CHBE 484: SEEDS Term Paper

Green House Gas Emissions Associated with UBC Supply Management's Use of the Iron Mountain Storage Facility

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SUMMARY

In 2007 the government of British Columbia set out green house gas (GHG) emissions reduction targets for all institutions within the public sector; these targets are to be reached by 2010 and to be maintained for subsequent years. Additionally, the province has asserted that public institutions will have to become carbon neutral and attain net zero emissions by 2010. The University of British Columbia (UBC) is a public institution and therefore will fall under the carbon neutrality regulations established by the government. If UBC does not reach carbon neutrality in 2010 they will have to purchase carbon credits at a price of $25 dollars per tonne from the Pacific Carbon Trust.

Iron Mountain is an off-site storage facility that UBC uses in order to keep physical records; Iron Mountain also provides services that allow for electronic storage. The main objective of this project is to outline the opportunity for cost and emission savings which UBC Supply Management may attain by eliminating the paper storage process at Iron Mountain. UBC Supply Management sends approximately 80 boxes to Iron Mountain each year for storage, each box containing 3,000 sheets of papers; all of these records are already stored electronically therefore leading to a redundancy of storage and a waste of paper. Furthermore, all of the boxes that are sent to Iron Mountain are stored there for 7 years, however there is currently no procedure in place that ensure that the boxes are removed after 7 years, therefore creating an accumulation of boxes.

It was found that the total GHG emissions associated with UBC Supply Managements use of Iron Mountain are 104.05 tonnes of CO_2 equivalent. Of this 91.02 tonnes of CO_2 equivalent are associated with the physical storage of the paper documents within Iron Mountain, UBC is not directly responsible for these emissions however it is important to note that UBC is contribution to these emissions and should their use of the Iron Mountain storage facility be discontinued UBC would not be contributing to such a large amount of GHG emissions annually. Without including the emissions from storage the emissions associated with UBC Supply Managements use of the Iron Mountain storage facility are 13.03 tonnes of CO_2 equivalent per year, this includes emissions from paper, boxes, and transportation. Furthermore, as noted above the emissions due to paper cannot be included in this sum because these emissions have already been accounted for in UBC's total emissions inventory.

The total costs that are associated with UBC Supply Managements use of Iron Mountain is $5,839.04 dollars per year if the costs of paper are included, and $2,869.04 if the costs of paper are not included. Furthermore, come 2010 the cost of purchasing carbon credits from the Pacific Carbon Trust will be $325.80 dollars per year if the emissions from paper are included and $50.20 if the costs from paper are not included.

The majority of the emissions associated with the interactions between UBC Supply Management and Iron Mountain are associated with the physical storage of the paper once it arrives at Iron Mountain. The second largest emissions category is associated with the paper produced in order to be stored at Iron Mountain. The use of this paper, as well as the storage space, is unnecessary and redundant as all of the records are already stored electronically; these emissions could be avoided by UBC if the physical facility were not used. It is suggested that UBC Supply Management should discontinue their use of Iron Mountain as a physical storage location; this would have a total reduction in emissions of 104.5 tonnes of CO_2 equivalent per year which is a sum of the emissions from boxes, transportation, storage and paper.

Additionally, as noted there is no procedure in place to ensure that boxes are removed from the Iron Mountain storage facility. As can be seen in the analysis of one storage life cycle the annual storage emissions associated with storing 80 boxes, which is the number of boxes added per year, for one year is 10.33 tonnes of CO_2 equivalent. If the boxes are not removed after 7 years these emissions will continue and will accumulate as more boxes are added. It is recommended that, should the Iron Mountain storage facility continue to be used, there should be some procedure put in place to ensure that a box, or a set of boxes, is removed from storage after 7 years.

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BACKGROUND

In 2007 the government of British Columbia set out green house gas (GHG) emissions reduction targets for all institutions within the public sector; these targets are to be reached by 2010 and to be maintained for subsequent years. Additionally, the province has asserted that pertinent institutions will have to become carbon neutral and attain net zero emissions by 2010. The government of British Columbia will be the first government to have made and achieved such a commitment in North America.

The University of British Columbia (UBC) is a public institution and will fall under the carbon neutrality regulations established by the government. If UBC does not reach carbon neutrality in 2010 they will have to purchase carbon credits at a price of $25 dollars per tonne from the Pacific Carbon Trust. In order to achieve carbon neutrality UBC has set forth the UBC Climate Action Plan to reduce their GHG emissions by 2010.

The Social Ecological Economical Development Studies (SEEDS) program is one UBC initiative that is helping find opportunities for the reduction of GHG emissions. The SEEDS program involves students, staff and faculty working together to further sustainable practices at UBC. This project was initiated by staff at Supply Management who are interested in eliminating the duplication of records stored in Iron Mountain. Currently, both paper and electronic records are retained for a period of 7 years. A sister project in Sauder School of business is concurrently investigating the logistics associated with Supply Management storing records completely electronically and avoiding the duplication of paper record retention.

Iron Mountain is a storage facility which has been operational for 55 years in over 26 countries. Iron Mountain offers many services too safely and securely store records for businesses worldwide. They are able to help companies manage their storage by giving them access to their documents twenty four hours a day and seven days a week, delivering documents upon request, and providing a regular pick up schedule based on necessity. These are just to name a few of the services offered by Iron Mountain. UBC uses the Iron Mountain facility located in Coquitlam BC to store records; this record storage includes both paper storage and electronic storage.

