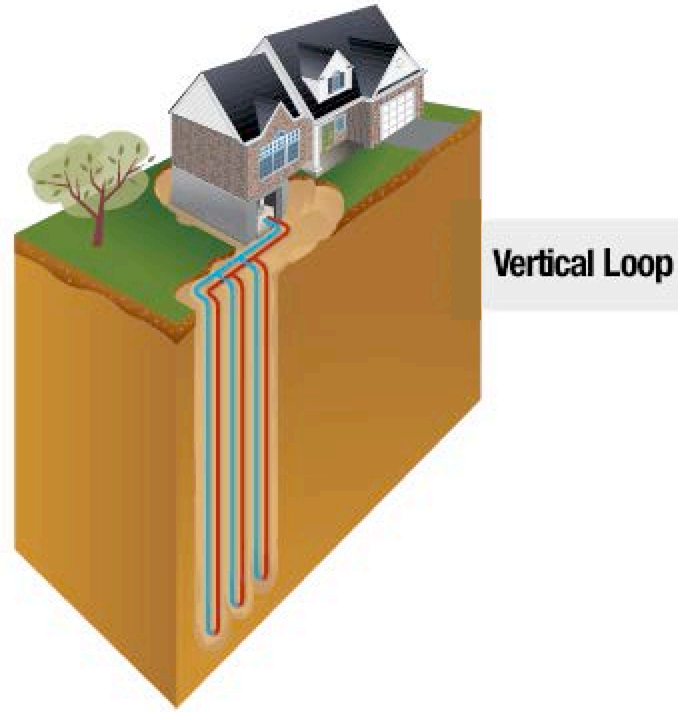
Rocky Mountain Front Ranges

Foothills

Prairies

GHX Options





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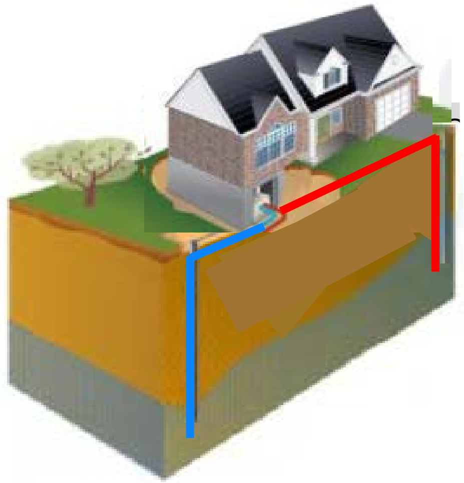

Common Types of Ground Heat Exchangers (GHX's)

