Market Analysis for the Development of a Data Centre

A high level assessment of the feasibility of attracting external clients to a Data Centre located in Yukon

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for the Government of Yukon
Economic Development Department

WCM CONSULTING INC.

77 WARD AVENUE
SHARON, ONTARIO
LOG IVO
CANADA

www.wcmconsulting.com

GEORGE SCHRIJVER
Principal

TEL: 905-478-8523
MOBILE: 905-252-1549
FAX: 905-589-0180
E-MAIL: george@wcmconsulting.com

WCM client service principles are the foundation of our practice

We:

- **understand** your objectives and requirements
- **make** commitments to you and meet them
- **provide** value and build trust through technical competence and consistent results
- **demonstrate** professionalism through effective interaction and communications
- provide a **no surprises** experience
- tell you what you ***need*** to hear, not just what you want to hear

Table of contents

A Executive summary

The Government of Yukon wished to determine whether Yukon would be considered as a suitable location to build a Data Centre. A Data Centre is a facility used to house computer systems and associated components, such as telecommunications and data storage units. It includes backup power supplies, redundant data communications connections and environmental controls to ensure that the equipment operates at all times within acceptable temperature and humidity conditions. Data Centres are located around the world as distributed data storage facilities, and the demand for these facilities is increasing due to today's rapid growth in the use of the Internet for most communications. This demand is unlikely to abate.

Once such a facility is established, the direct staffing levels required would be low. However, a Data Centre is a clear enabler for other industries that demand rapid access to large quantities of data and it can act as a "cluster developer" for such industries, with the consequent positive impacts on economic development.

The intent of the project was to identify the various factors critical to site selectors when selecting suitable locations for Data Centres and to determine whether Yukon had the necessary conditions to be successful, or that remedies existed that could mitigate any disadvantages. As a first step this was to be a high level assessment to avoid more costly analyses should there be any obvious "red flags", or conditions that would rule out the possibility, and that had no reasonable remedy. The assessment was carried out through extensive research and using the telecommunications and computer industry knowledge of the consultants, as well as extensive experience in high technology business and economic development.

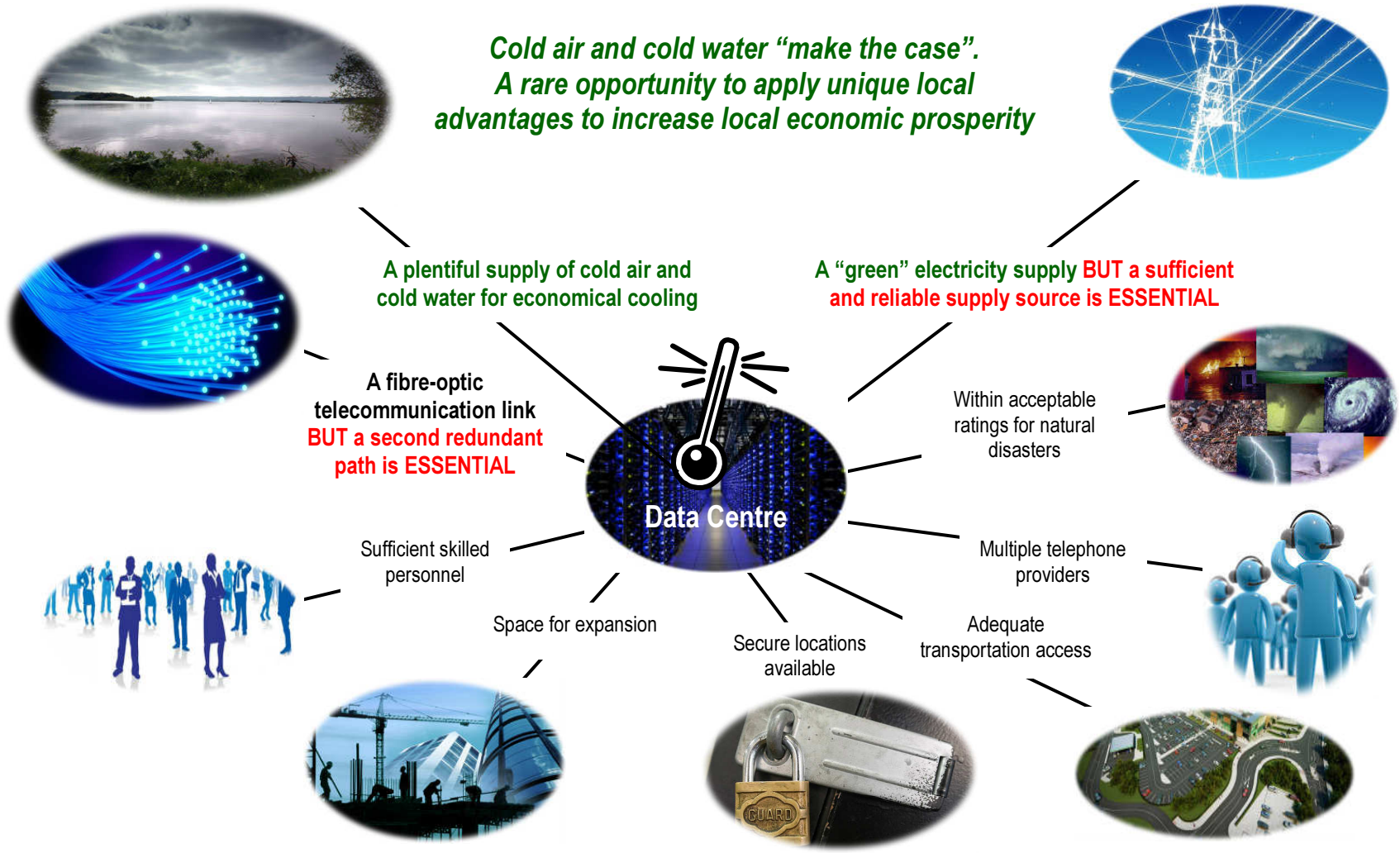
Conclusions and Recommendations

Based upon the research and analysis, **we have found no red flags that cannot be mitigated, albeit with some investment required,** and that **certain climatic factors may well enable Yukon to position itself as an "advantaged site"** for such an enterprise.

The absolute red flag is the requirement for a second, or redundant, fibre optic link to the Data Centre to ensure access to a sufficiently capable data pipeline at all times. We understand that this potential is being explored at this time. A second potential red flag is the assured supply of electricity to the chosen site at all times through, once more, a redundant path. Several proven options exist to address back-up electricity sources.

While electricity costs are higher in Yukon relative to other locations, the difference is not so great compared to other sites that already have Data Centres. All other important factors are either already within the required limits or capabilities, and those that require enhancement are within the realms of feasibility. The question will be the investment required to accomplish this.

Overview of factors and results of analyses



The deciding factor then comes down to cost of operations, which is clearly dominated by the cost to maintain the internal facility within the necessary temperatures for safe and reliable equipment operation, i.e. cooling costs. The major advantage of locating a Data Centre in Yukon will be the availability of cool ambient air and cold water. Our analysis shows that Yukon "wins" in this regard since this can have a dramatic effect on the cost of cooling a Data Centre. This would also somewhat offset the impact of the cost of energy, with less being required for cooling purposes.

One major corporation already taking advantage of a cold air locale is Facebook who has established a Data Centre in Luleå, Sweden. This was despite the relatively high cost of electricity in that locale, the concern for which diminishes with reduced electricity demand, accomplished through the use of natural ambient air and water cooling.

Based upon our analysis we are prepared to state that it ***is*** **feasible to consider Yukon as a suitable place to locate a Data Centre. We see no reason why Yukon cannot compete with other locations as a suitable site for a Data Centre, given that a second fibre optic channel is established and that a continuous and suitable electricity supply is assured at all times.**

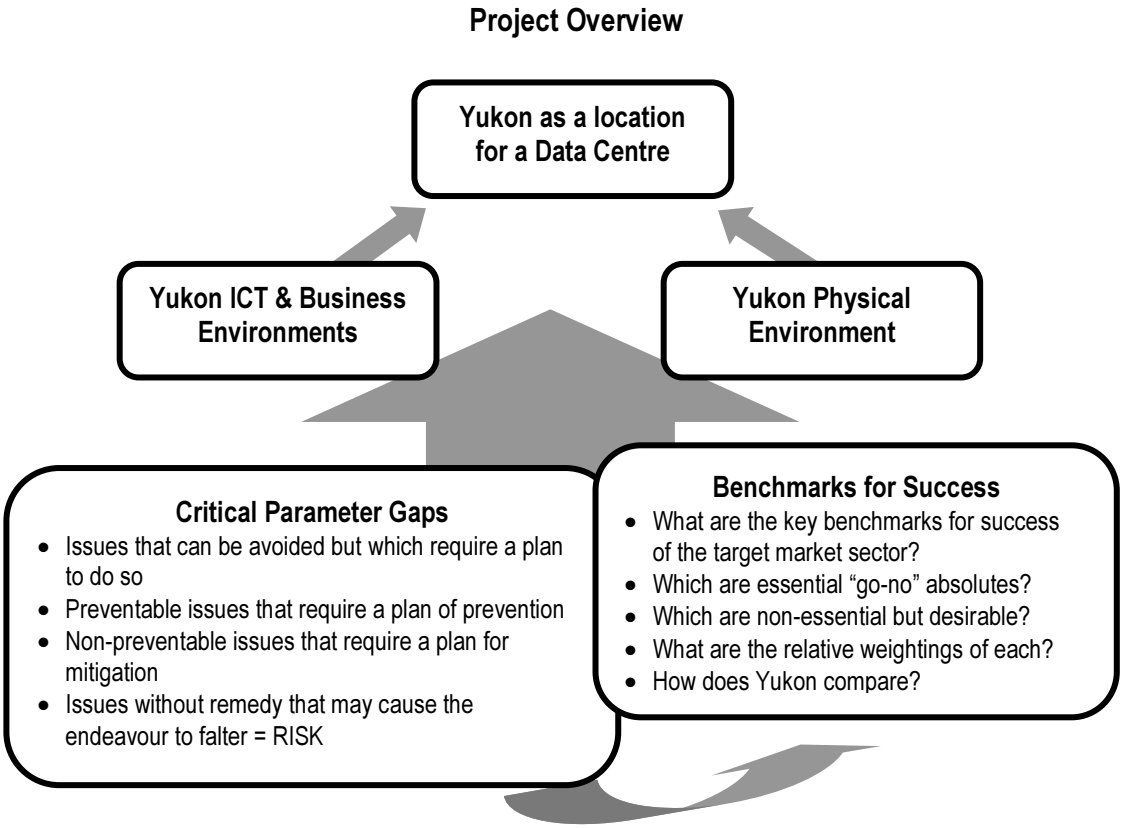
We believe that this is a significant opportunity for Yukon. This is one of those quite rare situations where the unique characteristics of a particular location can provide a very strong advantage and where all other factors are either acceptable, or can be made so. However, some investment is required to make this a reality.

If the project is to proceed we recommend that a small team be established to refine the feasibility analysis and to then create a business case that is sufficiently robust to pass the acid test of private sector investment attraction. This should then also be adequate to convince other types of investor or partnerships.

B Introduction

Purpose

The diagram below encapsulates the objectives as defined in the request for proposals.



This project is a typical economic development site selection initiative.

Overview of a Data Centre and the critical factors of site location

The following diagram represents the major aspects of Data Centre relationships with the critical factors of the jurisdiction in which it is located.

Access

- Equipment suppliers
- Skilled personnel

Power

- Electrical
- Diesel generator
- Fuel tank (size and location)
- Uninterruptible power supply
- PDUs (primary and secondary)
- Electrical distribution (dual paths)
- Building feeds, conduits, trenches
- Fuel for backup(s)

Security System

- Perimeter control
- Access control
- CATV
- Biometrics
- Centralized monitoring

Fire Protection

- Smoke detection
- Pre-action wet systems
- Dry systems

Floor Loading

Space Design

- Raised floor area
- Office area
- Ancillary equipment rooms
- Conference rooms
- Supply room
- Communication room
- Shipping / receiving / equipment staging

Raised Floor

- Height
- Tile size

Fault Tolerance (Tier 1 to Tier 4)

Cooling, heating, humidification

- Air cooling / HVAC
- Air circulation
- Water circulation
- Filtering (particulate levels)
- Humidity controls
- Waste heat removal
- Water cooling
- Open air cooling

Inside a Data Centre

Communication

- Fibre entrance paths
- Cable plant
- Phone systems

What are Data Centres?

Data Centres are much as their name would suggest. They are the storage nodes in digital telecommunications systems and can store vast amounts of digital data. Existing data is accessed and new data entered via high speed communications connections, most often consisting of fibre-optic links.

A data center can occupy one room of a building, one or more floors, or an entire building. Most of the equipment is often in the form of servers mounted in rack cabinets, which are usually placed in aisles. This allows people access to the front and rear of each cabinet. Servers differ greatly in size and can occupy many square feet of floor space.

Site selection for Data Centres

Proximity to available power grids, telecommunications infrastructure, networking services, transportation lines and emergency services can affect costs, risk, security and other factors that must be taken into consideration for Data Centre design. Location climatic conditions dictate what cooling technologies should be deployed and this impacts uptime and the costs associated with cooling. For example, the cost of managing Data Centre heat in a warm, humid climate will be much higher than in a cool, dry climate

Location is one of the factors that affect the energy consumption and environmental effects of a Data Centre. In areas where the climate favours cooling and ample renewable electricity is available, the environmental effects will be more moderate. Countries with favourable conditions, such as Canada, Finland, Sweden and Switzerland are trying to attract Data Centres.

Project Methodology

Site selection is one of the most important activities in economic development. However, economic developers do not carry this out; rather, companies and investors, or their agents, perform this activity. The role of the jurisdictional economic developer is to persuade the site selectors that their particular jurisdiction offers an overall composite competitive advantage compared to competing jurisdictions.

The early stages of the process should really be labelled as site *de*-selection. That is, the jury seeks to eliminate as many sites as quickly as possible that have serious deficiencies or disadvantages for the particular industry sector. Once the list is narrowed down, then the various surviving locations are compared for comparative advantages. The final process may devolve to one of negotiating with the optimum location jurisdictions, with the investors seeking cost concessions or other bonuses.

In our analyses in this project we also look for the critical “go-no” elements, as well as examining the factors that can be compared against other jurisdictions.

Extensive research of available reports and documents has been carried out; to this has been added the industry experience of WCM Consulting in the fields of computers, engineering and business operations, as well as in the discipline of economic development.