According to the World Resources Institute (WRI) standard companies that have an economic relationship, such as UBC and Iron Mountain, will have to include the associated GHGs in their overall carbon emissions. This SEEDS project will analyze the total GHG emissions associated with the storage facility and will outline the GHG savings if Iron Mountain hard copy services were eliminated in favour of electronic storage. Furthermore, to add perspective the GHG emissions of UBC as a whole will not be examined, rather the emissions associated with one department, UBC's Supply Management department, will be used.

INTRODUCTION

UBC is a public institute and will have to attain carbon neutrality by the year 2010 as was set forth by the government of British Columbia. The objective of this SEEDS project is to calculate the GHG emissions associated with UBC's, more specifically UBC Supply Management's, use of the Iron Mountain records storage facility in order to store hard copies of their records. According to regulations set forth by UBC it is stated that Supply Management must keep all documents for a minimum of 7 years, after this minimum time restriction has been met the documents can be destroyed. It should be noted that although after 7 years the boxes can be destroyed there is no procedure in place insuring that the documents are destroyed therefore boxes are

frequently left in Iron Mountain for greater than 7 years, this creates an accumulation affect . Currently Supply Management stores all documents electronically, however due to older methods of document retention Supply Management also generates paper copies of all of their electronic documents; these duplicate documents are stored at Iron Mountain. It can be seen that this duplication is a redundant and inefficient process; therefore one of the main objectives of this project is to quantify the costs and GHG emissions associated with this redundancy in order to demonstrate the opportunity for cost savings for UBC.

This project will closely focus on UBC's Supply Management department in order to analyze their contribution to the GHG emissions and costs associated with the use of the Iron Mountain storage facility. The proposed calculation will look at many GHG source such as transportation, paper, boxes and storage facility use. The paper will further more calculate the total cost of using the facility as well as the cost of the carbon credits that UBC will have to purchase in 2010 from the Pacific Carbon Trust unless this process has been changed.

METHODOLOGY

In this section the methodology used to analyse the green house gas (GHG) emissions associated with the interactions between UBC Supply Management and UBC's core physical storage facility, Iron Mountain will be outlined. The methodology includes the system boundary which define the GHG emissions, a description of the method of calculation used (the emissions factor method), as well as a detailed description of the emissions categories which will be employed while analysing the GHG emissions.

Throughout the report emissions will be calculated on an annual basis according to typical yearly interactions between UBC supply management and Iron Mountain, it should however be noted, as stated in the introduction, that records are kept at Iron Mountain for a minimum of seven years. Additionally, although all emissions will initially be calculated individually according to their respective emissions factors all of these emissions will be summed in the end. Furthermore, a monetary value will be associated with the emissions as well as with the interactions between UBC Supply Management and Iron Mountain. Finally, the emissions of 80 boxes over a 7 year storage lifecycle will be examined on a yearly and cumulative basis.

BOUNDARIES

The boundaries of this report will encompass the activities of UBC Supply Management and Iron Mountain as they relate to one another. This will therefore include production of physical documentation to be stored, transportation of documentation, and storage of documentation, as well as all things relating to these categories. The method employed to determine the boundaries is in compliance with the method set out by UBC in its overall GHG Inventory which follows the World Resources Institute (WRI) standard. This method is the equity share approach for establishing operational boundaries which states "a company accounts for GHG emissions from operations according to its share of equity in the operation. The equity share reflects economic interest..." (WRI/WBCSD, 2004). Because the storage at Iron Mountain is in the economic interest of UBC all of the GHG emissions will be included as stated above.

EMISSIONS FACTOR METHOD

The GHG emissions in this report are all calculated according to the emissions factors method. An emissions factor can be said to be the average emission rate of GHG emissions for a given source, using the emissions factor method a standard emissions factor is multiplied by a physical value associated with the GHG

producing activity to give a CO_2 equivalent production of GHG. The term CO_2 equivalent is used in order to convey that the GHG emissions come not only from CO_2; the factors in this report also include GHG emissions associated with CH_4 and N_2O.

In order to comply with the method set out by UBC, used in the overall UBC GHG inventory, the same emissions factors have been used in this report as were used in the overall UBC GHG inventory calculations. This will also make the calculated numbers more relevant to UBC.

TRANSPORTATION

In order to quantify the GHG emissions associated with the transportation of records to and from Iron Mountain it was initially necessary to determine the distance from UBC Supply Management to Iron Mountain's storage facility. The distance to drive from UBC Supply Management to Iron Mountain was obtained by mapping the driving route both on Mapquest (Mapquest, 2009) and on Google maps (Google maps, 2009); the average of the two distances was taken in order to add accuracy. The estimated total distance from Iron Mountain to UBC Supply Management was found to be 35.31 km. Additionally, this distance was doubled in order to account for the fact that the Iron Mountain vehicle much first arrive at UBC and then return to Iron Mountain.

Subsequently, from communications with Iron Mountain it was found that the type of vehicle driven to UBC is a cargo van; the average fuel efficiency of a cargo vans was determined to be 6.59 km/L (US Department of Energy, 2009).

Next, the number of trips made annually from UBC to Iron Mountain was obtained from UBC Supply Management records. It was determined that on average one trip was made per week, with the addition of 17 records call-backs per year; this is equivalent to 73 trips made from UBC Supply Management to Iron Mountain annually.

Finally, the emission factor associated with driving a vehicle that runs on gasoline was obtained from the Canadian Standards Association (CSA, 2007); this emission factor was found to be 2.443kg CO_2 eq. /L.