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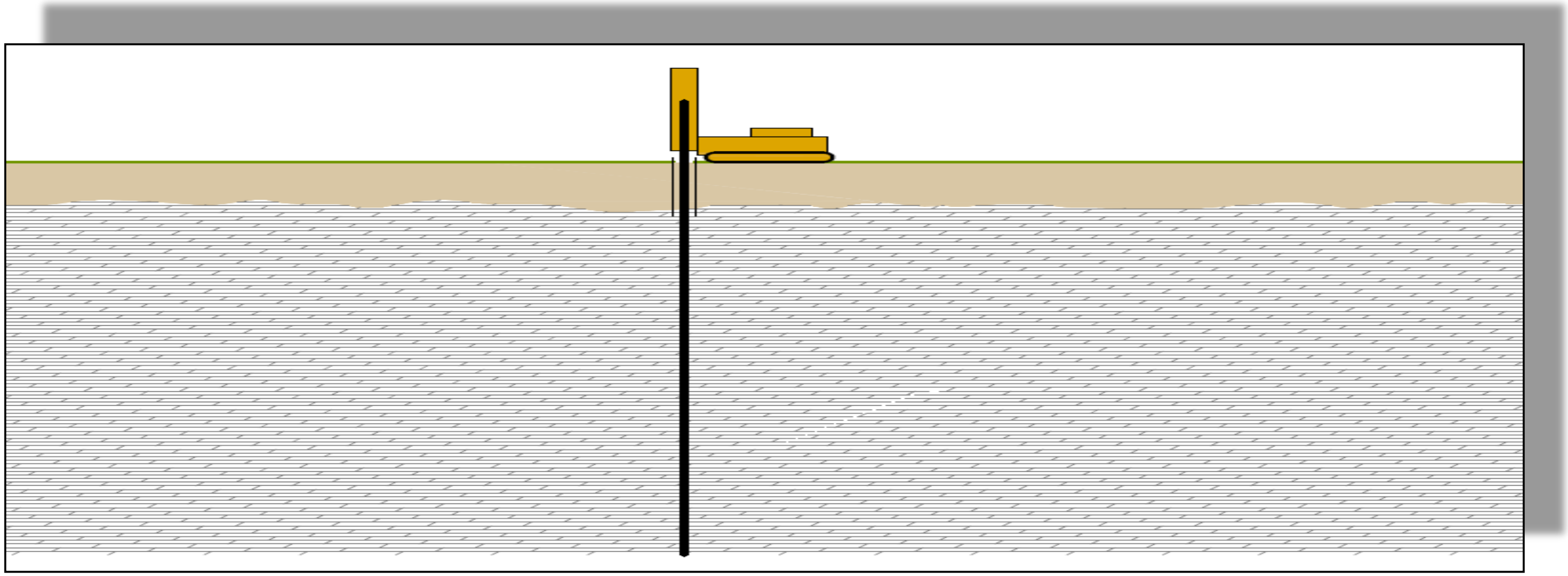
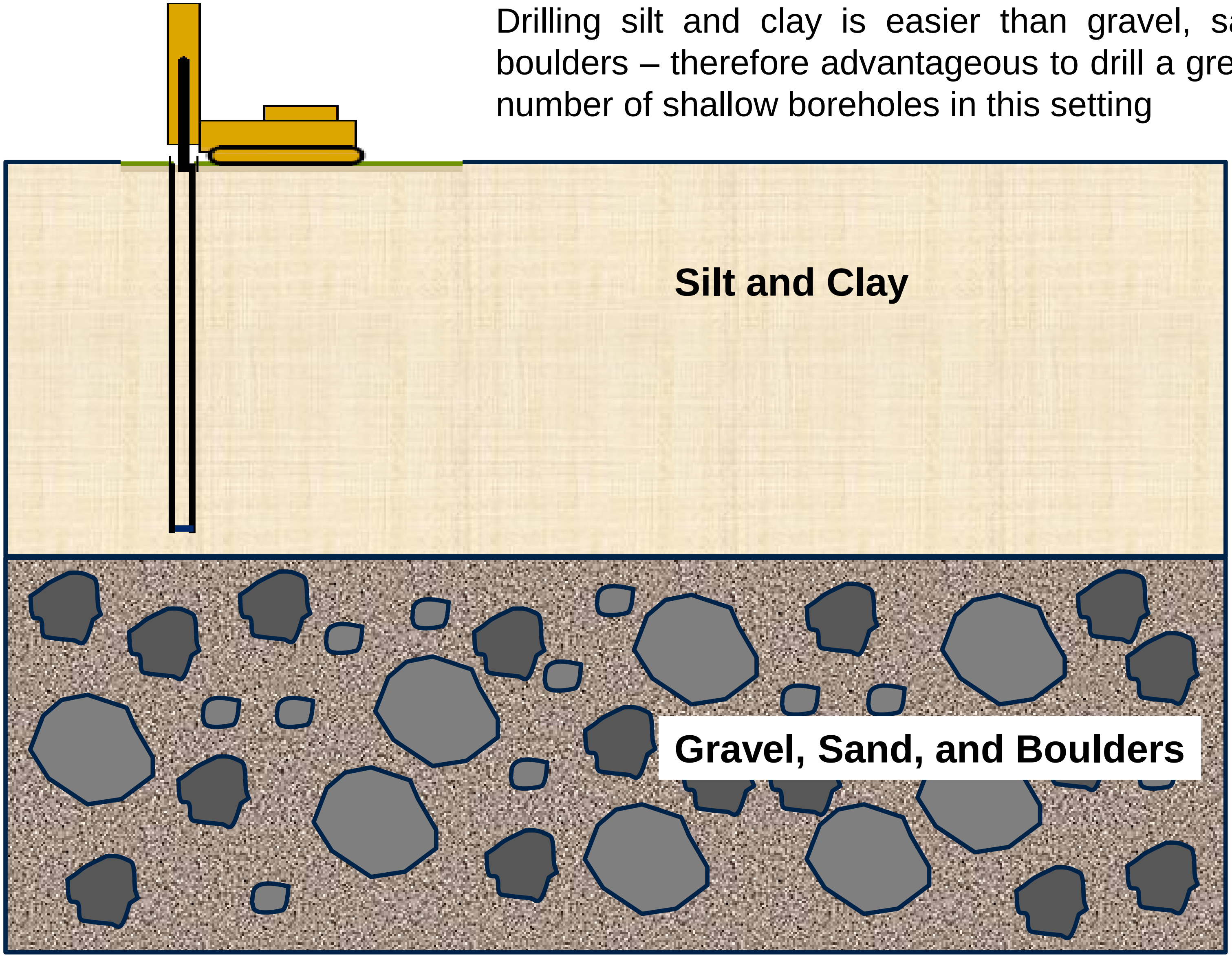
Vertical Borehole Method