Comparison jurisdictions

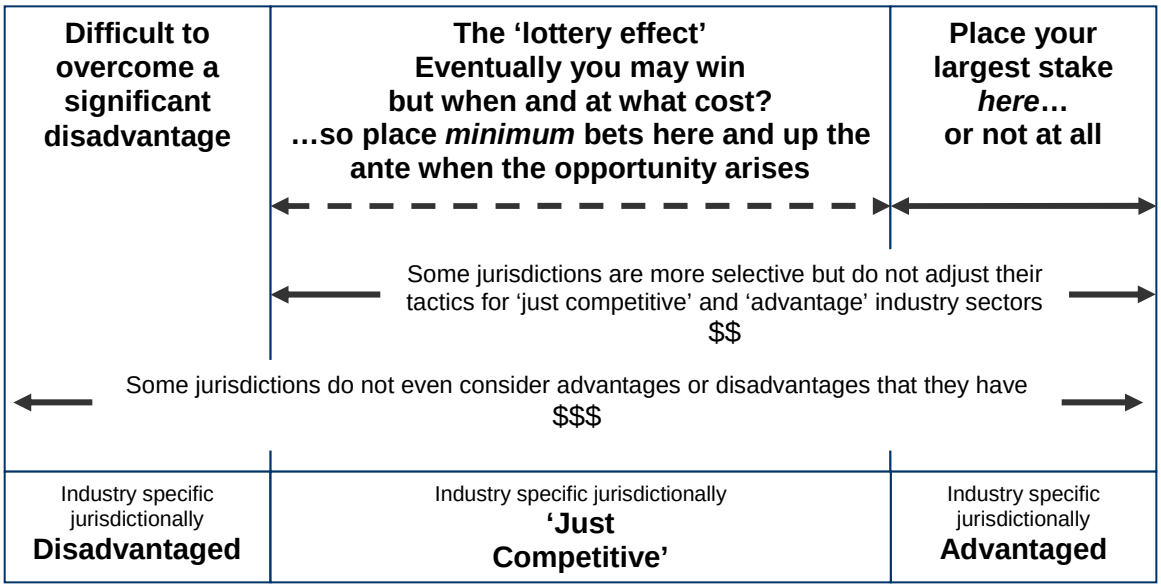
Any number of jurisdictions may be compared with Yukon. We have selected the following eleven, with a rationale for each:

Jurisdiction	Rationale for inclusion in comparison
Luleå, Sweden	Existing Data Centre: Facebook
Hamina, Finland	Existing Data Centre: Google
Prineville, Oregon	Existing Data Centre: Facebook
Altoona, Iowa	Existing Data Centre: Facebook
The Dalles, Oregon	Existing Data Centre: Google
Lenoir, North Carolina	Existing Data Centre: Google
Sepang, Selangor (Malaysia)	Existing Data Centre: Cyberjava *(a government driven investment as part of an economic cluster development initiative)*
Anchorage, Alaska	Possible competing similarly located US site
Winnipeg	Possible competing major Canadian location
Montreal	Possible competing major Canadian location
Saskatoon	Possible competing major Canadian location

In some cases surrogate locations have been used for various comparisons. This is necessary since detailed data is not available for the precise locations. This is especially true for factors such as ambient air temperature, water and similar geophysical elements. However, the practical differences are considered to be minor and should not affect the analyses.

Advantaged, competitive and disadvantaged in economic development

An honest inspection of the strengths and weaknesses of the jurisdiction is essential. Where the weaknesses can be mitigated then well and good; where not, this must be accepted and those industries that would find this to be a disadvantage removed from the focus. The vital importance of assessing the strengths and weaknesses of jurisdictions cannot be over-stated and these form the very basis for a practical and effective attraction strategy, founded in facts and economic reality.



These factors can vary greatly from one industry to the next…each must be assessed

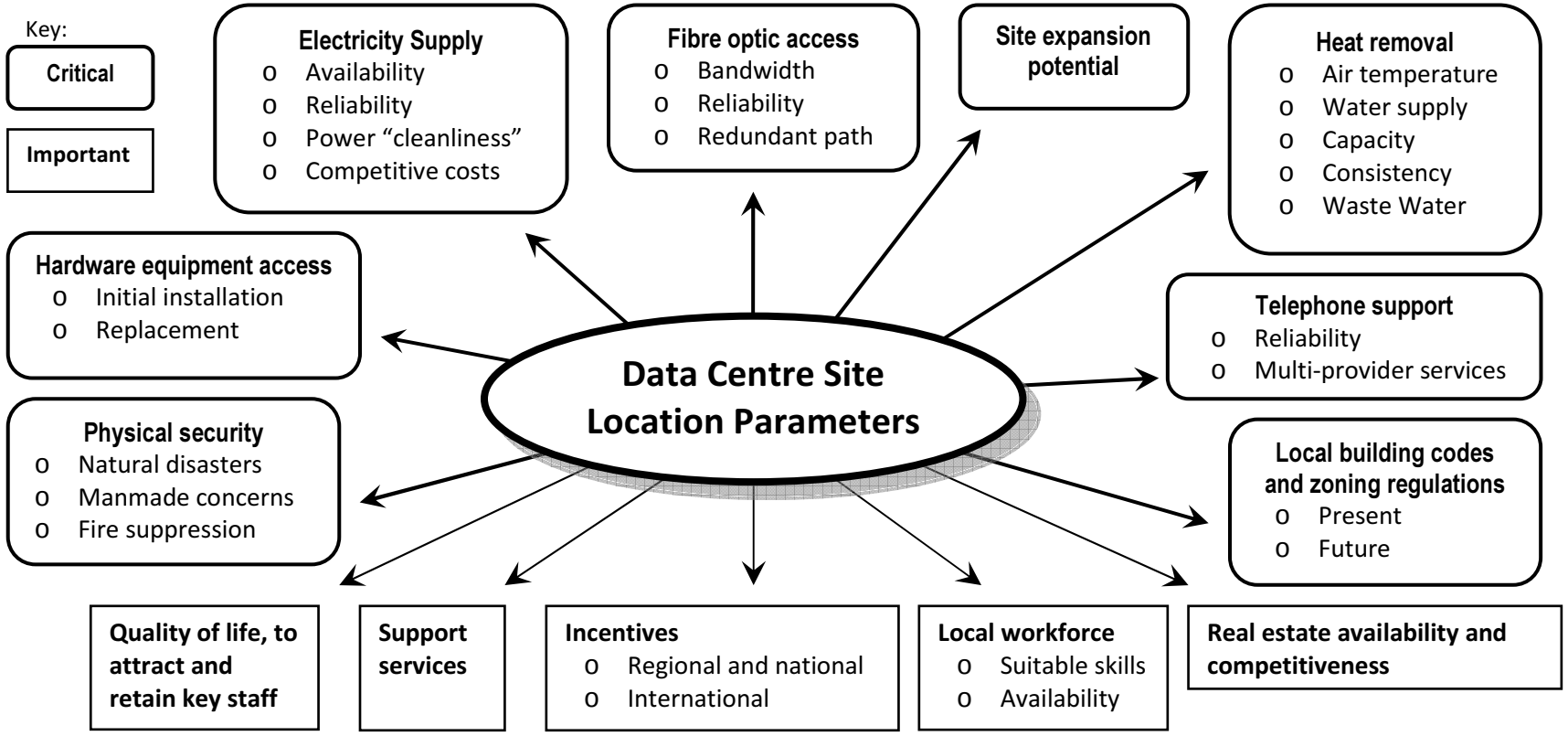
Further, since there will be many sectors in which the jurisdiction is 'just competitive', it is very tempting to focus on all of these. Recall that every runner in the Boston Marathon is competitive, but that there is only one winner – *the runner with the* ***advantage*****.**

Being competitive is not the same as winning. It is a buyer's market in that there are usually far fewer opportunities than jurisdictions wanting those opportunities. So only the 'demonstrably best' are likely to win.

The essence of *this* project is to understand the disadvantages and advantages of Yukon as a location for a Data Centre and whether the former may be mitigated. **If so then an active approach can be taken to attract investment.**

C Key parameters and results of research and analyses

This diagram represents some of the major location parameters considered for review at the outset of the project. Additional factors for review arose in the course of the project. All are discussed following this diagram. Extensive use is made of extracts from referenced documents.



Availability tiers and downtime

Availability of the services offered by a Data Centre is a most essential parameter. Therefore downtime in a Data Centre is one of, if not ***the*** critical concern when considering the long-term viability of an installation. According to various sources, downtime costs $7,900 USD per minute and this amount is increasing annually due to increases in the potential revenue per minute.[1]

This is the vital under-pinning of many of the other factors to be discussed in this report; ***that is, these other factors must be aligned to contribute towards the highest possible level of service.*** Yukon cannot directly impact this most critical performance characteristic but it can, and must, be established as a location that has the elements necessary to contribute positively to the desired performance levels.

The table defines the requirements to meet the various standards, with Tier 4 being the highest performance level.

Tier Level	Requirements
1	Single non-redundant distribution path serving the IT equipment Non-redundant capacity components Basic site infrastructure with expected availability of 99.671%
2	Meets or exceeds all Tier 1 requirements Redundant site infrastructure capacity components with expected availability of 99.741%
3	Meets or exceeds all Tier 2 requirements Multiple independent distribution paths serving the IT equipment All IT equipment must be dual-powered and fully compatible with the topology of a site's architecture Concurrently maintainable site infrastructure with expected availability of 99.982%
4	Meets or exceeds all Tier 3 requirements All cooling equipment is independently dual-powered, including chillers and heating, ventilating and air-conditioning (HVAC) systems Fault-tolerant site infrastructure with electrical power storage and distribution facilities with expected availability of 99.995%

[1] http://www.Data Centredynamics.com/focus/archive/2013/12/one-minute-data-center-downtime-costs-us7900-average

Zero down-time is ideal, but the tier system does allow for the unavailability of services as listed below over a period of one year (525,600 minutes):

Tier 1 (99.671%) status would allow 1729.224 minutes
Tier 2 (99.741%) status would allow 1361.304 minutes
Tier 3 (99.982%) status would allow 94.608 minutes
Tier 4 (99.995%) status would allow 26.28 minutes

Source: "Data Center Site Infrastructure Tier Standard: Topology" (PDF). Uptime Institute. 2010-02-13.

While the differences between the percentages appear to be very small, they can have a dramatic effect on performance, customer satisfaction and profitability.

Electricity Supply

Given the critical role electricity plays in a Data Centre operation - a reliable and economical system of electricity sources is essential.

Availability

Sufficient power availability is an absolute necessity, else the operation cannot perform its function; it is also often the main source of energy to drive the cooling systems. Unlike most other "office" style facilities, Data Centres consume large amounts of power, much more in line with the demand usually seen in large industrial processes where the generation of heat is the primary means of production.

Power draw is on the rise for Data Centres and ranges from a few kW for a rack of servers in a closet to several tens of MW for large facilities, including reserve capacity. Some facilities have power densities more than 100 times that of a typical office building.[2]

[2] "Data Center Energy Consumption Trends". U.S. Department of Energy. Retrieved 2014-06-13

Reliability

Power consumption is on the rise, and brownouts and blackouts are becoming more common in areas that have poor power infrastructure. Data Centres require enormous amounts of power, and failures can cause unexpected downtime[3]. More than one provider is very desirable to minimize disruption caused by a single source failure. Highly reliable energy connections can create opportunities to reduce a Data Centre's investment in back-up generators and UPS equipment and the risk of downtime[4]. Redundant supply paths are a highly desirable feature in a location.[5]

Facebook are specifying backup diesel generators with a total output of 40 MW for their Luleå, Sweden Data Centre facility[6]. There are other back-up energy sources from which to derive electrical power and these are discussed further in Appendix II. Any challenges presented with respect to power supply reliability appear to have existing, proven solutions which can be implemented in Yukon.

Power "cleanliness"

While being located near a source of generated electricity can reduce transmission costs, this is often not ideal from a power "cleanliness" perspective. The switch gear inherent in generating systems causes some element of electrical noise; when ported over hundreds of miles of transmission lines and integrated with other generating facilities in a grid, these disturbances are largely dampened. This beneficial effect is greatly reduced when located close to one source. Power conditioning is the solution but it comes at a capital and operating cost.

Data Centres typically require some degree of power conditioning – this precludes the use of passive standby UPS configurations for any critical Data Centre equipment. However, most mass-produced Data Centre servers and equipment can operate through significant power disruptions; most server power supplies have a specified input voltage range of more than +/- 10% relative to the nominal voltage. Computing equipment power supplies are often designed to operate in non-Data Centre environments, and therefore utilize internal AC to DC power supply converter designs that can accept typical utility power disturbances.