BOXES

The boxes that are used to send and store paper in the Iron Mountain Facility are standard 25L cardboard boxes with a mass of 0.42kg; approximately 80 of these boxes sent to Iron Mountain annually. The emissions factor that was used in order to quantify the GHG's emitted by producing cardboard box was obtained from the Environmental Defence Fund website (Fund, 1995), this emissions factor is for non-recycled paper and was found to be 2.84 Tonne CO_2 eq./Tonne of paper. It is recognised that this factor may introduce some error when being used for a cardboard box, however this factor will be used in order to comply with the UBC standard and to ensure relevance.

PAPER

The standard paper used to print at UBC, more specifically at UBC supply management, is 30% recycled paper that has a mass of 18.16kg per 1000 sheets. It is estimated that there are 240,000 sheets annually printed in Supply Management in order to be stored at Iron Mountain, this is known because every Iron Mountain box contains 3,000 sheets of paper, and as stated above 80 boxes are sent to Iron Mountain from Supply Management annually. The emissions factor relating the amount of 30% recycled paper to the amount of GHG

emissions was obtained from the Environmental Defence Fund website (Fund, 1995) and was found to be 2.53 Tonne CO_2 eq./Tonne of paper.

It should be noted that although the emissions associated with printing the physical documents to be stored at Iron Mountain will be calculated they will not be added into the final sum of GHG emissions due to the fact that UBC has already included this in the overall UBC GHG inventory. If these emissions were added into the sum of GHG emissions again they would be being duplicated.

STORAGE

In order to quantify the GHG emissions resulting from the storage of the documents at the Iron Mountain facility it was necessary to determine the electricity used by Iron Mountain in order to run the facility. In order to do this the results of the Commercial Buildings Energy Consumption Survey (Energy Information Administration, 2003) conducted by the Energy Information Administration were used. This survey presented the average electricity use by a storage facility as 72kwh; from this figure the annual electricity consumption was determined. An emissions factor of 84 tonne CO_2 eq./GWh (Hanova et al., 2007) was found for electricity in British Columbia, this factor includes electricity generated within British Columbia as well as electricity imported from outside British Columbia. Furthermore, because UBC supply management occupies only 620.40 ft^3 of the total Iron Mountain storage space of 1,300,000ft^3, or 0.048% of the total storage volume the GHG emissions found for the whole facility were multiplied by 0.048%, this ensures that the emissions associated with just the UBC Supply Management and not the whole building are taken into account.

It should be noted that although the GHG emissions arising from the actual storage at the Iron Mountain facility will be calculated, UBC is not responsible for these emissions; therefore, they should not be added into UBCs total carbon inventory and UBC will not need to purchase carbon credits in order to offset these emissions. That being said in the results and discussion section, the cost of the carbon credits that would be associated with the actual storage at Iron Mountain will not be included however the GHG emissions will be included.

RESULTS AND DISCUSSION

The main objective of this SEEDs paper is to determine the total emissions associated with UBC Supply Management's use of the Iron Mountain storage facility. The sources of emissions which will be analyzed include transportation, boxes, paper and storage emissions. The total cost incurred due to the use of the Iron Mountain facility as well as the total cost incurred from CO_2 emissions will be calculated to determine the overall cost contribution to UBC.

TRANSPORTATION

As stated in the methodology portion of this report an emission factor of 2.443 kg/L is used for gasoline fuel vehicles, this emissions factor was obtained from the Canadian Standards Association (CSA, 2007). Using this emissions factor, a fuel efficiency of 6.59km/L, and a total travel distance of 35.31 km it is determined that emissions of 26.18 kg CO_2 equivalent are generated per trip from UBC Supply Management to the Iron Mountain storage facility and back. Taking into account that there are approximately 73 trips from Iron Mountain per year, the annual GHG emission is calculated to be 1.91 tonnes of CO_2 equivalent per year. This figure corresponds to 1.84% of the total GHG emissions associated with the interaction between UBC Supply Management and Iron Mountain; these total emissions include emissions from paper, boxes, transportation and

storage. As the cost of CO_2 emissions in 2010 will be $25 dollars per tonne, the cost of annual CO_2 emission due to transportation between UBC and Iron Mountain is calculated to be $47.80 dollars.

The contract between Iron Mountain and UBC has established a trip charge rate of $15.98 dollars per trip which is equal to $895 dollars annually assuming the truck travels only 56 times during a year. Moreover, an average of 17 boxes is recalled to UBC Supply Management per year, which corresponds to a delivery cost of 238 dollar per year. Therefore, the total annual cost of transportation is 1,181 dollars; this figure corresponds to 17.34% of the total annual costs of the interactions between UBC Supply Management and Iron Mountain. The results are tabulated in Table 2 of Appendix B and all the detailed calculations are provided in Appendix D of this report.

BOXES

Using an emissions factor of 2.84 Tonne CO_2 eq./Tonne of paper as retrieved from the Environmental Defence Fund website (Fund, 1995) and knowing the mass of a box, it was determined that the GHG emissions per box is 1.19 kg of CO_2 equivalent per box. Taking into account that UBC Supply Management sends 80 boxes annually to Iron Mountain, the annual CO_2 emission associated with the boxes used for shipping and storage is found to be 95.4 kg of CO_2 equivalent per year. This represents 0.09% of the total GHG emissions due to transportation, boxes, storage, and paper. The cost of annual CO_2 emission in 2010 will be $2.39 dollars per year. The cost of each box is reported from Iron Mountain to be $2.50 dollars; therefore the annual cost of boxes is equal to $200 dollars. Additionally there are 98 boxes per year shredded or retrieved by Iron Mountain; this costs $222 plus an additional $209 dollars for retrievals. The total final cost associated with boxes adds up to $634 dollars per year, this cost represent 9.30% of the total annual costs incurred during the interactions between UBC Supply Management and Iron Mountain. The results are tabulated in Table 3 of Appendix B; furthermore, detailed sample calculations are provided in Appendix D of this report.