- Most adaptable method and often only suitable method for many sites



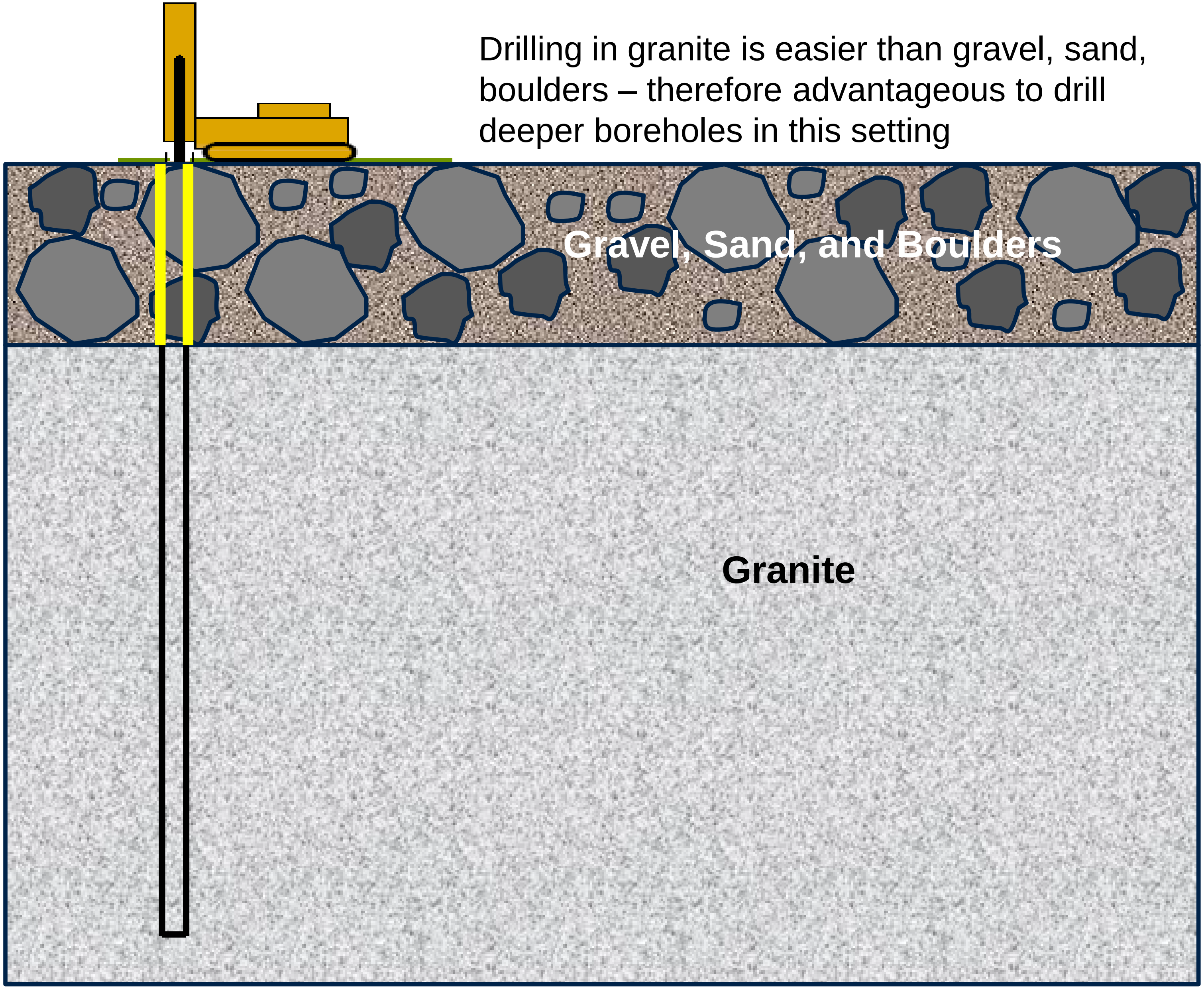
Adapt Design for Ground Conditions

Drilling silt and clay is easier than gravel, sand, boulders – therefore advantageous to drill a greater number of shallow boreholes in this setting



Adapt Design for Ground Conditions

Drilling in granite is easier than gravel, sand, boulders – therefore advantageous to drill deeper boreholes in this setting