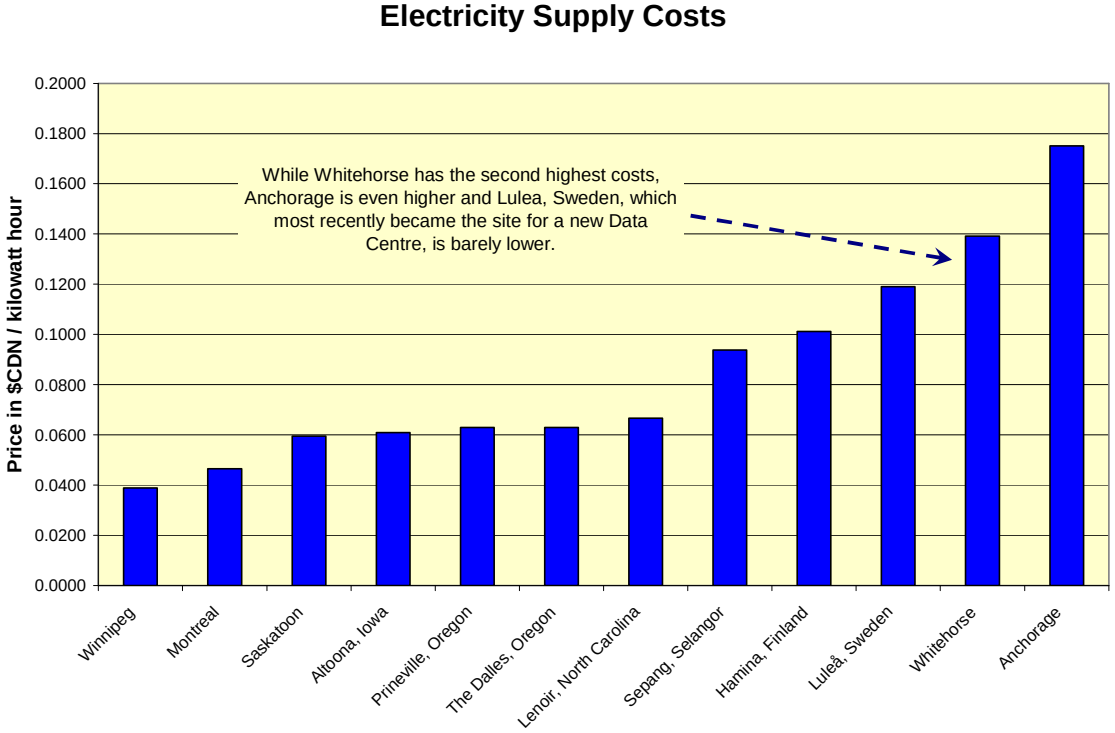
In general, the greater the level of power conditioning used, the lower the system efficiency.[7] That is, the process required to condition the supply in itself causes a loss of usable energy. Greater power conditioning capability often entails greater amounts of electrical waste and adds additional heat loads that the mechanical cooling system must remove.[8]

[3] http://gigaom.com/2011/12/10/latimer-where-to-build-data-center/
[4] http://www.ibrd.gov.nl.ca/publications/ExciteDataCenterReport_Summer2013.pdf
[5] http://www.it.northwestern.edu/bin/docs/DesignBestPractices_127434.pdf
[6] http://www.dailymail.co.uk/sciencetech/article-2054168/Facebook-unveils-mass
[7] http://hightech.lbl.gov/dctraining/strategies/ei.html

Competitive costs

Given the massive electricity requirements for Data Centres, power related costs are of critical importance when comparing potential site locations. Electricity costs comprise roughly 20% of the total cost of operations for a typical Data Centre.[9]

By 2012 the cost of power for the Data Centre is expected to exceed the cost of the original capital investment.[10] Energy costs are a significant consideration in Data Centre location due to their high energy consumption. The most competitive locations in North America have available power below $0.05 per kilowatt hour (kWh). The energy generation fuel source mix is also an increasingly important factor, as companies prepare for potential carbon reduction or carbon tax legislation, and look to leverage green energy sources for public support and global stewardship. For higher power density facilities, electricity costs are a dominant operating expense and account for over 10% of the total cost of ownership (TCO) of a Data Centre.[11] By 2012 the cost of power for the Data Centre is expected to exceed the cost of the original capital investment.[12]



[8] http://hightech.lbl.gov/documents/data_centers/06_Data Centres-PGE.pdf
[9] http://www.apcmedia.com/salestools/cmrp-5t9pqg/cmrp-5t9pqg_r4_en.pdf (Pg 4)
[10] "Quick Start Guide to Increase Data Center Energy Efficiency". U.S. Department of Energy. Retrieved 2014-06-10.
[11] J Koomey, C. Belady, M. Patterson, A. Santos, K.D. Lange. Assessing Trends Over Time in Performance, Costs, and Energy Use for Servers
[12] "Quick Start Guide to Increase Data Center Energy Efficiency". U.S. Department of Energy. Retrieved 2014-06-10.

Electric power availability in Yukon

The primary source is hydroelectricity generated at multiple locations by the public utility Yukon Energy.[13] Currently the generating capacity is between 75 and 90 megawatts (MW) depending on the time of year since hydroelectric generating capacity is limited by the available water supply in the winter months. Back-up electric power generation is addressed primarily through diesel generators and liquid natural gas (LNG); wind farms produce only a minor contribution.[14]

Whitehorse is not currently connected to any external grids which would mean, from a Data Centre perspective, that the rated available supply would be no more than 75MW. However, multiple grids internal to Yukon servicing different areas have been integrated as of 2011. This creates a more flexible and more reliable power distribution capability, permitting load demand in one area to be met through generation facilities in another.[15]

Projects are under consideration by Yukon Energy to expand capacity by up to an additional 70MW of capacity. This would double the effective supply of electrical energy to customers.[16]

Please see Appendix II for additional information regarding existing and alternative electricity supplies.

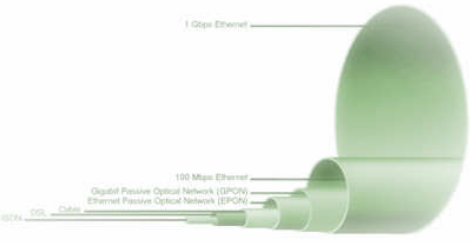
"Greenness" of energy sources

The availability of "green" power may be seen as a cost savings to companies concerned about potential carbon reduction or carbon tax legislation.[17] It is also a "marketing factor" for many users who have growing concerns about the environment. Google, among other corporations, is committed to using renewable energy sources wherever possible. Microsoft is also moving in this direction[18].

Working with local utilities, Data Centres can often use power purchase agreements to get clean energy at competitive prices as well as the renewable energy certificates to reduce their carbon footprint.[19]

[13] http://yukonenergy.ca/energy-in-yukon/our-projects-facilities/hydro-facilities/
14 http://www.yukonenergy.ca/energy-in-yukon/our-projects-facilities/back-up-electricity/diesel-facilities/
[15] http://yukonenergy.ca/blog/one_integrated_grid
16 http://www.yukonenergy.ca/energy-in-yukon/our-projects-facilities/new-hydro/
[17] http://www.ibrd.gov.nl.ca/publications/ExciteDataCenterReport_Summer2013.pdf (Pg 6)
[18] http://www.datacenterknowledge.com/archives/2012/09/17/microsoft-were-eliminating-backup-generators/
[19] http://www.google.com/about/Data Centres/renewable/

Fibre optic/telecommunication access



Data Centre site selectors look for high-capacity fibre routes with multiple telecommunication carriers, and multiple physical fibre lines to ensure competitive rates and continued reliable service should one carrier have a service interruption."[20]. There is only one such “pipeline” to Yukon with such capacity and this singular channel would likely be a “no-go” factor in the site selection process.

As an analogy, consider a typical warehouse operation. Such businesses require a means by which to bring in goods and to send out goods; transportation systems provide this. Now consider a Data Centre: data forms the goods and the transportation mechanism is the fibre optic channel. In either case it is wise not to relay upon a single road or cable to always be 100% available.

Bandwidth

The rapid growth of Internet and cloud computing applications has resulted in Data Centre network bandwidth requirements that outpace Moore’s Law.[21] Simply, Moore’s law states that the number of transistors in a dense integrated circuit doubles every two years. This doubling is being exceeded by the rate of increase in Data Centre performance; data carrying “pipelines” must be designed with the ability to add bandwidth on a regular basis in order to meet this growth in Data Centre capabilities.

Reliability

Given the cost of downtime as mentioned previously, reliability in the fibre optic access to Data Centre customers is crucial to promoting both short and long-term success at a particular locale.[22] This is no less important than a reliable source of electrical power.

A redundant path for fibre optic connectivity strengthens the overall reliability of the Data Centre’s ability to provide the data they host to their customers and maintain their uptime ambitions or commitments.

It is vital for companies locating new Data Centre facilities to have confidence in the ability to be served by redundant telecommunications infrastructure. Access to multiple points of presence, telecommunications “trunk” lines and national carriers is the solution.[23]

[20] http://www.ibrd.gov.nl.ca/publications/ExciteDataCenterReport_Summer2013.pdf (Pg 8_
[21] http://static.googleusercontent.com/media/research.google.com/en//pubs/archive/36670.pdf
[22] http://www.Data Centredynamics.com/focus/archive/2013/12/one-minute-data-center-downtime-costs-us7900-average

Multi-provider phone support

This is similar to the rationale for having multiple service providers for other critical systems.

Site expansion potential

Growth in data demand will fuel the need for efficient use of existing buildings, as well as the development of complimentary service buildings, including future partner Data Centre storage buildings. Since proximity to a related facility factors into the speed of communications between them, the ability of a site to expand either on the same, or nearby land will improve service standards as well as contribute to a smaller carbon footprint.[24]

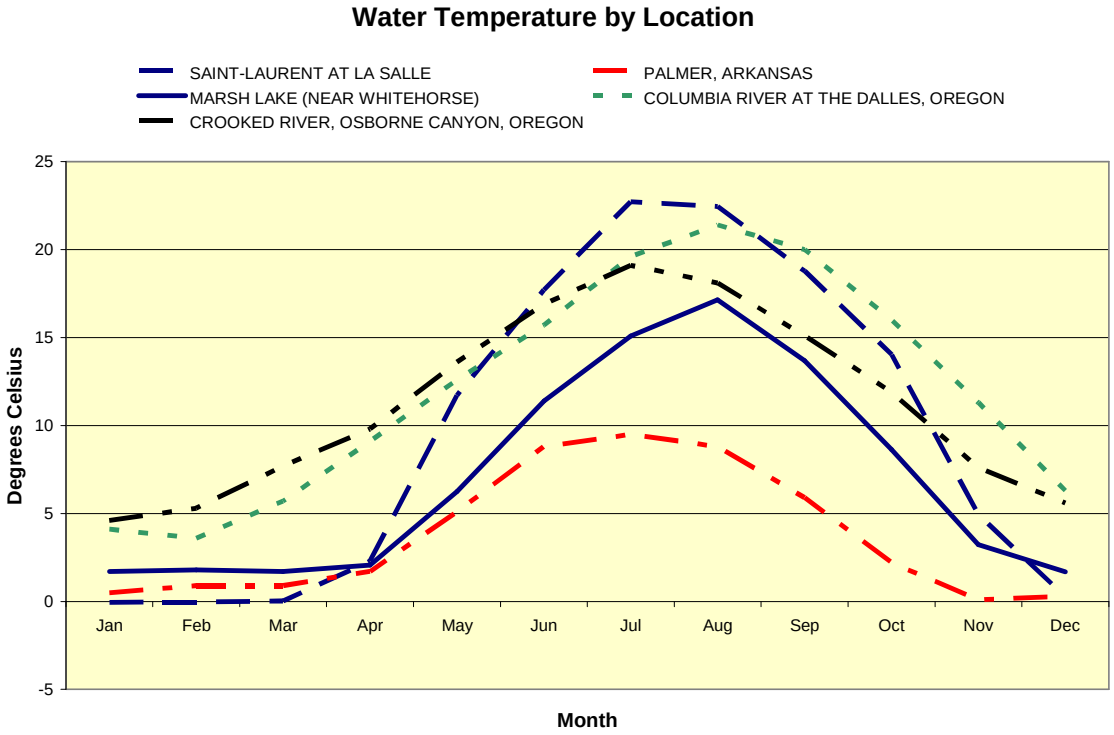
Heat removal

Excessive heat was the No. 1 facilities concern among Data Centre managers in a 2006 survey by IT consultancy, Gartner Group, Stamford, Conn.[25] When high heat levels occur, "servers typically respond by cutting power consumption, in turn reducing performance."[26]

Water supply characteristics

Climate and Data Centre design drive water consumption, but all designs require some level of water and wastewater services for employees, cooling, and for fire protection.[27]

Water Usage Effectiveness - WUE characterizes water use from both Data Centre site operations and source energy generation. WUE is defined as the ratio of total annual water usage to total IT equipment energy. Total annual water usage is based on both site water usage and the water use associated with source thermoelectric power generation. WUE will vary based on the energy water intensity factor (EWIF) associated with the water used to produce energy.[28]



Cold water availability / capacity is a site selection criteria of many Data Centre projects - Intel consider it when evaluating the physical capacity of a potential location[29]

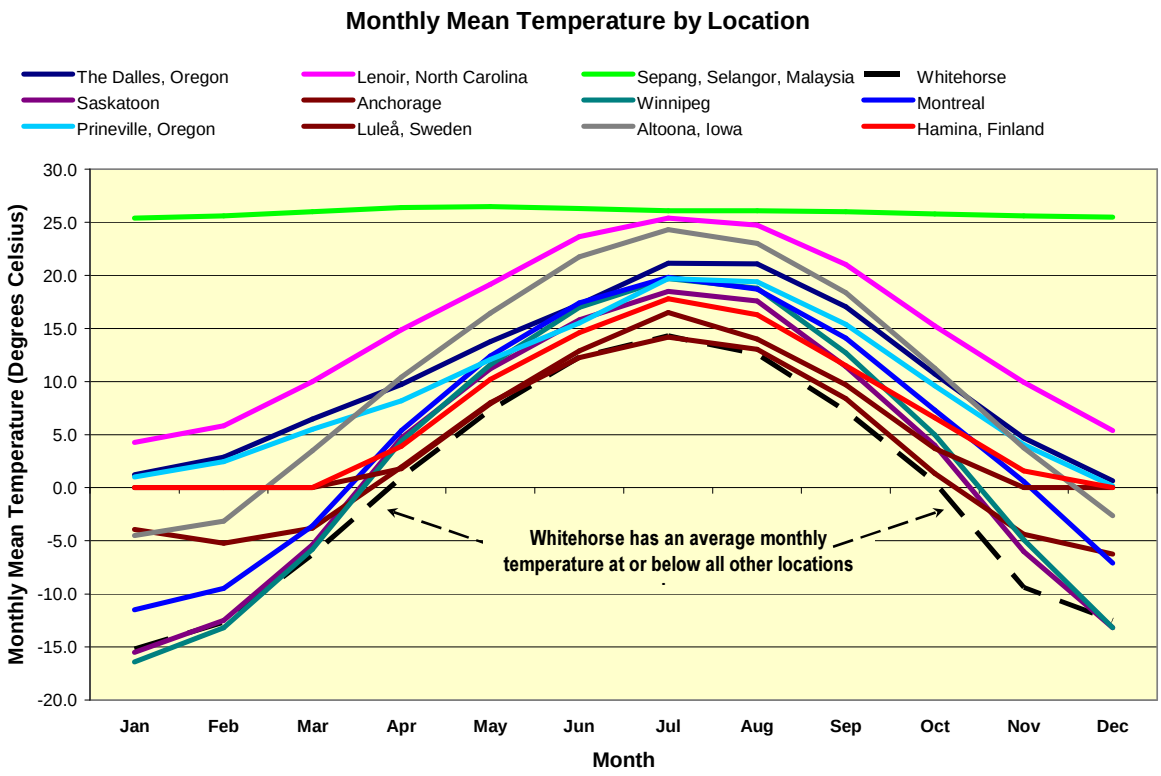
As an alternative, or in combination with air cooling, water cooling is used by Data Centres as a means of cooling systems and improving their overall Power Utilization Effectiveness. As an example, Google is currently using sea water from the Bay of Finland as part of their cooling systems[30]

Waste water from the local community is another option for cooling equipment. The NSA, currently headquartered at Fort Meade, has entered into an agreement with Howard County to pay for a pump station that would supply almost 5 million gallons of reclaimed wastewater per day to NSA's high performance-computing center.[31]

Given the advantages of water cooling, a consistent water supply allows for a Data Centre to design their systems to incorporate a predictable and affordable means of improving their Power Utilization Effectiveness.