PAPER

Using an emissions factor of 2.53 tonne CO_2 equivalent per tonne of paper (Fund, 1995), the total emissions produced from paper are calculated to be 11,027 kg CO_2 equivalent per year which makes up 10.60% of the total emissions of transportation, box, storage, and paper.

The total costs associated with the paper stored at Iron Mountain are a combination of the paper and ink costs as well as the future emission costs of $25 dollar per tonne. The price of printing each sheet of paper is $0.011 dollars per copy which includes both ink and paper costs. The total annual cost of printing paper by UBC Supply Management accumulates to 396 dollars per year. The total cost of CO_2 equivalent in one year accumulates to $276 dollars per year. When the annual least cost is added to this sum a total paper cost accumulates to $ 2,796 dollars per year. The total cost of paper used for storage at Iron Mountain represents 41.05% of the total annual costs associated with the interactions between UBC Supply Management and Iron Mountain due to a combination of box, paper, storage, and transportation. The total emissions are tabulated in Table 4 in Appendix B and calculations are outlined in Appendix D.

STORAGE

It is important to note that the GHG emissions produced by using the storage facility are not incorporated into the UBC total emissions inventory; however, there are significant GHG emissions produced by

the use of the storage facility. The total emissions due to UBC Supply Management using the storage facility accumulates to 91.02 tonne CO_2 equivalent per year. Out of all the emissions categories storage is by far the largest emission source; it produces 87.47 % of the total emissions. Although UBC is not responsible for purchasing these carbon credits the price associated with the GHG emissions would be $2,275.55 dollars per year. UBC can reduce their contribution to these emissions by eliminating the use of the storage facility. The cost of using the Iron Mountain storage facility accumulates to $2,200 dollars per year which makes up 32.30% of the total annual costs incurred during the interactions between UBC Supply Management and Iron Mountain. The total emissions are tabulated in Table 5 in Appendix B and calculations are outlined in Appendix D

TOTAL EMISSIONS AND COST

In 2010 when UBC will have to attain carbon neutrality to meet the new regulations concerning GHG emissions put in place by the BC government, UBC will have to purchase carbon credits from the Pacific Carbon Trust at the price of $25 dollars per tonne of CO_2 equivalent emitted. The total emissions associated with UBC Supply Management's use of the Iron Mountain storage facility accumulates to 104.06 tonne CO_2 equivalent per year, this figure includes emissions associated with boxes, paper, storage, and transportation. From the above mentioned total the emissions due to paper use equate to 11.03 tonne CO_2 equivalent per year which is equivalent to 10.60 % of the emissions as described earlier. This emissions contribution cannot be included in the total emissions calculation associated with the interactions between UBC Supply Management and Iron Mountain because this number has already been accounted for by UBC's total emissions. However, for the purposes of this project it can be mentioned that UBC Supply Management's use of paper to store records at Iron Mountain contributes 11.03 tonne CO_2 equivalent per year which is equal to $276 dollars per year in carbon credits. Furthermore, the emissions that are associated with the physical storage of the documents in the Iron Mountain facility accumulate to 91.02 tonne CO_2 equivalent per year which is equivalent to 87.47% of the emissions as described earlier. UBC is not responsible for these emissions however it is important to recognize that UBC is making a contribution to these emissions simply by using the Iron Mountain Facility. The total emissions associated with the use of Iron Mountain from just boxes and transportation accumulates to 2.01 tonne CO_2 equivalent per year which equates to $50.17 dollars per year in purchased carbon credits. Figure 1 below outlines the CO_2 emissions per emissions category associated with UBC Supply Managements use of the Iron Mountain storage facility.