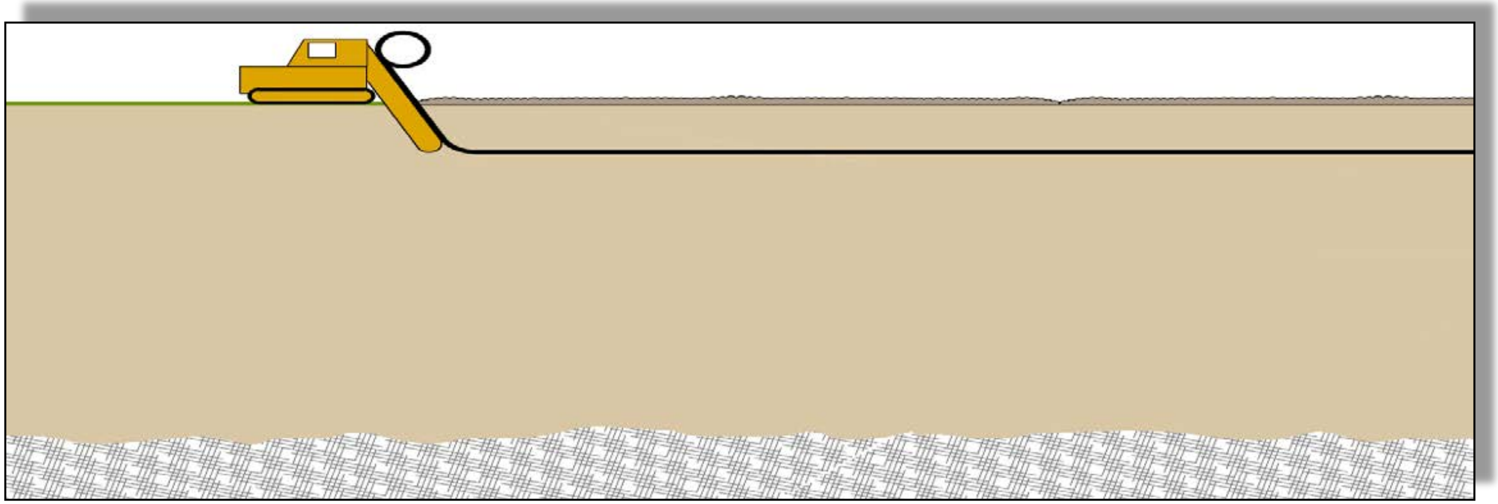


Special Cases

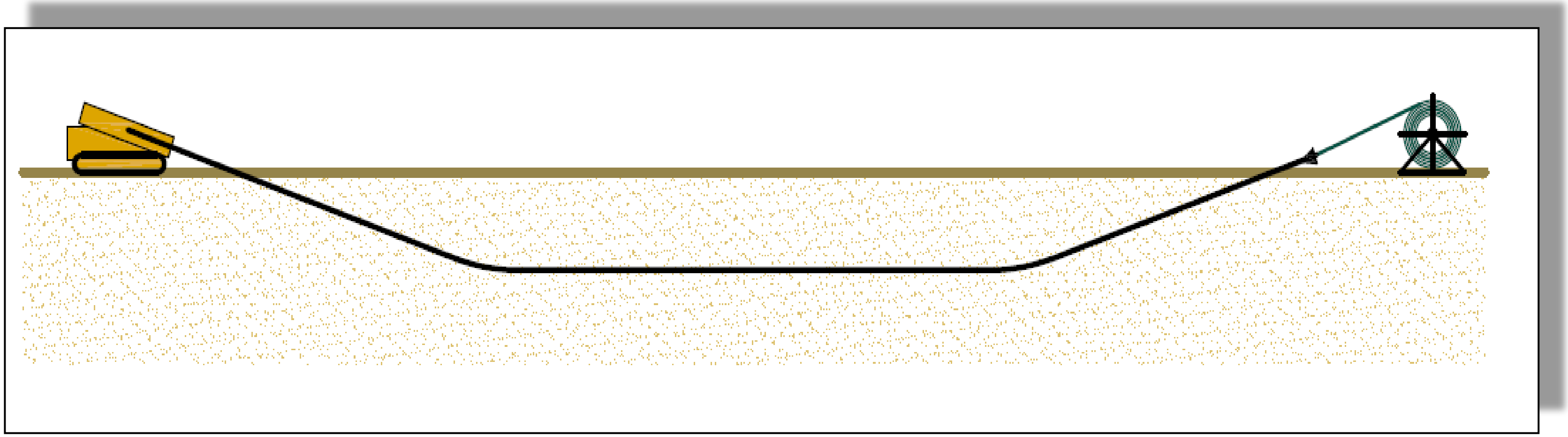
Example: Schools with large Land to Building Area Ratio