[29] http://www.intel.com/content/dam/www/public/us/en/documents/white-papers/selecting-a-data-center-site-intels-approach-paper.pdf
[30] http://www.google.ca/about/Data Centres/inside/locations/hamina/
[31] http://www.tomsitpro.com/articles/nsa-data-center-green-technology-security-maryland,1-1566.html

Air temperature



Although there are other more refined metrics that are made, Power Utilization Effectiveness (PUE) is a broad measurement of how efficiently a computer Data Centre uses energy; specifically, how much energy is used by the computing equipment in contrast to cooling and other overhead. It is calculated as the ratio of total amount of energy used by a computer Data Centre facility to the energy delivered to computing equipment.

Many Data Centres are being constructed where cool air is brought in from the outside and is used to contribute to IT equipment cooling.[32]. Given the costs of open air cooling compared to air conditioning cooling, as well as water cooling, open air systems are an opportunity for a Data Centre to improve its Power Utilization Effectiveness in a cost efficient manner. ***Based upon the air temperature chart above, Yukon has an opportunity to exploit this cooling mechanism.***

[32] http://gcn.com/blogs/emerging-tech/2013/02/microsoft-data-center-cooling-breath-fresh-air.aspx

Access for hardware equipment delivery

Unlike a manufacturing facility, heavy goods traffic would not be a daily occurrence; however, good access is still required for semi-trailers.

It is not uncommon for data operators to reinvest 50 percent of their original capital investment in equipment upgrades every three years.[33] Very large Data Centres may use shipping containers packed with 1,000 or more servers each;[34] when repairs or upgrades are needed, whole containers are often replaced (rather than repairing individual servers).[35]

Operational and support staff

In theory, the operation can "go dark"; that is, no human need be on site and the entire facility can be controlled remotely from anywhere in the world where there is a suitable telecommunication link.

In practice on-site or available manpower may range from a dozen up to 100 or more with many factors coming into play to determine this. Apart from physical security and maintenance staff, some technically qualified people will be required to monitor and maintain the system. The numbers required of such qualified technicians should be capable of being filled by local Yukon residents.

Appendix IV provides a broad demographic analysis based upon Statistics Canada data and this raises no cause for concern.

Physical security

High-risk areas are to be avoided, such as airport-approach corridors, flood plains and areas that are prone to natural disasters, such as earthquakes, tornadoes or hurricanes.[36]

Also to be avoided are potentially hazardous areas, such as cafeterias, machine shops, wet labs or other facilities where fires or machine vibrations could present a hazard to Data Centre operations.[37] A site should be sufficiently removed from neighbouring structures to enhance security.

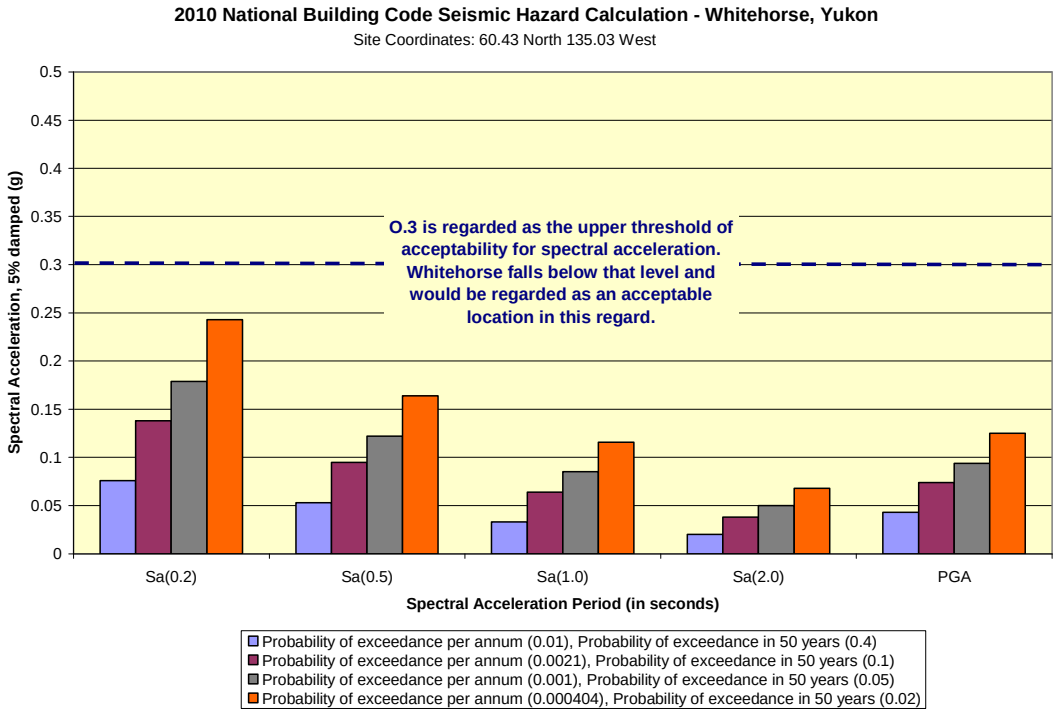
[33] http://www.ibrd.gov.nl.ca/publications/ExciteDataCenterReport_Summer2013.pdf (Pg 7)
[34] Google Container Datacenter Tour (video)
[35] Walking the talk: Microsoft builds first major container-based data center
[36] http://www.it.northwestern.edu/bin/docs/DesignBestPractices_127434.pdf
[37] http://www.it.northwestern.edu/bin/docs/DesignBestPractices_127434.pdf

A good setback from main highways or access streets is preferred. If located in a multi-tenanted building, the ends of the building minimize disruptions from neighbouring tenants [38]

Fire Suppression

IT systems are protected by different types of fire suppression systems including: gaseous, chemical and water-mist[39]. Water mist based systems are quickly becoming more popular due to their "green" nature as opposed to the use of chemical systems. [40] In mist form the potential damage to equipment is minimized, when compared to conventional deluge sprinklers.

Natural disasters



Natural disasters/weather events such as hurricanes, floods, tornados and earthquakes create much concern for Data Centres. These types of weather events can interrupt Data Centre operations for a lengthy period of time, beyond what is addressed through reasonable contingency plans.[41]

[38] http://www.it.northwestern.edu/bin/docs/DesignBestPractices_127434.pdf
[39] http://www.techrepublic.com/blog/it-security/the-mystical-world-of-data-center-fire-suppression/
[40] http://en.wikipedia.org/wiki/Automatic_fire_suppression#Health_and_environmental_concerns
[41] http://www.indygov.org/eGov/City/DMD/Planning/Resources/Documents/Key%20Factors%20Influencing%20Site%20Selection%20Decisions%20for%20Data%20Center%20Facilities-Inside%20IN2011.pdf

Incentives

Tax incentives are a common tool used by jurisdictions to attract investment.

The high levels of capital investment and rapid asset depreciation cause depreciation rules and property tax policy to have a significant impact on Total Cost of Ownership and can be a significant differentiating factor between locations."[42] For example, Data Centre developer DuPont Fabros Technology (DFT) has invested more than $900 million in facilities in Ashburn, Virginia under the local sales tax exemption program. Several providers have taken advantage of Virginia's recent sales and use tax exemption for purchase or lease of equipment and software by Data Centres"[43]

Note that tax and other incentives are just one of the various cost factors of "being in a jurisdiction" and these are often used to offset other less competitive costs. It is the **overall composite cost**, over time, of being in one jurisdiction over another that is most important. Please see the discussion on the "Competitive Alternatives" methodology described briefly in Section F, Recommendations.

Some examples of incentives are provided in Appendix III.

Regulatory structures

Clearly these must be "Data Centre friendly"; that is, by design or by accident, the net regulatory environment, both locally and nationally, must not place the Data Centre at a disadvantage in any respect. This will require a more in-depth analysis than is contemplated in this project; however, such regulatory structures are usually within the control of governments and may be adjusted if the need is pressing and the rewards sufficiently high.

[42] http://www.ibrd.gov.nl.ca/publications/ExciteDataCenterReport_Summer2013.pdf (Pg 7)
[43] http://www.Data Centreknowledge.com/archives/2013/10/15/dft-tax-incentives-prompted-900-million-investment-in-ashburn/

D Other considerations

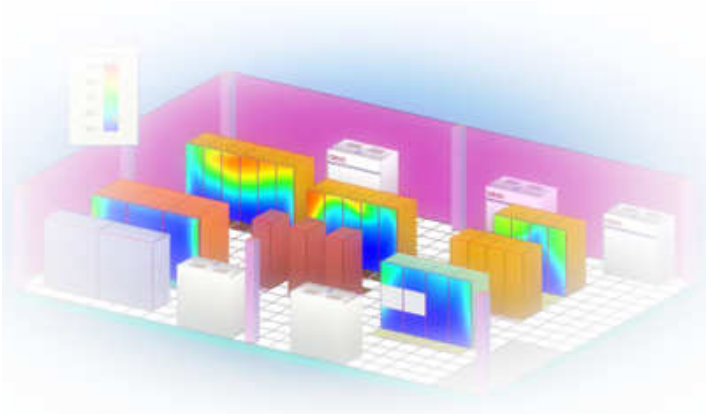
Cooling the Data Centre

While much quantitative information is available to assess the cost of cooling a Data Centre, it still exists in a fragmented form. At least four factors come into play, being:

- Ambient air temperature
- Water temperature and availability for cooling
- Electricity cost (if used for cooling)
- Natural gas cost (if used for cooling)

Existing abandoned mines may also serve well here. The rationale for the use of mines as data center locations is based primarily on cheaper cooling, as well as a naturally more secure environment. There are existing examples of organizations using this approach including the Lefdal Mine in Norway[44] and the "Iron Mountain" in Pennsylvania[45]

If "suitable" mines are available, it may provide an even greater opportunity for environmentally aided cooling. While there are abandoned mines in Yukon, many are considered environmental threats and require an investment to mitigate the existing risks before any future use considerations. [46], [47], [48], [49], [50], [51]



Since the operating and capital costs vary between jurisdictions, and the site location will greatly affect the factors both positively and negatively, it is not meaningful to create factor-to-factor comparisons between locations. Instead, a **composite model,** which permits the comparison on an overall “cost-to-cool”, or Power Utilization Effectiveness rating, is required. Please see the recommendation in Section F of this report.

[44] http://www.lefdalmine.com/
[45] http://www.ironmountain.com/Services/Data-Centers/National-Data-Center.aspx
[46] http://www.emr.gov.yk.ca/aam/about_abandoned_mines.html#Other_Type_II_Mine_Sites
[47] http://www.emr.gov.yk.ca/aam/mount_nansen.html
[48] http://www.emr.gov.yk.ca/aam/clinton_creek.html
[49] http://www.emr.gov.yk.ca/aam/what_are_abandoned_typeii_sites.html
[50] http://minelistings.com/country/canada-mines-for-sale
[51] http://www.nrcan.gc.ca/home

Economic development potential

Direct job creation potential

Clearly jobs will be created to some extent if the Data Centre is housed in a newly constructed or refurbished building. The same would apply to the initial effort to bring the necessary utilities into the operation; likewise for any physical access requirements such as roads.

Once operational, the demand for manpower is then greatly reduced. In theory, the operation can "go dark"; that is, no human need be on site, but, in practice on-site or available manpower may range from a dozen up to 100, with many factors coming into play to determine this.

The entire operation can be controlled remotely from anywhere in the world where there is a suitable telecommunication link. This control element would be used to remotely monitor performance, identify any irregularities, and adjust the operation to mitigate failures (through redundant systems and paths) and so on. In a well designed Data Centre with appropriate levels of redundancy built in, little short of catastrophic physical failure (fire, flood and so on) would require an immediate human intervention. Identified operational failures that were mitigated with automated or semi-automated remedies to restore performance are suitably handled by, if necessary, flying in well trained company personnel to restore full functionality. Of course, such personnel could also be stationed locally.

The shorter the physical distance between processing centres, the faster the communication. This can be essential if the tasks performed by one Data Centre must be carried out in conjunction with another, through some coordinated or parallel processing activity. Thus Data Centres *can* act as a magnet or "cluster developer" to attract new Data Centres, especially those from the same or allied companies. *However, the same limitations apply for each additional Data Centre built;* once completed and operational the need for human operators is greatly diminished.

Indirect economic development effects

This should be considered as a main economic development thrust of the Data Centre.

Faster and more powerful is better when it comes to data processing. As speeds and capabilities climb, more and more tasks can be considered which hitherto were simply not practical. While the power of super-computers such as the Cray has existed for decades the cost of these are prohibitive for all but very large organizations with very specialized needs.

Everyday organizations can now consider such tools as being within accessible and economical reach, most especially in those industries that require the interchange of large amounts of information. Such industries are very often part of what is called the “Creative Economy”. Once referred to as the “Information Age” this is extended greatly when it comes to the use of the information to “create things”. Since the early part of this century, there have been many papers written on this aspect of emerging and developing economies although the topic is not without its critics in terms of being a panacea. Such industries are much sought after by most jurisdictions. Searching for “Creative Class” or “Creative Economy” will yield many different perspectives. For a recent specifically Canadian view please see:

> “The Boiling Frog Dilemma: Saving Canada from Economic Decline”
> ©2012 Todd Hirsch, ISBN 978-0-9879269-0-6, published by P & P Publishing
> *In particular, Chapter 6 provides some definition of the Creative Economy*

Potential long-term economic development benefits

Data Centres have existed for decades in one form or another but the recent proliferation has been driven by the rapid expansion in Facebook, Google and similar companies as well as the growth in “cloud computing”.

The future of Data Centres and the advantages of Yukon

Data Centres are likely to remain an important part of the global economy for many years to come. At present the demand for such facilities is increasing and, as users find more ways to enjoy and exploit access to vast amounts of data, the demand will increase yet further. If anything, the local cooling cost advantages of Yukon will increase over time as more densely packed servers come into use and the consequent heat generated increases per cubic metre of Data Centre physical capacity.