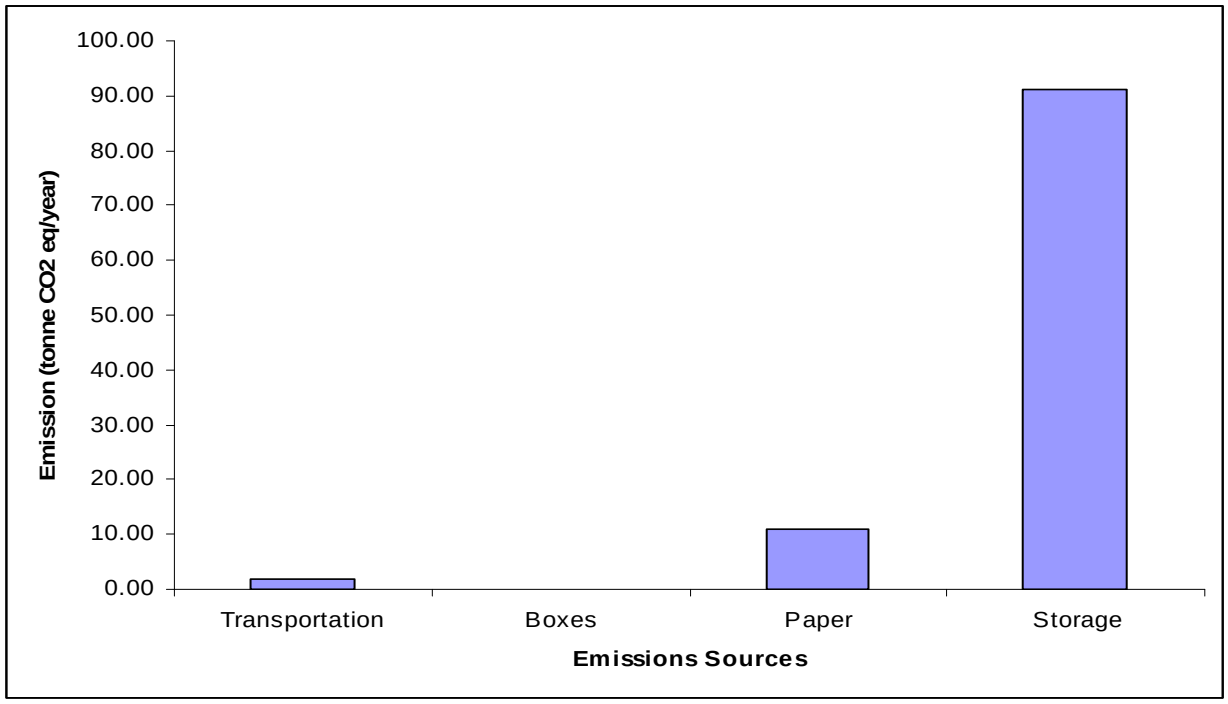

Figure 1 – Sources of Emissions

Other costs which must be considered include storage costs, paper costs, box costs, shredding costs, and transportation costs. The storage cost for UBC Supply Management is $2,200 dollars per year based on storage costs of $158.2 dollars per month and administration fees of $25.12 dollars per month. The delivery costs for box recalls based on an average of 17 recalls per year and an average of one trip per week accumulates to $238 per year. As mentioned above, the annual paper and ink costs for the 80 boxes per year accumulate to $396 dollars per year. The shredding costs accumulate to $431.2 dollars per year. The sum of all of the above costs is equal to $2,869.04 dollars per year not including paper costs. If paper costs are considered the total would be $5,839.04 dollars per year. When 2010 arrives and carbon credits must be purchased the total cost adds up to be $2,919.21 dollars per year without paper and $5,714.87 dollars per year with paper for UBC Supply Managements interactions with Iron Mountain. Figure 2 below outlines all of the costs associated with using the Iron Mountain facility not including the costs associated with emissions.

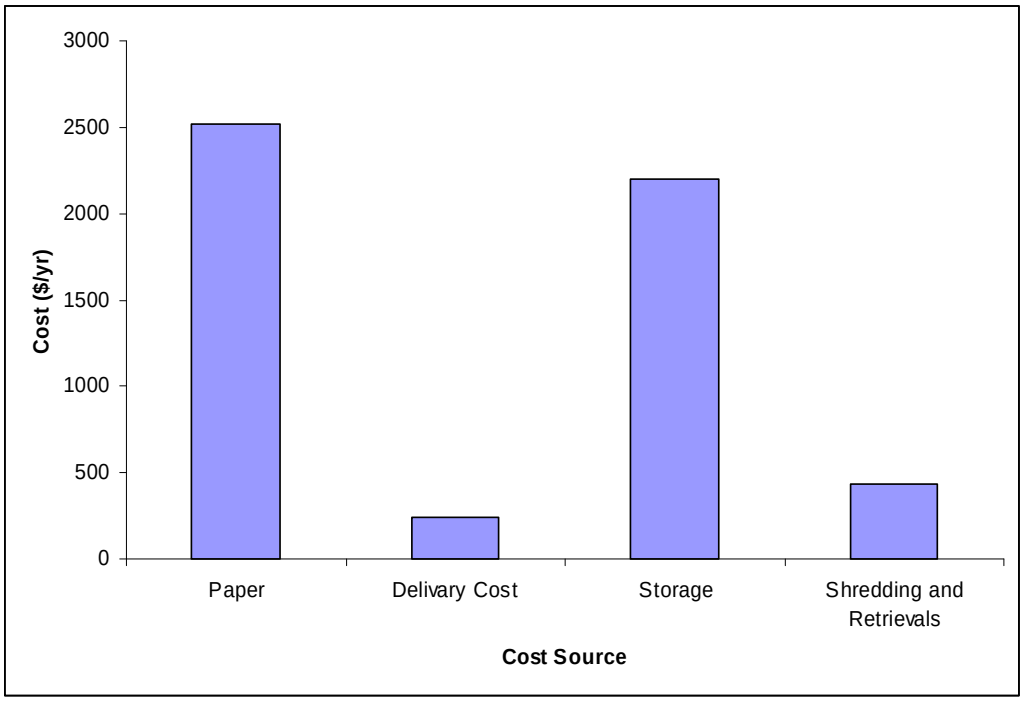

Figure 2 – Sources of Costs

The main objective of this project is to outline the opportunity for cost and emission savings which UBC may attain by eliminating the paper storage process at Iron Mountain. Currently UBC Supply Management keeps electronic copies of all of the paper stored at Iron Mountain; these electronic copies are also stored at Iron Mountain. The UBC Supply Management office recognizes this redundancy in storage and using the above mentioned costs of $5,714.87 dollars per year sets forth to eliminate paper storage at Iron Mountain as electronic storage is much more affordable and convenient.

UBC has several other offices and departments which require the use of the Iron Mountain storage facility; the sum of all of the carbon credits that will need to be purchased annually in order to meet government GHG emissions regulations for all of these offices and department will be a significant sum of money.