❖ Unique opportunities for horizontal ground loop configurations

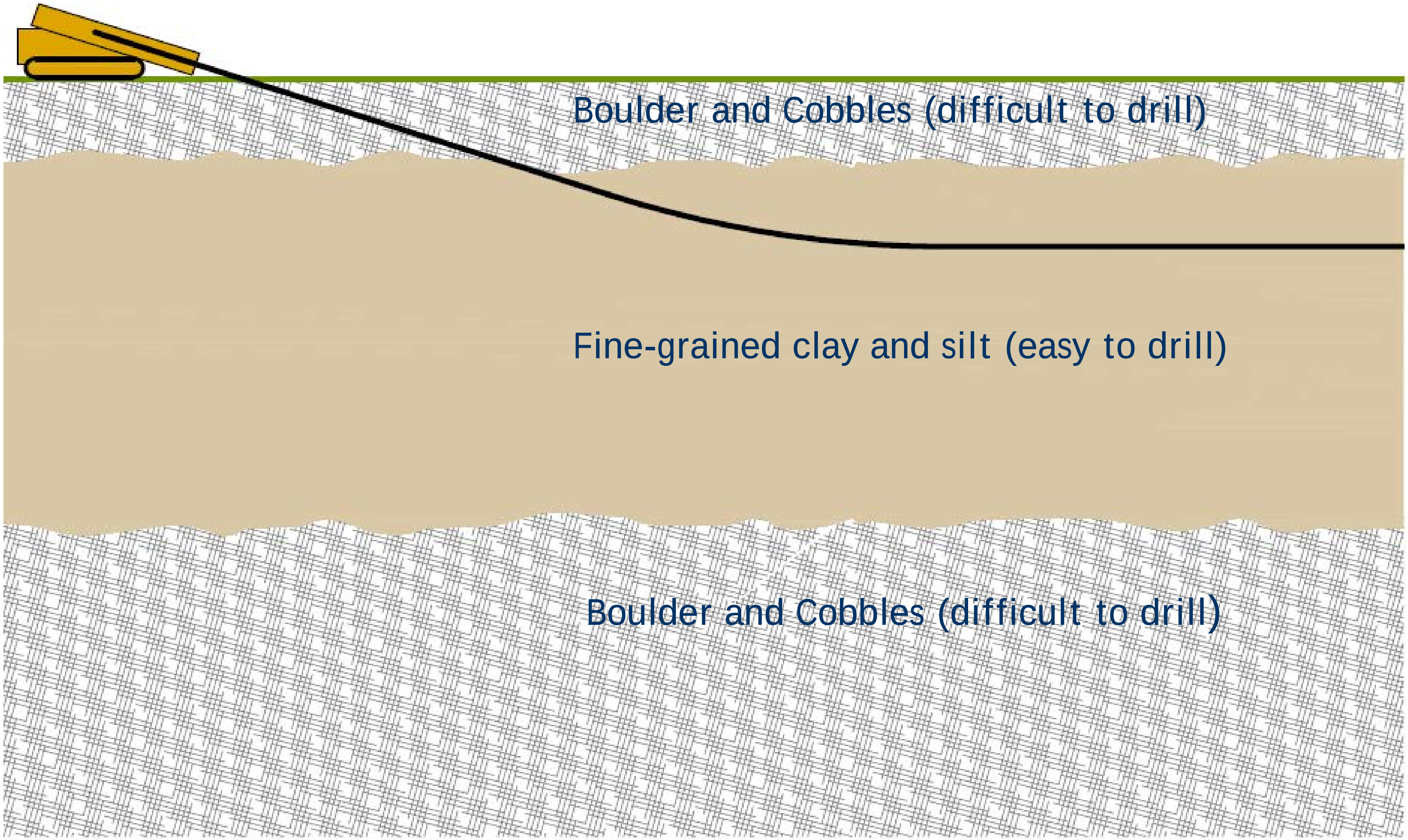
Chain Trench Method



Horizontal Directional Drilled (HDD) Method



Adapt Design for Ground Conditions



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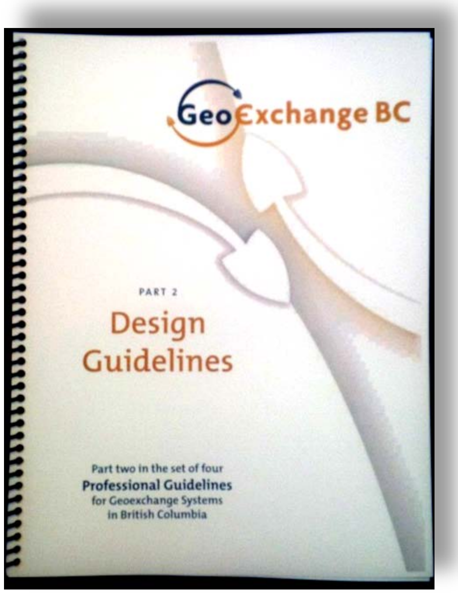
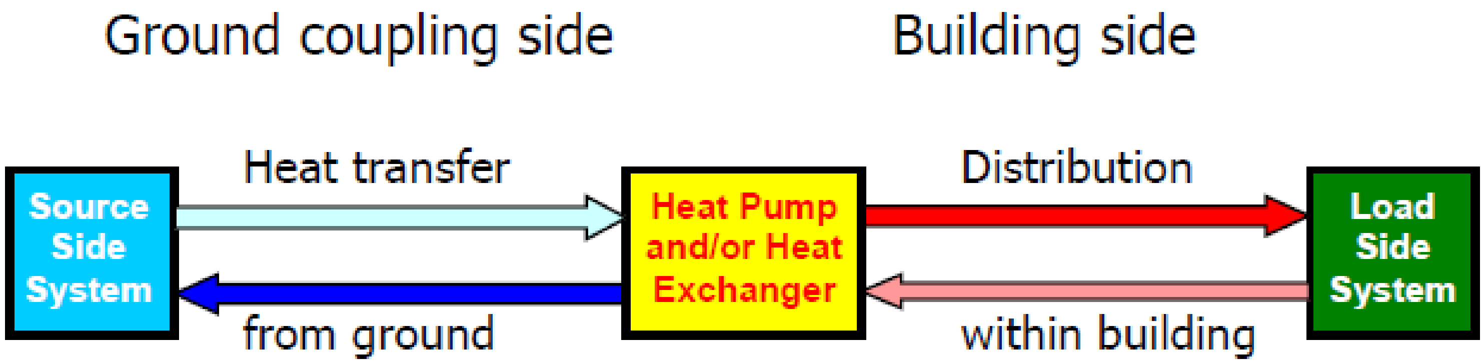
Part 2 - Design

- GeoExchange BC Part 2 *Design Guideline* outlines design strategies and objectives particularly for BC settings
- Mechanical Design and GHX Design
- Intended to be used as a BC supplement to ASHRAE and other resource guides
- Theme - minimize temperature lifts in system for high performance and durability
- Incorporate QA/QC measures
  - Designer needs to thoroughly review installation (much concealed work)

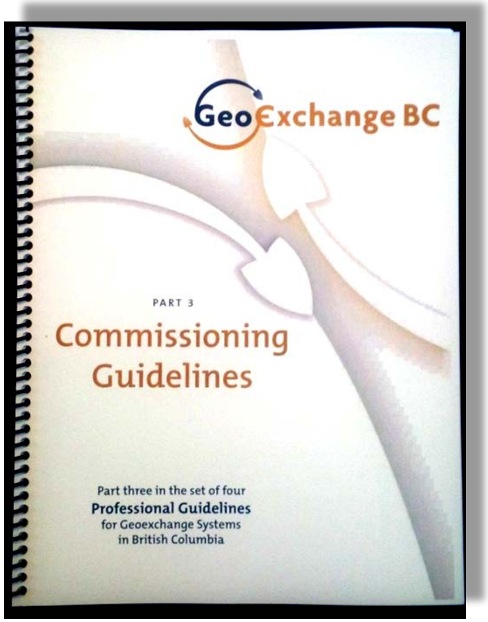


DESIGN OBJECTIVES



- ❖ COP of 3.5 or higher routinely achievable
- ❖ Design Considerations
  - ➢ New or retrofit – retrofits can be very challenging
  - ➢ Central or Distributed heat pump systems
  - ➢ Hybrid combinations and apportioning loads
  - ➢ Low temperature distribution systems when possible
  - ➢ Seek simplicity when possible

Part 3 - Commissioning



- Critical steps often overlooked
- Air is an enemy - thorough purging of air is critical
- Good designs simplify commissioning
- Significant number of systems are never commissioned properly
- Systemic and methodical approach is required
- GeoExchange BC Part 3 Commissioning guideline describes a methodical step-by-step approach

Checklist Approach

GeoExchange VCL GHX

Schedule C - Pressure and Flow Test Record Sheet

Page __ of __ Project: ______________ Project Number: ______________

I. PRESSURE TEST

Header ID	Date	Start Pressure (psi)	Start Time	End Pressure (psi)	End Time (min 12 hours)	Pressure loss (psi)	Comments
Whole System							