Primarily through miniaturization, advances in technology will reduce the space requirements for a given amount of data storage capacity. New Data Centres will be built with the latest technologies and existing ones will be upgraded, perhaps as often as every three of four years, such being the pace of technology advancement. If the cubic metres required to store 100 terabytes of data is reduced by half, then the same Data Centre could now store roughly twice the amount of data as prior to an upgrade.

Given the physics and chemistry involved in semiconductor miniaturization, it is reasonable to assume that less heat will be created by newer generations of servers. While the exact numbers will vary according to the particular technology development, the heat generated for these new devices might be reduced by 30% compared to the previous generation.

However, unless radically new technologies are employed, this does not mean that the amount of heat generated in the Data Centre is also halved. If the Data Centre owner merely maintains the *same* amount of data storage using these new devices then the heat generated would also be reduced by 30%. Clearly this is not the trend; instead of "wasting" half of the physical capacity of the Data Centre space, the trend is to use this space to the maximum possible limit, or effectively doubling the data storage capacity.

In doubling the data storage capacity, the overall heat generated in the newly configured data Centre is now increased by 40%. While this is a worthwhile overall reduction in generated heat per Terabyte of storage, it emphasizes even more strongly the advantages of the economical cooling available from cold air and cold water.

"Greenness" in data Centres is becoming an increasing factor in their design. The "greener" the Data Centre" the more acceptable it is environmentally and, in all probability, it can be operated at a lower cost under the right environmental conditions. Yukon has many of the right conditions.

Projections of economic impact

The recent growth in Data Centres is still a relatively new phenomenon and there are few hard statistics to go by to determine the longer term economic development benefits that can accrue. However, it is possible to examine potential economic development opportunities, based upon the doors that can open for the jurisdiction in which a Data Centre is located. It is important to bear in mind that, as with any other opportunity, whether in business of in public sector economic development initiatives, a singular factor such a Data Centre is rarely sufficient alone to spur additional growth. Just as cold air and cold water give Yukon an advantage as a site for a Data Centre, many other factors must also be in good order. Similarly, while the Data Centre will open the doors to other potential economic development opportunities, passively waiting for these new ventures to arrive is not sufficient.

There are few direct economic downsides to a Data Centre that have been identified; the issues are one of creating the necessary infrastructure to make the Data Centre a reality so that the natural advantages of the cold air and cold water in Yukon can be brought to bear. Specifically these are the twin, or redundant, high-speed fibre-optic connection and ensuring sufficient and reliable electrical supply. While these are crucial to a Data Centre, the benefits of such infrastructure investment are not restricted to a Data Centre. In calculating the return on investment of such enhancements, it is vital to consider the additional socioeconomic benefits that will accrue that are not a result of the data centre itself, even if it spurred the investment in that infrastructure.

Please see Appendix I for some commentary on Data Centre economic development impacts.

Data privacy concerns

Recent revelations that the US National Security Administration's surveillance practices are far more wide-reaching than previously thought are already having a material impact on the IT services industry in the US. About 25% of UK and Canadian IT decision makers recently surveyed are planning to move their company data outside of the US as a result of the scandal, ignited by the leaks of classified NSA documents by the agency's former contractor Edward Snowden.

This should provide any Canadian location with an advantage over U.S. locations. The close physical proximity to the U.S. but with a jurisdictional “firewall” may be a crucial factor.

E Conclusions

We mention all of the factors researched in the previous section, but some only in passing where the significance is obvious to the overall feasibility assessment.

Rating key:

- DIS = Presently Disadvantaged
- NEU = Presently Neutral (or effectively so)
- ADV = Presently Advantaged

Remedy key:

- YES = Can be remedied, largely at the discretion of the jurisdiction; the investment cost and the will to do so are critical
- NA = No remedy considered to be necessary
- TBD = Cannot be ascertained at this time or within scope of project

Major Factor	Sub-Factor	Rating	Remedy	Summary Comments
Electricity supply	**Availability**	**NEU**	**YES**	**Hydroelectric generating facilities are the primary source of electrical energy and a unified grid has been created internal to Yukon. Adequacy of supply will depend on the demands of the particular Data Centre. The reliability of the system will require a technical review but proven back-up technologies are already in use supporting Data Centres.**
	Reliability	**NEU**	**YES**	
	Power "cleanliness"	DIS	YES	Proximity to a hydroelectric source may require additional investment in power conditioning and implies higher ongoing operating costs. These can be remedied with investment.
	Competitive costs	DIS	YES	With sufficient will this can be remedied. Also dependent on the Power Utilization Effectiveness as a result of cooling requirements.
	"Greeness" of source	ADV	NA	Hydroelectric generation is "green" compared to other sources of electrical power.
Fibre optic / telecommunication access	Bandwidth	NEU	NA	This is a function of the fibre optic link rather than the Data Centre.
	Reliability	**DIS**	**YES**	**RED FLAG - A second fibre optic path is the solution.**

Major Factor	Sub-Factor	Rating	Remedy	Summary Comments
Multi-provider phone support		NEU	NA	
Site expansion potential		NEU	NA	A site can be selected with sufficient space for expansion.
Heat removal	Water supply characteristics	ADV	NA	Water temperature is relatively advantageous, and with an adequate supply.
	Air temperature	**ADV**	**NA**	**This is perhaps the most advantageous factor for Yukon and would most likely form the basis of the business case.**
Skilled support personnel		NEU	NA	Depending upon the size and nature of the Data Centre, a few dozen to a hundred personnel may be needed. Skills in local personnel are likely to be sufficient for most purposes.
Access for hardware equipment delivery		NEU	NA	A road can be built if needed, but may already exist in a given location.
Physical security		NEU	NA	An appropriate site location can be identified and the necessary systems installed. Geophysical risks are below the critical rating thresholds.
Regulatory structures, taxes and tariffs		NEU	NA	These are a matter of will and investment cost.

Note that a single red flag left remedied is sufficient to eliminate a location from consideration. Being neutral in most factors is often adequate and is the most common outcome in many site selection processes once the disadvantaged locations have been eliminated. ***Then a single significant advantage can cause the location to be selected.***

The fundamental question posed by this project was: **is it feasible to consider Yukon as a suitable place to locate a Data Centre.**

Based upon the research and analysis to date, **we have found no red flags that cannot be mitigated, albeit with some investment required,** and that **certain climatic factors may well enable Yukon to position itself as an "advantaged site"** for such an enterprise.

The absolute red flag is the requirement for a second, or redundant, fibre optic link to the Data Centre to ensure access to a sufficiently capable data pipeline at all times. We understand that this potential is being explored at this time. A second red flag *may* be the assured supply of electricity to the chosen site at all times through, once more, a redundant source and path.

While electricity costs are high in Yukon relative to other locations, the difference is not so great compared to other sites that have Data Centres. All other important factors are either already within the required limits or capabilities, and those that require enhancement are within the realms of feasibility. The question will be the investment required to accomplish this.

The deciding factor then comes down to cost of operations, which is clearly dominated by the cost to maintain the internal facility within the necessary temperatures for safe and reliable equipment operation. The major advantage of locating a Data Centre in Yukon will be the availability of cool ambient air; our analysis shows that Yukon "wins" in this regard and this can have a dramatic effect on the cost of cooling a Data Centre. This would also somewhat offset the impact of the cost of energy, since less will be required.

Facebook has established a Data Centre in Luleå, Sweden. This was despite the relatively high cost of electricity in that locale, the concern for which diminishes with reduced electricity demand, accomplished through the use of natural ambient air and water cooling.

We see no reason why Yukon cannot compete with other locations as a suitable site for a Data Centre, given that a second fibre optic channel is established and that a continuous and suitable electricity supply is assured at all times.

We also see this as a rare and viable opportunity for Yukon to develop in a burgeoning niche, making full use of a unique and virtually cost-free natural factor: ambient air temperature.

How does Yukon wish to proceed generally?

Guidance in this area may preclude following paths that are of little interest to the Government of Yukon *but an answer is not essential at this point in the process.* Given that there is interest in pursuing the development of a Data Centre, there many investment options, including various combinations of these options. Some of these are as follows, but the list is not exhaustive:

Pursue the development of the Data Centre:

1. On the basis that, at least initially, it will be built and run by the Government of Yukon
    a. This may be a permanent situation where the use of the facility is rented or leased to various users.
    b. Or it may be intended to sell the Data Centre, in part or in whole, to the private sector at some point in the future.
2. On the basis that a public-private venture will be sought from the outset.
3. On the basis that Yukon will be promoted and marketed to potential Data Centre owners/developers directly; the purely private sector investment case.

If a clear path cannot be identified now, then the assumption should be made that path 3 will be pursued since this will require that the most robust case be built if positive outcomes are to be expected. If such a case can be built then this should suffice in large part to meet the requirements of paths 1 and 2 also.

F Recommendations

These are based upon the preceding conclusions.

Feasibility study refinement and business case development

Often there is a three stage process when such projects are investigated. These may be classified as:

1. A relatively low cost pre-feasibility or high-level assessment of the possibilities, often with most emphasis on red-flags or the parameters which would diminish the potential at an early stage; the intent is to prevent wasting further time and resources on a "dead-end" situation. This was the nominal purpose of the current project.
2. Given a positive outcome of 1, the next stage would be a full blown feasibility assessment, including cost estimates and many other factors. Please see Appendix V for a general outline of such efforts.
3. The transformation of the results of 2 into a compelling business case, designed to convince investors through demonstrable facts and information, formatted for the specific understanding of each class of potential investors. If the full feasibility assessment is done thoroughly then virtually all of the required information should now be present and formatting this into the appropriate structure of most interest to the potential investors becomes the main task.

In the current project we believe that we have gone beyond the intent of a pre-feasibility analysis (1), and have provided much information that would belong in the full feasibility assessment (2). Therefore, in order to reduce Government of Yukon costs and the elapsed time to complete, we suggest that the usual three-part process can be reduced to two, through the completion of the full feasibility study that has already been started in the current project, and then transforming this immediately into the targeted business case.

Completing and refining the full feasibility assessment

This would consist largely of:

- Discussions regarding the possible intent of the Government of Yukon, as described at the end of the previous section. If some direction can be given then the project can become more focused and efficient.
- Expanding, if required, the comparison locations beyond the eleven already examined for the critical and important parameters.
- Fill out the details of the feasibility analysis just completed. This would focus on the research of additional quantitative data to refine the analyses already completed
- Confirming that no new critical parameters exist through further research and discussions with the Data Centre industry.

- Discussions, possibly incognito, with potential Data Centre industry clients to:
    - Verify and refine the conclusions already drawn
    - Identify further areas for examination
    - Obtain key "advantage" factors from the perspective of the potential client.
- Obtaining cost estimates for facility development and servicing as well as ongoing operational costs.
- Deriving a composite model to assess the best mix of cooling methodologies to optimize the Power Utilization Effectiveness of a Data Centre located in Yukon.

This would entail understanding the costs and, in some cases, availability of the various options such as ambient air, available water, electricity supply, natural gas and so on. It should be possible to derive a model which permits a "what if" capability to show how much reliance can be placed upon each, at what capital cost and ongoing running cost. This would permit the proposed Business case to best position Yukon in using its advantages and mitigating its disadvantages. It would also promote the as having an in-depth understanding of the needs of the potential investor, which is generally appreciated as a positive relationship builder.

It is generally best not to assume who pays for what at this stage but to determine what the total cost would be, and to then prepare to negotiate with investors/operators as to how it can come about as the opportunities arise.

Examples of other factors are provided in Appendix V for a generic feasibility analysis and this would be refined for the purpose of the Data Centre in order to be efficient in that assessment.

Business case development

As described earlier, a thorough and well assembled feasibility analysis should lead seamlessly to the creation of a business case. The major task is then one of formatting the information to develop a *compelling* case.

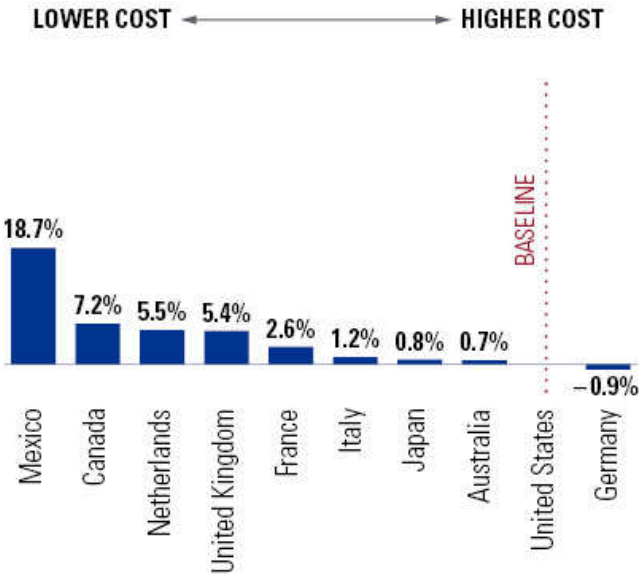
While much quantitative information has already been included, and more will be added, *the entire set still remains in a fragmented, non-composite form.* There is no simple equation to demonstrate the benefits of one location over another; particularly in the case of the Power Utilization Effectiveness, multiple factors come into play that can impact costs: air and water temperature, electricity, natural gas costs, and so on.

It is always best to assume that investor attention spans will be short initially, and that a readily understood composite message should be derived that has impact and that will increase their interest such that serious consideration is given. A composite which demonstrates a clear "bottom-line" advantage is a powerful tool and this can be derived for a Data Centre.

We recommend drawing from a well established concept used in the economic development world for many years. This concept was brought to prominence in Canada by the consulting firm KPMG in the "Competitive Alternatives" series. More can be learned at http://www.competitivealternatives.com/ but we summarize the process below.

- A representative "company" is conceived for a given industry sector.
- Based upon experience in that sector, a profit and loss statement is derived, representing the costs and financial performance of that company.
- Local jurisdictionally costs are then researched for each comparison location and these are entered into the model.
- The main cost factors considered are:
    - Labour costs –not a major factor for a Data Centre
    - Facility costs
    - Transportation costs – these will be of concern when establishing the Data Centre and must be considered from time to time when major server upgrades are carried out
    - Utility costs – perhaps the major factor for a Data Centre
    - Taxes imposed by senior levels of government
    - Local property taxes

Note that costs that are *not* site sensitive are not considered; in the case of the Data Centre an example would be the costs of the servers and similar equipment.



As a high-level example, the KPMG chart shows the overall combined 2014 results for both manufacturing and services for a variety of jurisdictions. Canada fairs well in this regard. For the purposes of the Data Centre, various existing models can be cannibalised and new parameters introduced to create a more representative Data Centre operation.