EMISSIONS OVER ONE STORAGE LIFE-CYCLE

In addition to the total annual emissions the emissions of 80 boxes over one storage cycle of 7 years was examined, these emissions were examined assuming that the 80 boxes are removed from the Iron Mountain facility once they have been there for 7 years. The cumulative storage cycle emissions of each set of 80 boxes over a 7 year period accumulates to 95.43 tonne CO_2 Equivalent per year. This total is calculated based on the emissions associated with producing the paper, the box, as well as the transportation of the boxes from UBC to Iron Mountain in one year. Yearly emissions which remain constant every year are the emissions associated with storing the boxes at Iron Mountain. Figure 3, below, outlines the annual emissions of 80 boxes over a 7 year period as well as the cumulative emissions of the 80 boxes over the 7 year storage cycle period. It should be noted that recall emissions are not included since the number of recalls for 80 boxes per year is not available. Furthermore, it should be noted that if the boxes are not removed after 7 years they will continue to emit 10.33 tonnes of CO_2 equivalent per year until they are removed.

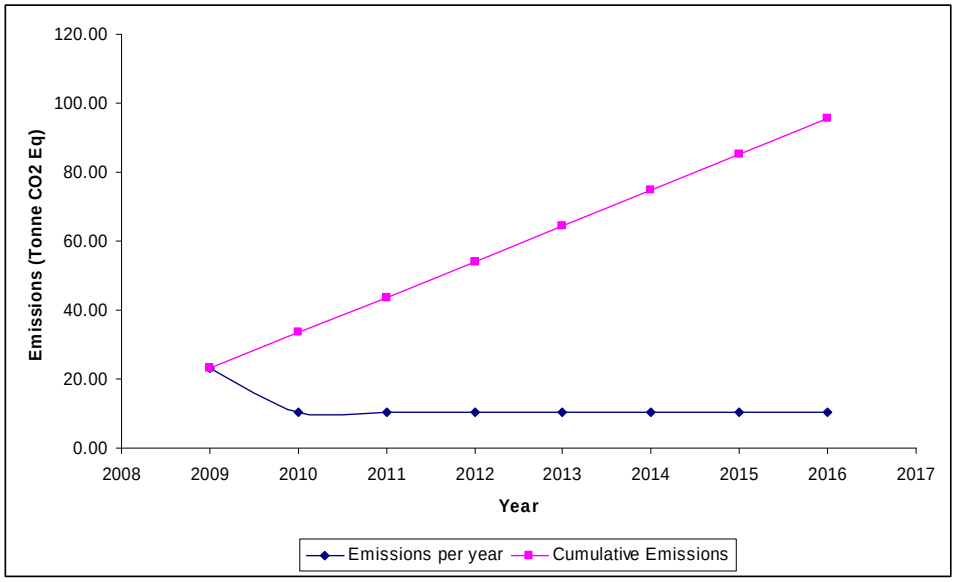

Figure 3 - Storage Cycle of 80 Boxes

CONCLUSION

The main objective of this project is to outline the opportunity for cost and emission savings which UBC may attain by eliminating the paper storage process at Iron Mountain. It was found that the total GHG emissions associated with UBC Supply Managements use of Iron Mountain are 104.05 tonnes of CO_2 equivalent. Of this sum 91.02 tonnes of CO_2 equivalent are associated with the physical storage of the paper documents within the Iron Mountain facility; UBC is not directly responsible for these emissions. However it is important to note that UBC is contribution to these emissions and should their use of the Iron Mountain storage facility be discontinued UBC would not be contributing to such a large amount of GHG emissions annually. Without including the emissions from storage the emissions associated with the UBC Supply Managements use of the Iron Mountain storage facility are 13.03 tonnes of CO_2 equivalent per year, this includes emissions from paper, boxes, and transportation. Furthermore, as noted above the emissions due to paper cannot be included in this sum because these emissions have already been accounted for in UBC's total emissions inventory.

The total costs that are associated with UBC Supply Managements use of Iron Mountain is $5,839.04 dollars per year if the costs of paper are included, and $2,869,04 if the costs of paper are not included. Furthermore, come 2010 the cost of purchasing carbon credits from the Pacific Carbon Trust will be $325.80 dollars per year if the emissions from paper are included and $50.20 if the costs from paper are not included.

The majority of the emissions associated with the interactions between UBC Supply Management and Iron Mountain are associated with the physical storage of the paper once it arrives at Iron Mountain. The second largest emissions category is associated with the paper produced in order to be stored at Iron Mountain. The use of this paper, as well as the storage space, is unnecessary and redundant as all of the records are already stored electronically; these emissions could be avoided by UBC if the physical facility were not used. It is suggested that UBC Supply Management should discontinue their use of Iron Mountain as a physical storage

location; this would have a total reduction in emissions of 104.5 tonnes of CO_2 equivalent per year which is a sum of the emissions from boxes, transportation, storage and paper.

Additionally, as noted there is no procedure in place to ensure that boxes are removed from the Iron Mountain storage facility. As can be seen in the analysis of one storage life cycle the annual storage emissions associated with storing 80 boxes, which is the number of boxes added per year, for one year is 10.33 tonnes of CO_2 equivalent. If the boxes are not removed after 7 years these emissions will continue and will accumulate as more boxes are added. It is recommended that, should the Iron Mountain storage facility continue to be used, there should be some procedure put in place to ensure that a box, or a set of boxes, is removed from storage after 7 years.