Final whole system pressure test witnessed by

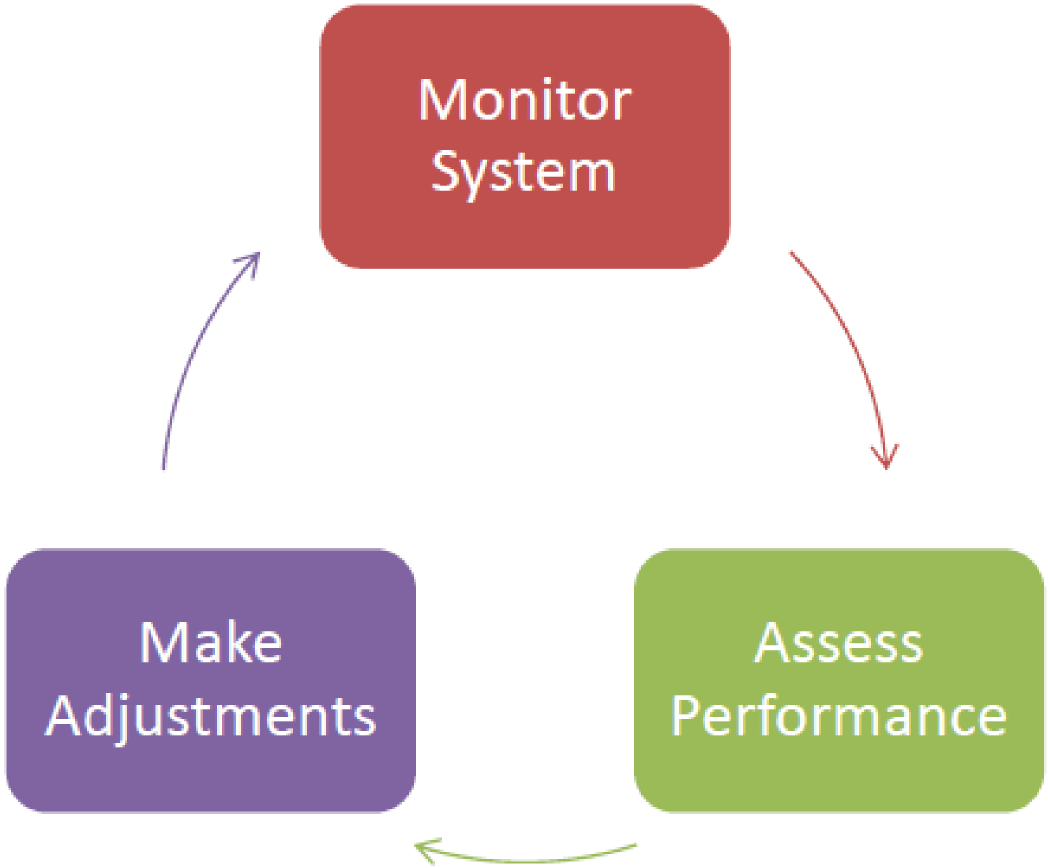
Signed: ______________ (Witness) Date: ______________

II. FLOW TEST

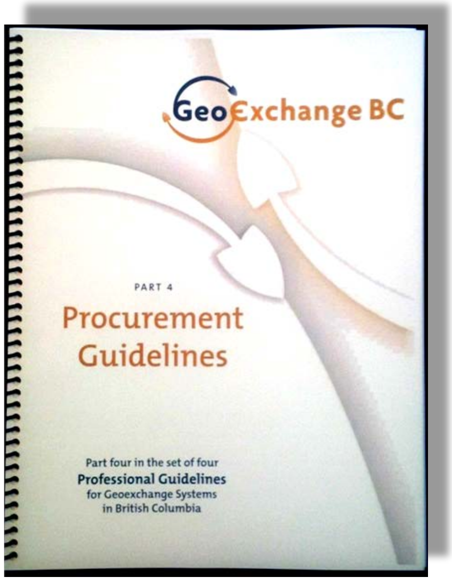
Header ID	Date	Design Flowrate				Design Flowrate +30%				Design Flowrate - 30%			
		Calculated Flow (USgpm)	Measured Flow (USgpm)	Inlet Pressure (psi)	Outlet Pressure (psi)	Calculated Flow (USgpm)	Measured Flow (USgpm)	Inlet Pressure (psi)	Outlet Pressure (psi)	Calculated Flow (USgpm)	Measured Flow (USgpm)	Inlet Pressure (psi)	Outlet Pressure (psi)

Signed: ______________ (Installer)

System Monitoring -
Pre-requisite to Efficient Performance



Part 4 - Procurement



- The Part 4 *Procurement Guideline* describes several types of procurement strategies
- Tenders for GHX contracts need to provide adequate information for contractors so they can adequately manage risk and for owners to reduce costly change orders
- Poor tender packages lacking crucial information is a very common problem plaguing the industry

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Right people… Right scope… Right time…

- Successful geoexchange systems manage to **engage the r*ight people, on the right scope, at the right time***.
- With cost for GHX capacity varying by factor of 10x, skilled guidance can deliver value