The methodology is simple but powerful, and is in the "language of business".

Economic development professionals in Canada have used these analyses for many years to provide a compelling case for the location of a given type of industrial plant in Canada. This was especially so prior to 2003, before which the Canadian dollar had been valued at between two-thirds and three-quarters of the U.S. dollar, with the U.S. being the most common competing jurisdiction. At or near parity, the cost advantages are reduced but still present and noticeable in many sectors.

Timing of subsequent efforts

We would recommend allowing several months for completion, given that this next phase will require interfacing and discussions with third parties such as potential Data Centre investors and no-one can control their availability and timing.

Formation of a small team

A small team should be considered to achieve the above recommendations. The team could be composed entirely of Government of Yukon staff, entirely of private sector consultants or a combination of both. This will depend on the disciplines required and the availability of Government of Yukon personnel. Some disciplines would be used more than others and roles would include, in probable order of time demand:

1. Project organization management, general research and business case development
2. Expertise in cooling
3. Knowledge of computer systems, especially when holding discussion with the industry
4. High power electrical generating/transmission knowledge
5. Water supply knowledge
6. Natural gas distribution for industrial purposes

We will not assume the resource availability of Government of Yukon personnel. For roles 4, 5 & 6 we are certain that this expertise exists in the Government of Yukon or its agencies, and since interactions with the appropriate authorities would be essential in any event, these disciplines might best be filled by Government of Yukon or related agency personnel. Roles 1, 2 and 3 could be addressed internally or through external consultants, reporting to a key oversight person in the Government of Yukon.

G Appendices

I Potential long term economic development benefits of a Data Centre

The following have been drawn from various reports and commentators; although founded on reasonable assumptions, most are speculative in nature so they should be treated as possibilities, and not certainties.

From an announcement on the Welsh Government web-site: March, 2014

> "Clearstream Group invested £2m in its new datacentre in Church Village converting a former electricity substation into a modern, highly secure centre. The investment was supported by £75,000 from the Welsh Government and backed by a £200k loan from Finance Wales.
>
> On a visit to the company this week Economy Minister Edwina Hart heard how the facility is supporting the growth of local businesses while also helping to retain key IT skills and revenues in the region.
>
> The datacentre now employees 16 high-skilled IT and facilities staff, and has created further jobs in the local IT community through IT resellers in South Wales offering their own Cloud services from the centre
>
> The Minister said: "I am pleased to hear the investment by Clearstream, which has been supported by Welsh Government and Finance Wales, is making an important contribution to the local economy and enabling other businesses to become more competitive.
>
> "Predictions show that optimisation of ICT by businesses could generate a further £1.5bn for the economy over the next five years and the Welsh Government is committed to helping more Welsh companies exploit these developments. We want a thriving and competitive digital economy driving innovation, productivity and growth."
>
> Clearstream provides businesses with integrated server hosting and managed high speed broadband and fixed line networks, and had previously provided co-location services using third party data centre space.
>
> As demand for these services increased with the growth of cloud computing, faster broadband speeds and increasing dependency on robust IT systems, the company decided to develop its own centre.
>
> It relocated its hosted customer systems to Church Village providing a more cost effective and efficient service to clients. The investment has also enabled the company to reduce its operating costs and develop new services and revenue opportunities.

CEO Paul Webb said they are now providing services to businesses that were previously hosting in more expensive data centres in London, Bristol and Birmingham. He said: "Data centre space across the UK is increasingly expensive and in short supply. We are now one of three public data centres in South Wales and are providing businesses in Wales – and across the UK with a cost competitive service.

"We estimate our service is bringing in around £6.5m in direct and indirect spend into the Welsh economy annually. This is set to increase to £20m annually over the next five years as customers that were previously buying hosting in cities around the UK are now benefiting from a local service."

BLS & Company: 2013

Mission critical facilities – more specifically data center operations – will continue to be strong economic drivers around the country; with expectations for data center construction to double in just five years, far exceeding levels prior to the financial crisis. So what is fuelling this trend? Consumers, technological advances and changes in the way organizations conduct their business may all be driving this need. And communities may provide the environment where data centers can thrive. And while communities and economic developers may have once been slow to respond to this rising need, they are quickly catching up.

The value of a data center to a community: Data center projects provide communities with fiscal benefits and opportunities for economic diversification:

- Capital Investment: While it's true that a data center may not yield a significant number of new full time jobs, these projects are capital intensive, infusing millions of dollars into the local community and creating potentially hundreds of construction positions. They also create ripple effects, drawing in ancillary businesses and vendors that support and maintain data center facilities.
- Revenue generators: A recent 150,000 sq ft data center project in the Northeast generated $100 million in capital investment and created 25 high paying permanent jobs as well as 5000+ construction jobs. In assessing the larger economic benefit, this project resulted in $3.4 million in income tax, $4.1 million in sales tax and over $11 million in utility tax. In addition, the facility is expected to purchase millions of dollars of equipment and services annually, generating over $30 million in sales tax revenue over the 20 year life of the project.
- New Industry: Data centers can represent more than just jobs or capital investment, they can also mark a tangible sign that the community is broadening its industry base, transitioning into a new digital economy, and illustrating credibility and viability of the community's economic conditions.

David Chernicoff for Five Nines: The Next Gen Datacenter: February 2013

ViaWest, who opened their latest facility in North Las Vegas two weeks ago, has certainly created a datacenter that stands out in a colo market filled with competitors searching for a competitive edge. Their new Lone Mountain Data Center is an Uptime Institute Tier 4 certified design, a level that has not previously been achieved by a colo facility and something that is certain to be a differentiator in the industry.

With 74,000 sq ft of raised floor space, LEED, Energy Star, and Green Globe certifications, ViaWest has pulled out all the design stops in building their flagship facility. From the perspective of the datacenter industry, the new datacenter facility is a excellent example of datacenter state-of-the-art and an impressive accomplishment.

But is that a reason for the City of North Las Vegas to see it as a turning point for a community that has been mired in the economic doldrums for a very long time?

North Las Vegas has seen a few other businesses over that last few years that opened to major fanfare and flared out and died quickly, leaving the city in no better economic shape. The highest profile of these businesses, the ill-fated Amonix solar panel manufacturer, brought a significant number of jobs and attention; attention that proved to be detrimental when the operation collapsed in 2011, taking the jobs and area investment with it.

The ViaWest datacenter is certainly a low-risk operation, in terms of concerns over the viability of the project. ViaWest is a well-established datacenter provider and their decision to build a flagship facility means that the datacenter isn't going anywhere anytime soon.

But the nature of the datacenter business is that it doesn't bring long-term large scale economic prosperity to areas where one off datacenters are built. Even if other datacenter providers choose to build in the same area, as we are seeing in Oregon and in North Carolina, the overall impact on the local economy, in terms of jobs and related business, once the datacenter facilities are completed and operational, is usually pretty minimal.

North Las Vegas will be able to point to the ViaWest facility as a business that has chosen to be in their city, but to expect ongoing economic benefit seems to be an unrealistic choice. While it is true that some number of people will relocate to the area to work in the facility, there is no compelling reason for them to choose to live in the same city. The nature of the valley is such that people are more likely to put quality of life choices ahead of proximity to the office when choosing to relocate themselves and their families.

Hopefully North Las Vegas will be realistic about what the ViaWest facility means to their city.

From: The Impact of Data Centers on Local Economies: 2012

Whenever word gets out that an organization is planning a new data center, there's always a whole plethora of government officials trying to convince that organization that their region is the best location. Tax breaks, energy incentives, real estate discounts…anything to get the data center in their city or state. For the most part, operators are glad to accept such gifts – after all, the cost of operation isn't exactly negligible. But what about the reason these incentives are being offered? Exactly why do these governmental organizations want a data center in their area? It's obvious that they benefit the economy, somehow – but in exactly what way?

First and foremost, there's job creation – a data center has a phenomenal impact on the job market in whatever region it's constructed, although not for the reasons one might expect. Even the largest facility doesn't require a terribly large staff to operate it – at most, several hundred or so employees will suffice. Where the impact lies, then, isn't in the people the data center employs, but the jobs its presence creates. The facility itself, notes Gigaom, is "but one element of a collaborative organization that includes research & development, marketing, sales, service, and support…a few thousand on-site employees could help a company employ tens of thousands more offering the services of that data center." Not only that, there are part-time employees, temporary workers, consultants, contractors, suppliers, manufacturers…you get the idea.

These jobs, in turn, generate a considerable chunk of income, which ends up creating even more jobs as a result. After all, each employee is a living, breathing person, and many of them have families to care for – they're going to need access to the same goods and services as the rest of us. Food, clothing, entertainment, construction, lawyers…If those services don't already exist in the region where the data center's situated, they'll eventually make their way there out of necessity. Furthermore, each of the men and women who provide these services will, in turn, require access to services of their own.

Factor in that most data center employees are fairly well-paid and thus have a higher propensity for consumption, and you've got what's essentially guaranteed growth in the economy of whatever region a data center happens to be. UC Berkeley Professor Enrico Moretti says that jobs such as these are "innovation jobs;" with each individual position generating five additional job openings. That's an impressive number, particularly given today's sluggish job market.

We also shouldn't neglect the fact that many of these data centers are colocation facilities which are utilized by organizations from virtually every field and industry, all of which employ their own staff. This, in turn, translates to additional job creation, both within the region and without.

Last, but not least, there's the money the data center organization is expending on utilities. In most cases, this is going back to the government (or, at the very least, utility organizations) in some way, shape or form. This, combined with the immense potential of data centers where job creation is concerned, makes them an attractive prospect indeed.

From DataCenter Dynamics: May 2014

Luleå Business and Economic Development was formed in 1997 to foster growth in the private sector. It is 51% owned by private companies and 49% by the Luleå municipality.

After realizing the potential of the region's infrastructure – connectivity and power set up to service the mining industry – it set up an organization called the Node Pole with the municipalities of Boden and Pitea in the Norrbotten county, which sits east of the Gulf of Bothnia. Node Pole is really a data center site developer.

Fredrik Kallioniemi is the VP of business development for the Node Pole. He has founded several IT companies himself and has worked with TeliaSonera, the main fiber carrier for Sweden. Kallioniemi says the Node Pole's aim is to make building data centers in the region as painless as possible.

"We have sites set up already that we have complete control over so that way when we get clients we allow them to be ready to go to market as fast as they can. We have the land permissions clients need, building and generator permits ready to go and we can have 40MW connected at a site with all the contractors required within six months of an order. We have companies such as Cisco, Schneider Electric, Siemens, ABB, Skanska, NCC, Bravida and construction companies ready to act," Kallioniemi says.

"We do applications in our own name then transfer them to the operator to fast track the process. We need to do this if we want to attract colo companies, which we think will bring a higher number of jobs to the region. Large internet companies like Facebook can afford to invest in doing a lot of this themselves and they already have blueprints and technology partners they prefer to work with."

He says the Node Pole is now in the final stage of some data center deals and Sweden is looking like a strong contender in both. "We are also being considered as one of the top three choices for another data center. Our work with these providers started about a year ago. Together they make up about 160MW of data center capacity. We also have another potential 200MW on the books," Kallioniemi says.

Facebook announcing its second build has helped. He says as a result the Node Pole is meeting more companies than it has ever dealt with. "They see Facebook is investing billions of dollars, so it must have done its homework. This will lead to continued sales," Kallioniemi says.

"What companies like is that we have sites located close to our hydropower facilities. We have one site in Boden which is only 600m from the hydropower station – you can put a cable in directly to it if you need to bring in 150MW."

It is an interesting approach but one that is paying off for this region in Northern Sweden. When I visited hotels (which there are many of) were in demand and restaurants – once few and far between – were not in short supply. The town's universities are also increasingly catering to more technical oriented subjects – even Facebook is offering some programs for local students.

Sweden is not the only Nordic country taking such initiatives to such extremes. Iceland's municipal governments have also bought land that comes with prearranged permissions for new data center builds. It is part of a new Nordic approach to attracting data center investment and in many cases to find new ways of creating growth by harnessing power sources (in Iceland's case geothermal) that are native to the country.

From Gigaom: October 2012

Data Centers have come under attack as terminally wasteful and "dirty" enterprises that offer little in the way of jobs. Joe Weinman, senior VP at Telx, disputes that, and says in fact they indirectly employee countless thousands across many industries.

The U.S. presidential election is now only a week away, and if there is one thing that this election is about, it's jobs. The tech world has had its own running debate about jobs—one focused on the question of just how much large-scale data centers contribute to employment and the economy. After all, not only has the New York Times bemoaned energy use by data centers —using an analysis I've argued misses the bigger picture —but it's also claimed that although data centers may cost hundred of millions of dollars, they "don't bring in very many jobs [since it] takes relatively few people" to run them. It is true that today's data centers don't require hordes of on-site staff, but that's ultimately an incomplete way to look at their impact on employment and the broader economy.

One might calculate the jobs impact of data centers by considering a company that uses its data centers to offer search, mail, video, apps, compute, storage, or other services over the Internet. A large data center might have from 100 to as many as 300 on-site employees. And a large company might have a dozen such data centers, or perhaps a few more, which works out to a couple of thousand jobs. Good, but not earth shattering in today's economy.

Such a simplistic calculation misses the larger point, however. Although the data centers are but one element of a collaborative organization that includes research & development, marketing, sales, service, and support, those couple of thousand on-site positions help such a company to employ tens of thousands more on a full-time basis offering the services delivered from those data centers, even after adjusting for employees in non-services divisions. Eliminate the data centers and there goes the service delivery; no services, no revenue; no revenue, no jobs. To put it another way, data centers are the physical embodiment of a digital services business that employs many more people than the on-site staff.

Even that argument doesn't tell the whole story. After all, such companies also have part-time employees, and hire temps, consultants, general contractors, and so forth. Procured components or systems such as chips and storage must be designed, manufactured, distributed, and supported, creating more jobs upstream in the supply chain.

The income from those tens of thousands of jobs also serves to create even more jobs. Presumably, virtually every employed worker pays part of his or her salary to pay taxes and thus employ federal, state, and local government workers or drive stimulus projects that employ still other workers in the private sector. And, most employees buy clothes, order lattes, pay for utilities, and so on.

Economists refer to the marginal propensity to consume: the percentage of an additional dollar of disposable income that people will spend, thus creating other manufacturing or service jobs. For example, someone who is deeply in debt and earning minimum wage may have a low marginal propensity to consume, paying down debt rather than rushing out to buy goods and services.