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APPENDIX A – EMISSION FACTORS

Table 1 – Emissions Factors

Item	Unit	CO2	CH4	N2O	Total	Reference
Gasoline	kg/L	2.36	0.00012	0.00026	**2.443**	(CSA, 2007)
Electricity	tonneCO2e/GWh		not incl. imports		**24**	(Hanova et al., 2007)
Electricity	tonneCO2e/GWh		Incl. imports		**84**	(Hanova et al., 2007)
Paper						
30% recycled	Tonne CO2e/tonne paper				**2.53**	(Fund, 1995)
0% recycled	Tonne CO2e/tonne paper				**2.84**	(Fund, 1995)

APPENDIX B – TABULAR RESULTS

Table 2 – Transportation CO_2 Emissions and Costs

Type of Car	Distance (miles)	Distance (km)	Double Distance [return trip] (km)	Type of Fuel	Emissions Factor (kg/L)	Fuel Efficiency (mpg)	Fuel Efficiency (km/L)	Emissions (kg CO2 eq/trip)	Trips / Year (1 trip per week + 17 recalls)	Annual Emissions (kg CO2 eq/year)	Annual Emissions (Tonne CO2 eq/year)	Cost (To pick up $)	Cost $ (CO2)	% CO2 Emission	% Cost (CO2)	Total Cost ($)	% of Total Iron Mountain Costs
Truck (One time pick up/ drop off)	21.39	35.31	70.62	Gasoline	2.443	15.5	6.59	26.180849	73	1911	1.91	895	47.8	14.66%	14.66%	1,181	17.34%

Table 3 – Box CO_2 Emission and Cost

Box	Amount (boxes/year)	Factor (Tonne CO2 eq / Tonne paper)	Mass of Box (kg)	Emissions (kg CO2 eq/box)	Annual Emissions (kg CO2 eq/year)	Annual Emissions (Tonne CO2 eq/year)	Cost (per box) ($)	Cost of Boxes/yr ($)	Cost $ (CO2)	% CO2 Emission	% Cost (CO2)	Total Cost	% of Total Iron Mountain Costs
Additional boxes (per year)	80	2.84	0.42	1.1928	95.4	0.095	2.50	200	2.3856	0.73%	0.73%	634	9.30%

Table 4 –Paper CO2 Emission and Cost

	Mass / 1000 sheets (kg)	Factor (Tonne CO2 eq / Tonne paper)	Emissions (kg CO2 eq / 1000 sheets)	Annual Emissions (kg CO2 eq/year)	Annual Emissions (Tonne CO2 eq/year)	Cost $ (CO2)	% CO2 Emission	% Cost (CO2)	Total Cost	% of Total Iron Mountain Costs
Paper	18.16	2.53	45.9448	11026.752	11.02675	276	84.60%	84.60%	2796	41.05%

Table 5 –Storage CO2 Emission and Cost

	Space Heating (kwh)	cooling (kwh)	ventilation	water heating	lighting	cooking	refrigeration	office equipment	computers	other	Total (kwh) (J hr/s)	Annual Total (GWH per year)	Emissions Factor(tonneCO2 e/GWh)	Total Emissions (tonne CO2 eq. Per year)	Emissions For Supply Management Volume of Iron Mountain	Cost of Emissions
Warehouse and storage	1	4	6	1	39	-	10	1	1	9	72	2271	**84**	190730	91	2276

Table 6 –Delivery Cost

	# of Recall	Type of Delivary	Cost($/yr)
Delivary cost	17	next day	238

Table 7 –Paper and Printing Cost

	Annual paper use (sheets/yr)	Cost ($/copy)	Annual Lease Cost ($/yr)	Printing Cost ($/yr)	Total cost ($/yr)
Paper + Ink	36000	0.011	2124	396	2520

Table 8 – Storage Cost

	Volume (ft3)	Cost ($/month)	Administration fee($/month)	Total Annual cost ($/yr)	Cost for 7 year storage ($)	% of Total Iron Mountain Costs
Storage	620.4	158.2	25.12	2200	15399	32.30%

Table 9 – Shredding and Retrievals Cost

	# of Boxes/yr	Cost($)	Total Cost($)
Shredding		222	
Retrievals	98	209	431.2

Table 10 – Storage Life-Cycle Emissions of 80 Boxes

Year	Boxes	Emissions (Tonne CO_2 Eq)	Cumulative Emissions (Tonne CO_2 Eq)
2009	80	23.13	23.13
2010	80	10.33	33.46
2011	80	10.33	43.78
2012	80	10.33	54.11
2013	80	10.33	64.44
2014	80	10.33	74.77
2015	80	10.33	85.10
2016	80	10.33	95.43

APPENDIX C – CALCULATION OF TRANSPORTATION DISTANCE

Results of Mapquest Search

A: 2075 Wesbrook Mall, Vancouver, BC V6T
B: 175 Golden Drive, Coquitlam, BC V3K
Total Time: 47 minutes; Total Distance: 21.39 miles (34.42km)