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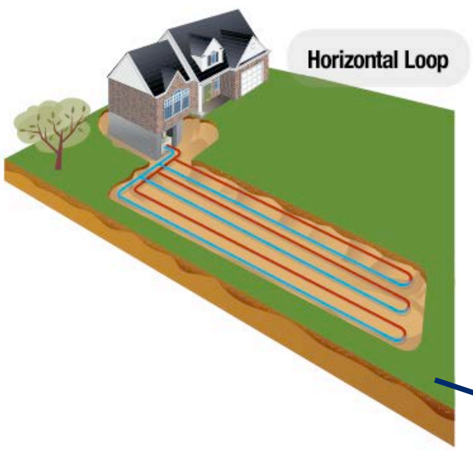
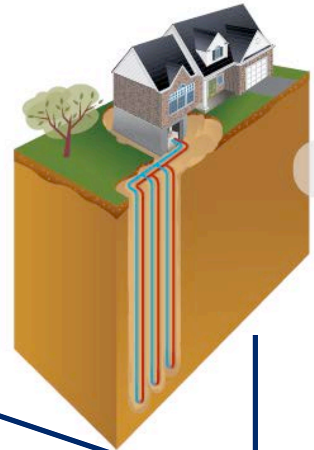
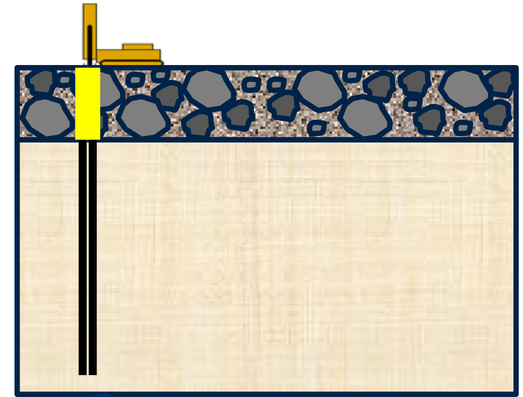
Geoexchange System Cost

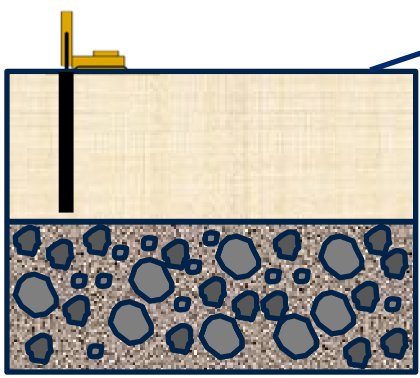


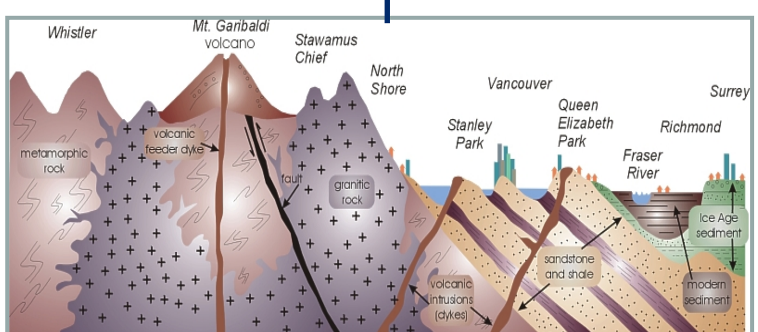


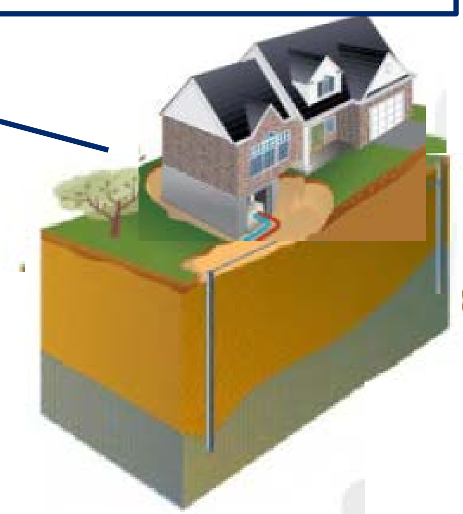


Cost ranges due to site setting and skill of designer to adapt to setting

Cost/kW Capacity ranges from <u>less than $300 to more than $2000</u>







Portfolio Assessments

- Portfolio assessments – more benefit at less cost
  - Units costs for geox capacity vary greatly from site-to-site
  - Retrofit compatibility varies greatly from site-to-site
  - Future life and maintainability of existing systems varies
- Some buildings much better suited than others for geoexchange
- Decision matrix approach

	Ground Setting	Retrofit Compatibility	Existing System Needs Upgrade
Building A	▲	▼▼	▲
Building B	▼	▼▼	▼
Building C	▲▲▲	▲▲	▲
Building E	▼▼	▲▲	▲
Building F	▲	▼	▼

Further Questions

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Chair of Board (Volunteer Position)

David Cookson, B.Eng., MBA
Project Director (Staff Position)

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