But, in the realm of high tech and data centers, UC Berkeley economics professor Enrico Moretti argues that so-called innovation jobs have a substantial multiplier effect. He calculates that each job in an innovation industry creates five additional jobs indirectly. A high-tech employee might use part of his or her income to retain a lawyer, who in turn engages an architect, who hires a landscaper, who patronizes a restaurant, and this process continues, ad infinitum. I would argue that it may not be innovation per se that creates the high multiplier, but rather that innovation and high technology jobs (as well as jobs in other professional disciplines, writing bestselling novels, professional sports, etc.) are likely to offer pay higher than minimum wage, and therefore as higher-paying jobs, correlate to a higher marginal propensity to consume, and thus a greater multiplier effect. According to the Bureau of Labor Statistics, the average hourly pay in the "Data Processing, Hosting, and Related Services" subsector is more than four times the federal minimum wage.

Consequently, if we are assessing job creation, we shouldn't just be looking at how many people happen to be walking down the aisles of data centers at a given moment, but the total employment impact—full-time, part-time, and indirect—of high-tech firms whose entire service portfolio is delivered via those data centers. In addition to those firms, in today's increasingly competitive economy, it is hard to find a company in other sectors, like hospitality, healthcare, petrochemicals, and transportation, among others, that doesn't in some way benefit from IT either for basic table stakes (say, reservation systems, patient records, logistics, customer relationship management) or to achieve some sort of competitive advantage: think better movie recommendations, more realistic computer graphics animation, faster equities trading, richer customer experiences. This IT, whether delivered through enterprise data centers, outsourcing or managed or cloud services, can help create or preserve jobs as well. Then, there are the pure-play companies in the multi-tenant data center and interconnection space (such as my employer, Telx) which employ not just on-site data center staff, but sales, support, operations, product management, and so forth.

If a firm were a person, one might argue that the data center is its brain. The human brain only weighs an average of three pounds, and thus accounts for only a few percent of body weight, yet uses 20 percent of the body's oxygen and 25 percent of its glucose. It's tempting to complain about energy use or to argue that something that only accounts for a few percent doesn't play much of a role, but this is hardly the case. Similarly, rather than considering only the few percent of a company's staff that is employed in a data center, understanding the big picture requires considering the enormous multiplier effect that a company's brain—its data center(s)—has on the whole corporation. In the example discussed, a couple of thousand jobs enable hundreds of thousands of others.

As the world increasingly exploits information technology for innovative services and competitive advantage, the data center is playing a rapidly expanding role in job creation and preservation and the health and recovery of the broader economy.

II Electrical power sources

Primary hydroelectric power sources

EXISTING YUKON ENERGY FACILITIES	Capacity or Type	Reference
Aishikik Hydro Facility	37 MW	http://www.yukonenergy.ca/energy-in-yukon/our-projects-facilities/hydro-facilities/aishihik-hydro-facility/what-is-its-capacity/
Mayo Hydro Facilities	15 MW	http://www.yukonenergy.ca/energy-in-yukon/our-projects-facilities/hydro-facilities/mayo-hydro-facilities/what-is-its-capacity/
Whitehorse Hydro Facility	40 MW Summer 25 MW Winter	http://www.yukonenergy.ca/energy-in-yukon/our-projects-facilities/hydro-facilities/whitehorse-hydro-facility/what-is-its-capacity/
Multiple New Hydro projects	Hoole potentially 70MW West Creek 25 MW 5 MW from other potential sources	http://www.yukonenergy.ca/energy-in-yukon/our-projects-facilities/new-hydro/
Backup sources	Diesel Wind (minor) Liquid Natural Gas	http://www.yukonenergy.ca/energy-in-yukon/our-projects-facilities/back-up-electricity/diesel-facilities/

Back-up sources of electricity

Back-up generating facilities using various sources (or combinations) of energy are available and may be configured to optimize performance factors for the site[52] [53]. Mobile trailer-mounted units are available providing 2 MW or more each[54].

[52] http://www.tomsitpro.com/articles/disasterrecovery-datacenter-it_facilities-generator-electricity,2-540-2.html
[53] http://www.generac.com/for-business/business-standby-products/bifuel-generators
[54] http://www.generac.com/all-products/generators/business-standby-generators#?cat=46&cat=-248&cat=168

Alternate power sources

Yukon Energy is developing an LNG plant to replace aging diesel generators that are used currently as a backup electricity source.[55] Other Data Centre sites, either existing or in development, are using LNG as a means of electricity generation, including Colorado[56] and Manhattan[57].

Wind and solar power are not viable options. Winds are not sufficiently consistent and solar power varies with the time of day and amount of overcast. They are not suitable as either a primary or back up supply of energy for a Data Centre. Further, the power output of wind and solar generating facilities is measured in kilowatts; Data Centres require megawatts.

Without a maritime coast line except in the Arctic, wave power is not an option for Yukon.

There are discussions regarding natural gas pipelines being developed in 'nearby' areas. These plans have received mixed approvals from Governments due to economic, environmental and political concerns[58]. Such discussions include the Alaska Highway pipeline, with some implementations suggesting the placement of pipelines through Whitehorse itself[59]. The Mackenzie Pipeline is also under discussion; this would go to Fort Simpson and then to Alberta. The economics of fracking are making the Beaufort Sea pipeline less likely[6061]

55 Article re: Yukon Energy getting approval for LNG plan
56 http://blogs.wsj.com/cio/2013/10/14/a-data-center-without-backup-generators-gets-green-light/
http://www.enterprisetech.com/2013/10/15/niobrara-opens-massive-data-center-home-range/
57 http://www.informationweek.com/modern-manhattan-data-centers-secret-gas-turbines/d/d-id/1106745?
58 http://yukon-news.com/news/feds-dump-47m-down-alaska-highway-pipeline-pit
59 http://en.wikipedia.org/wiki/Alaska_gas_pipeline
60 http://en.wikipedia.org/wiki/Mackenzie_Valley_Pipeline
61 http://www.mackenziegasproject.com/

III Incentives

The following are just a few of the examples of such tax incentives as offered by various jurisdictions at the time that this report was written.

- **Virginia** uses multiple tax breaks and financial incentives to position itself as a location for data center operations. Such incentives include exemption of purchases from sales tax, or use tax on equipment central do data center operations.[62]

  Lower property tax rates for data centers is allowed by Senate Bill 1133. This bill "Creates a separate classification, for purposes of permitting localities to set a lower personal property tax rate, on computer equipment and peripherals used in a data center."[63]

  "The new measure offers an exemption from the Virginia Retail Sales and Use tax for computer equipment bought or leased between July 1, 2010 and June 30, 2020 for use in a data center. The facility must be located in Virginia, generate capital investment of at least $150 million and create at least 50 new jobs that pay one and one half times the prevailing average wage in the locality. Interested companies will need to sign a memorandum of understanding with the Virginia Economic Development Partnership (VEDP) detailing the spending and jobs associated with the project."[64]

  " RagingWire Data Centers, ... has signed a rare memorandum of understanding (MOU) with the Virginia Economic Development Partnership (VEDP) committing to $150 million in capital investment and the creation of 50 new jobs over the next five years. In consideration for this significant commitment, RagingWire and its customers will be eligible to receive a Virginia sales tax exemption for the purchase of computer equipment and other related data center infrastructure components."[65]

- RagingWire takes advantage of **California** incentives as well. "... the company's California data center facilities in Sacramento are located in an Enterprise Tax Zone, as defined by the California Trade and Commerce agency. The Sacramento Enterprise Tax Zone designation allows RagingWire and its tenants to take advantage of a variety of incentives: hiring credits, sales/use tax credits, business expense deductions for depreciable equipment, 15-year net loss carryovers, net interest deductions for lenders, and state contract bid preferences."[66]

[62] http://www.datacenterknowledge.com/archives/2013/11/06/what-are-top-states-for-data-center-tax-breaks/
[63] http://lis.virginia.gov/cgi-bin/legp604.exe?131+sum+SB1133
[64] http://www.datacenterknowledge.com/archives/2009/05/13/virginia-passes-data-center-tax-incentives/
[65] http://www.ragingwire.com/news/virginia-sales-tax-exemption-for-data-center-customers
[66] http://www.ragingwire.com/news/virginia-sales-tax-exemption-for-data-center-customers

- **Texas** offers exemptions to qualifying data centers affecting the personal property taxes on anything deemed necessary and essential.[67]

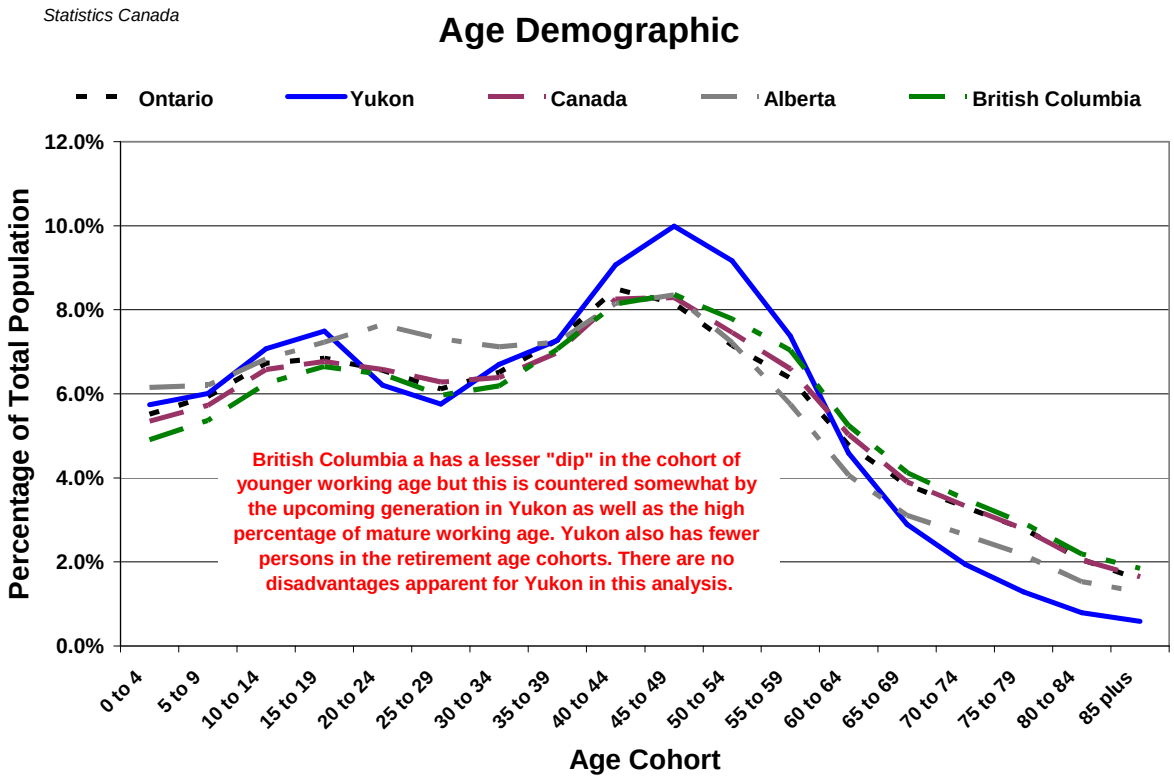
  Signed into law in June of 2013, "The bill .. exempt(s) from tax tangible personal property that is necessary and essential to the operation of a qualifying data center if the property is purchased for installation at, incorporation into, or in the case of electricity for use in, a qualifying data center if the tangible personal property is: electricity; an electrical system; a cooling system; an emergency generator; hardware or a distributed mainframe computer or server; a data storage device; network connectivity equipment; a rack, cabinet, and raised floor system; a peripheral component or system; software; a mechanical, electrical, or plumbing system necessary to operate the foregoing property; any other item of equipment or system necessary to operate any of the foregoing, including a fixture; and a component part of any of the foregoing."[68]
- **Nordic countries** are considering offering incentives of their own as a means of making their locales even more attractive to potential customers. "Data center construction in the Nordics has been on the upswing over the past few years. That part of the world is attractive for large data center builds primarily because of cold weather and abundant and relatively low-cost hydroelectric energy."[69]
- MSC Malaysia status multimedia companies operating in **MSC Malaysia Cybercities or Cybercentres** are eligible for the following incentives/facilities:
  - Pioneer Status with income tax exemption of 100% of the statutory income for a period of 10 years or Investment Tax Allowance of 100% on the qualifying capital expenditure incurred within a period of five years to be offset against 100% of statutory income for each year of assessment.[70]
  - Eligibility for R&D grants (for majority Malaysian-owned MSC Malaysia Status companies)[71]
  - Other benefits also include: Duty-free import of multimedia equipment, Intellectual property protection and a comprehensive framework of cyberlaws, Globally competitive telecommunication tariffs and services, Import duty, excise duty and sales tax exemption on machinery, equipment and materials.[72]

[67] http://www.datacenterknowledge.com/archives/2013/11/06/what-are-top-states-for-data-center-tax-breaks/
[68] http://openstates.org/tx/bills/83/HB1223/
[69] http://www.datacenterknowledge.com/archives/2014/05/23/sweden-considers-tax-cuts-lure-data-centers/
[70] http://www.ssic.com.my/Data_Centre_Potentials_in_Selangor_2012.pdf
[71] http://www.ssic.com.my/Data_Centre_Potentials_in_Selangor_2012.pdf
[72] http://www.ssic.com.my/Data_Centre_Potentials_in_Selangor_2012.pdf

IV Demographic analysis

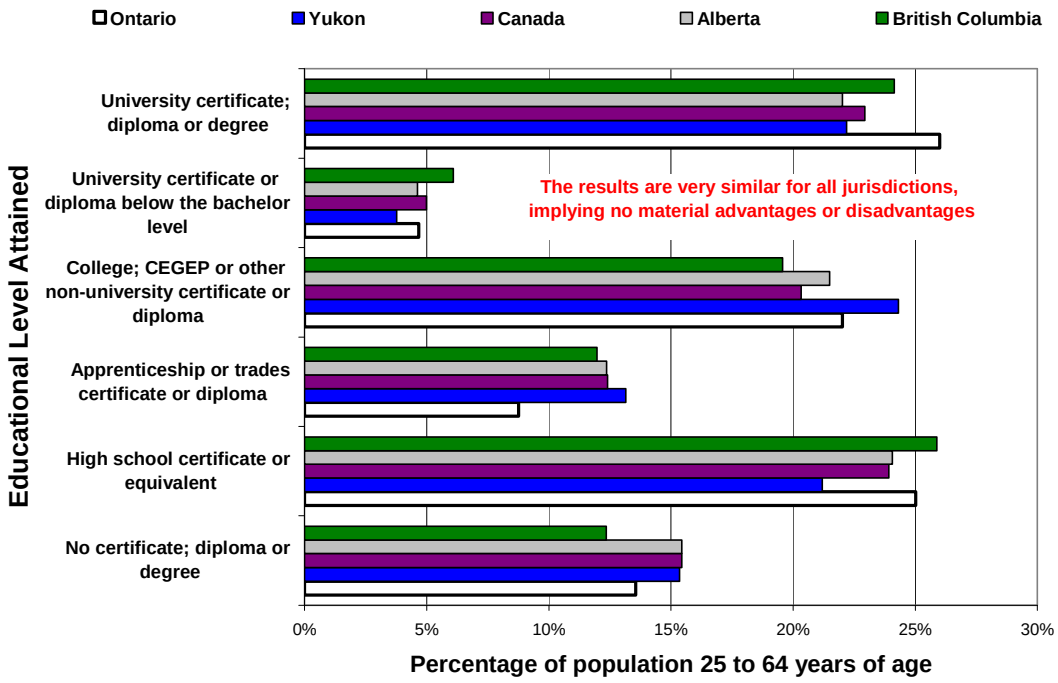
We routinely assess jurisdictions for key demographics that may influence economic development. The following are derived from Statistics Canada data. Such information is often accessed by potential investors when sifting through locations for a business and it is equally applicable here. Using a simple program developed by WCM, these comparisons take less than one minute per jurisdictions to perform. We have selected various comparative jurisdictions but any others in the Statistics Canada system may also be selected at the provincial and municipal levels. A brief WCM commentary is shown for each comparison performed.