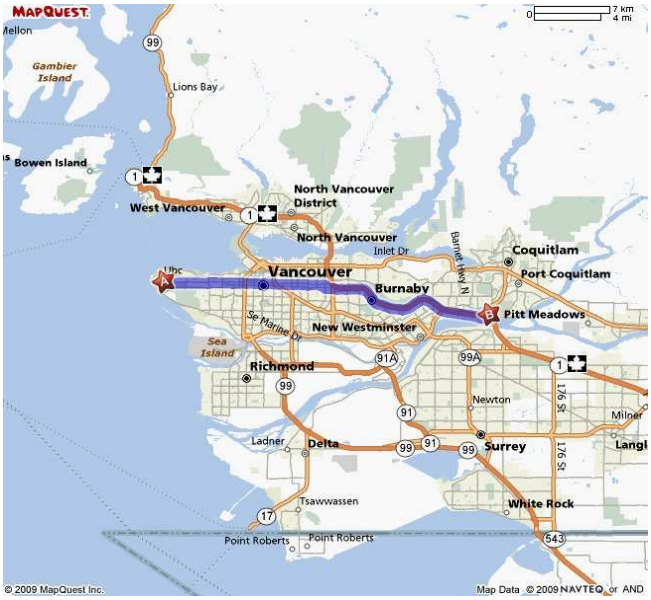

Figure 4 – Driving Directions as obtained from Mapquest

Results of Google Maps Search

A 2075 Wesbrook Mall, Vancouver, BC, Canada
B 175 Golden Dr, Coquitlam, BC, Canada
Total Distance: 36.2 km; Estimated Time: about 42 mins

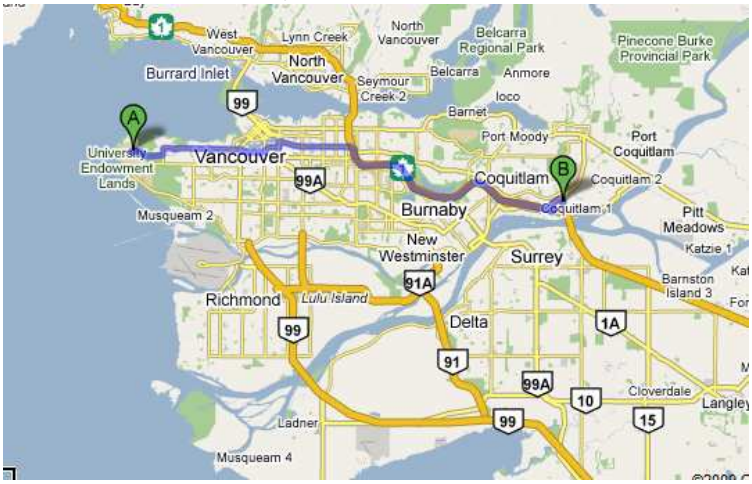

Figure 5 – Driving Directions as obtained from Google Maps

Table 11- Summary of Transportation Distances

Source	Distance
Google Maps	36.2 km
Mapquest	34.42km
Average	35.31 km

APPENDIX D – SAMPLE CALCULATIONS

TRANSPORTATION

Distance = 35.31 km , double distance = 70.62 km

Emission factor (gasoline) = 2.443 kg/L

Fuel efficiency = 6.59 km/L

Emissions (kg CO2 eq/trip) = 2.443 (kg/L)/ (6.59(km/l) X 70.62(km)) = 26.2 kg CO2 eq /trip

Annual Emissions (kg CO2 equivalent/year) = 26.2 X (56+17) weeks = 1911kg CO2 eq/year

= 1.91tonnes CO2 eq/yearCost Cost of CO2 in 2010 =

25 ($/tonne) X 1.91 (tonnes CO2 eq/year) = 47.8 dollars/tonne

Cost to pickup = 56 week X15.98 $/trip = $ 895

Delivery Cost = 17 recalls X 14$/transportation = $ 238

Total Cost = 47.8 $ + $ 895 + $ 238 = $1181

BOXES

Mass of a Box = 0.42 kg

Factor = 2.84 (tonne CO2 eq/tonne paper)

Emission = 0.42 X 2.84 = 1.193 kg (CO2 eq/box)

Annual emission = 1.19 X 80 boxes = 95.4 kg (CO2 eq /year)

Cost of CO2 in 2010 = 25 ($/tonne) X (95.4/1000) = 2.3856 dollars

Cost of Boxes/year = 80 X $ 2.50 = $ 200

Cost of shredding and retrievals = 222+209 = $ 431

Total Cost = 2.39 + 200 + 431 = $ 633.4

PAPER

Mass paper/1000 sheet = 18.16 kg

Emission factor = 2.53 tonne CO2 eq/tonnes of paper

Emission = 18.16 kg X 2.53 = 45.94 kg CO2 eq/1000 sheets

Assuming 80 boxes /year * 3000 sheets / box = 240000 sheets

Annual CO2 Emissions = 240000/ (1000) * 45.94/1000 = 11.027 tonne CO2 eq/year

Cost of CO2 in 2010 = 25 ($/tonne) X (11.027) = 276 dollars

Cost of paper &printing usage = 36000(Annual paper use)X 0.011 ($/copy) + $2124(lease/yr) = 2520 $/yr

Total Annual cost = 276 + 2520 = $2796

STORAGE

Total energy consumption (Kwhr) = 1(heating) +4(cooling) +6(ventilation) +1(water heating) +39(lighting)+10(refrigeration)+1(office equipment)+1(computer)+9(others) = 72 Kwhr

Annual Total (GWH per year) = 72Kwhr χ3600 χ24 χ365/10^6 = 2271 GWH per year

Emissions Factor(tonneCO2e/GWh) = 84

Total Emissions = 84 χ 2271 = 190729.7 (tonne CO2 eq. Per year)

Emissions for supply management volume of Iron Mountain = 190729.7 χ 0.048 = 91.02

% total Iron Mountain Area that is used by Supply management =

= 1.3 χ 10^6(ft^3)/620.40 (ft^3) χ 100= 0.048 %

Annual cost of emissions = 25 ($/tonne) X (91.02) = $2276