Statistics Canada



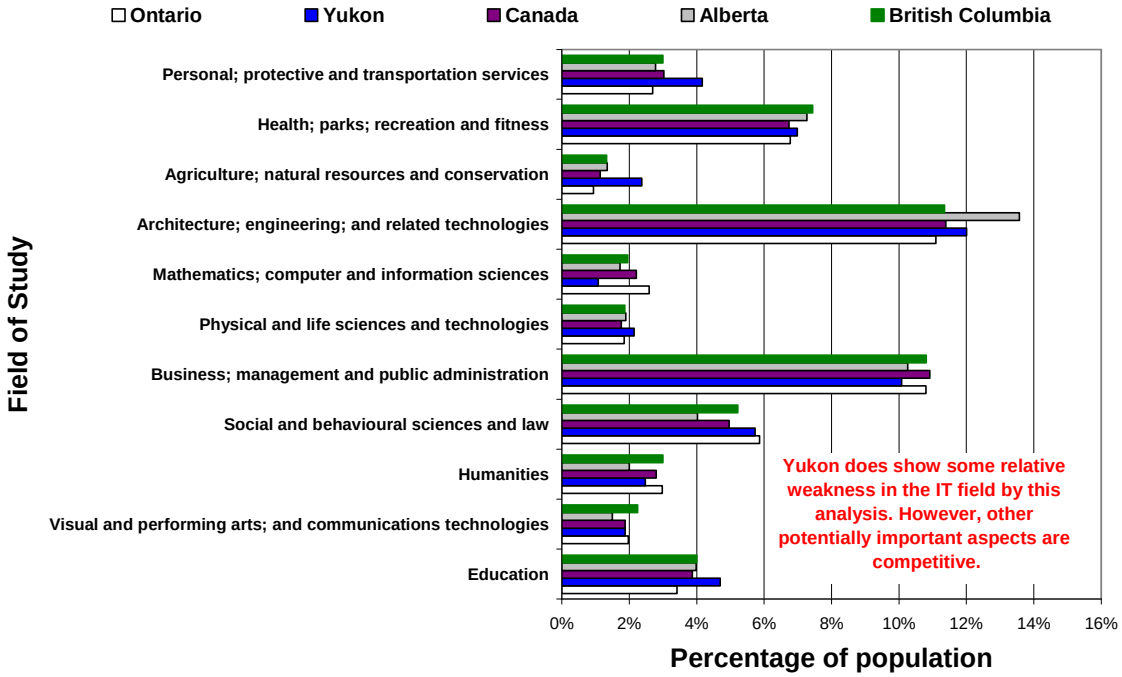
Statistics Canada

Educational Attainment

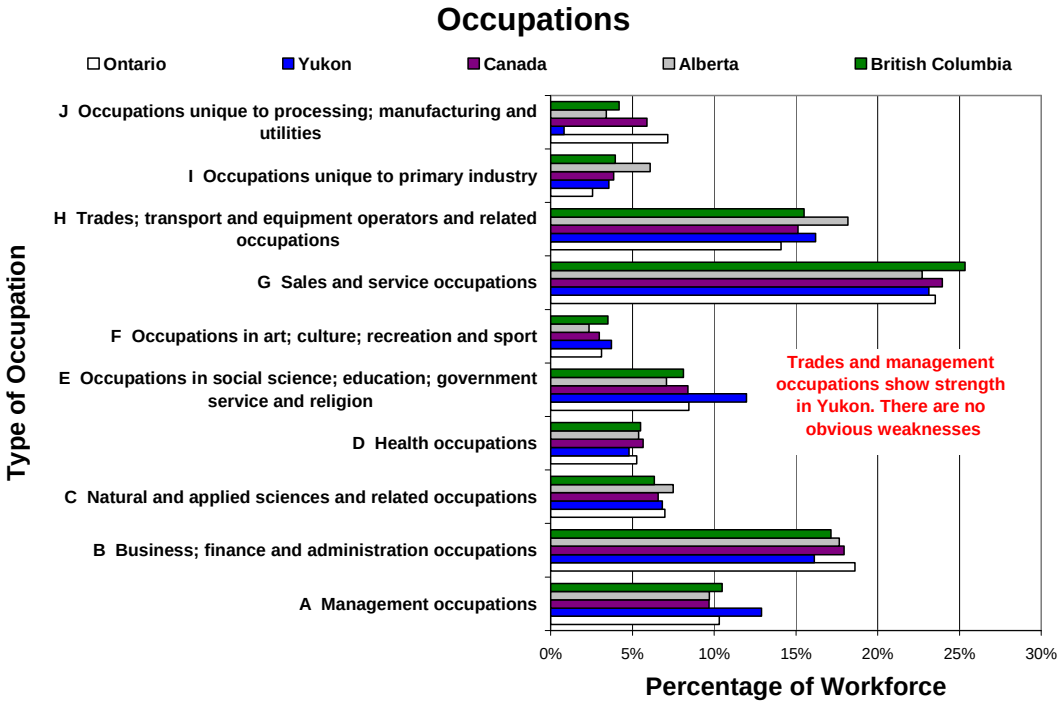


Statistics Canada

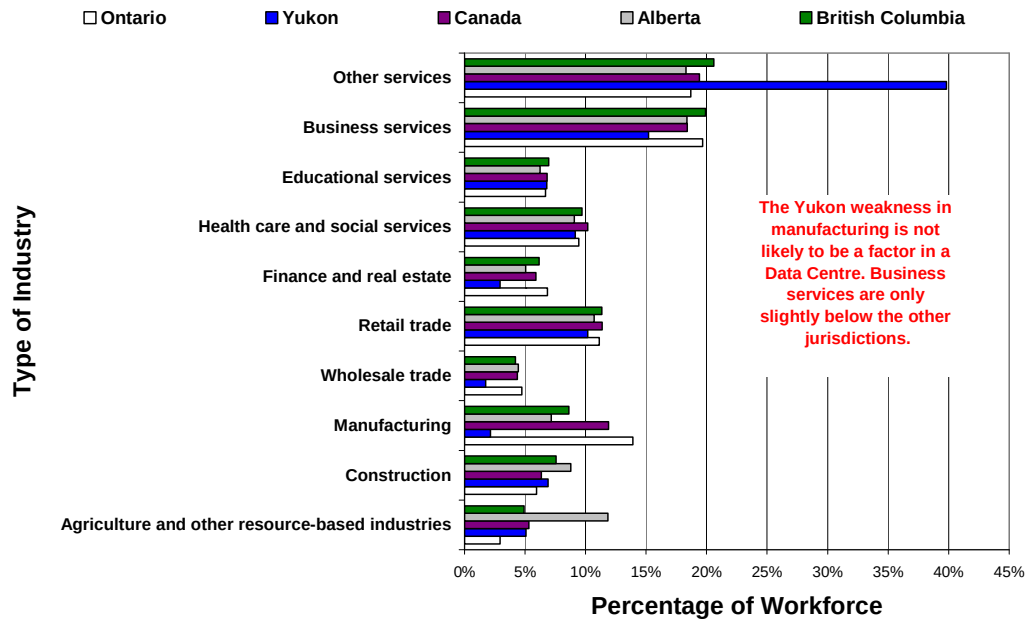
Major Field of Study



Statistics Canada



Statistics Canada



V Feasibility assessments

Overall characteristics of a feasibility study

There are fine descriptions of the methods to be used to conduct a feasibility study. We have drawn from just a few below and these have guided what is required for the ***pre***-feasibility review. The latter must respect the needs of the possible next step else it will not inform the validity of moving towards a formal feasibility study.

- A feasibility study is an evaluation and analysis of the potential of the proposed project which, in the most basis form, reduces to a benefit-cost analysis, with risk assessment inherent in the process.
- The process must be extensive and rationale, in order to provide comfort to the decision-makers, whether they elect to proceed or not.
- The SWOT: Feasibility must objectively and rationally uncover the strengths and weaknesses of the proposed project. Conclusions must be drawn, with a clear rationale these conclusions. Any "givens" must be enunciated clearly such that they may be challenged. It must also examine the opportunities and threats in the environment (business, physical and so on), the resources required to implement the project, and the prospects for success.
- Trends in all of the above must also be considered – a "future SWOT" or, as we call the entire process, a SWOT***T***.

Major elements of a feasibility review

Major areas that are often used for the feasibility assessment are as follows but the list is not exhaustive. There are variations and not all factors apply with equal weight to all projects:

- **Technical**
  - Is the project technically possible; that is, does the technology exist or must it be developed?
  - Data Centres require large amounts of "clean" (electrically) power on a very reliable basis; can this be provided?
  - What demands will this place on the external infrastructure and can these be met?
  - Are the human resources available, or that could be made available, to meet start-up and ongoing needs?

- **Legal**
  - Is the proposed project legal in the jurisdiction?
  - What are the key legal requirements? What Data Protection Acts must be taken into account?

- **Operational**
  - What is the optimum configuration to fulfil the needs?
  - Can this operational model be sustained and how?

- **Schedule**
  - Can the project be implemented within the timeframe necessary to achieve the intended goals of the project?
  - What are the best and worst case implementation schedules and to what degree will these affect the benefits and/or costs?

- **Resource conflicts**
  - Would the implementation of the project draw resources (financial and human) from other worthwhile projects?
  - What will be the impacts of these conflicts and how can they be resolved to minimize these impacts?

- **Environmental**
  - Impacts on the physical environment
  - The direct nature of these impacts
  - Possible reflected impacts on fauna and flora
  - Remedies

- **Cultural**
  - Are there cultural factors inherent in the community that may be impacted or which may adversely impact project success?
  - What are these and how may they be mitigated?

- **Financial**
  - Total estimated cost
  - Project financing, sources and cost of financing
  - Cash flow projections
  - Capital structure
  - Rate of return and/or rate of repayment of cash
  - Alternate uses of proposed structures and the recovery of cost there from
  - Sensitivity of financial performance to variations in project progress: cost, returns, resources and so on.

- **Demand (or market)**
  - This is usually the most crucial aspect of a feasibility analysis, since it is an area which is not under the direct control of the proponents or owners.
  - It is also the area in which the potential results can easily be inflated, causing an overly optimistic outcome.

- **Benefits (or returns)**

  Some possible returns may be anticipated for governments, amongst them:

  - The retention or increase in long-term employment to operate and maintain the facility. Given the nature of the Data Centre project, these are expected to be well-paying opportunities.
  - Additional federal, provincial and municipal tax revenues.
  - On a relatively short, one-time basis, construction jobs.
  - The potential to expand or attract related industries required to service the needs of the Data Centre, and the consequent gains in all respects.
  - The potential to expand or attract businesses that may benefit from proximity to a Data Centre, and the consequent gains in all respects.

In summary, the feasibility study should gather the information necessary to determine, with a rationale, in each case:

Practical feasibility – can the physical entity be realised? That is, are the technologies and capacities in place to implement the proposed concept and the location suitable for such construction?

Cost to implement – What is the cost to implement the project? The feasibility study would be required to identify all relevant costs in detail, with rationales. A sub-set of these considerations would be the risks that the costs will be higher, what factors may cause this and to what degree.

Benefits (returns) on the project investment – This is the major element to be determined through the feasibility study and it has a more speculative aspect than does cost. What are the benefits that may be accrued, to whom, the magnitude and the time frame over which these will occur. A sub-set of these considerations is the risk that the benefits will be lower and to what degree.

Seeking and remedying the red flags

No matter which aspect is being considered, a major task for each element under consideration is to determine what ***can go wrong*** and to put plans in place to address these potential road-blocks. Any potential road-blocks that cannot be addressed must be given very serious consideration before proceeding.

In the process of determining the nature of the road-blocks, it is vital to raise any and all issues, no matter if they seem to be almost irrelevant or inconsequential. Better to have considered and then set them aside, rather than simply dismissing them. This process can seem to be very "negative" (we keep raising problems!) but it results in a very confident outcome and one which will stand the scrutiny of others, most especially those who may be asked to invest in any future implementation.

Problems may be categorized as follows, downwards from those of least concern to most concern, in order, derived from well established Kepner-Tregoe methodologies:

Nature of the issue	***Action required in the implementation plan***
Potential issues raised but *confirmed as non-issues*	*To be noted as having been considered for future reference but no action is required*
Potential issues *which can be avoided*	*Action steps for avoidance to be identified*
Potential issues that cannot be avoided *but which can be prevented*	*Action steps for prevention to be identified*
Potential issues that cannot be prevented *but which can be sufficiently mitigated*	*Action steps for mitigation to be identified*
Potential irresolvable issues *(issues which cannot be avoided, prevented or sufficiently mitigated)*	*Above all, these are the key issues to be identified.* ***These must give "pause for thought" before the project is implemented.***