The City of Edmonton:
Sustainable Return on Investment Analysis of LEED™ Certification Levels for New Building Construction

Prepared for:
The City of Edmonton

Prepared by:
HDR Corporation

May 30th, 2014

HDR Corporation
Decision Economics

Risk Analysis – Investment and Finance
Economics and Policy

Sustainable Return on Investment Analysis of LEED™ Certification Levels for New Building Construction

The City of Edmonton

Prepared by:

HDR|Decision Economics
1525 Carling Avenue, Suite 510
Ottawa, Ontario

HDR Architecture Associates, Inc.
1525 Carling Avenue, Suite 500
Ottawa, Ontario

HDR is a global employee-owned firm providing architecture, engineering, consulting, construction and related services through our various operating companies. It was founded in 1917 and employs over 8,600 professionals in over 200 locations.

HDR|Decision Economics offers economic, statistical, and financial consulting services to global clients in both the public and private sector and employs a staff comprised of over 40 economists, financial analysts and statisticians throughout North America. The group has successfully completed over one thousand economic assessment studies in the past ten years to a diverse set of clients in the United States and Canada.

HDR Architecture currently has roughly 800 LEED™ Accredited Professionals, working on 36 million square feet of Sustainable Design projects (159 projects); currently HDR has 52 LEED™ Certified projects. With this experience, HDR understands the LEED™ Certification process and is aware of the nuances of the point rated system including what categories of credits have the most direct impact on construction, operating and replacement costs.

SROI originated from a Commitment to Action by HDR to develop a new generation of public decision support metrics for the Clinton Global Initiative (CGI) in 2007. SROI was developed with input from Columbia University's Graduate School of International Public Affairs and launched at the 2009 CGI annual meeting. Since then, the SROI process has been used by HDR to evaluate the monetary value of sustainability programs and projects with a combined value of over $15 Billion. It has been used by corporations and all levels of government.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Introduction:

HDR Inc. was engaged to provide a comprehensive economic business case, utilizing its Sustainable Return on Investment (SROI) analysis methodology, for the City of Edmonton (City) with respect to LEED™ certified construction levels. The City wishes to undertake an analysis to compare the lifecycle benefits and costs that different LEED™ certification levels provide. The scope of work includes two distinct build scenarios on three recently completed buildings in Edmonton to help inform potential changes in the City's Sustainable Building Policy. Scenario A compares the three buildings at LEED™ Silver certification level to those same buildings if built to the standard construction level for a municipally operated building in Edmonton. The term "*standard construction*" throughout this report refers to the level of performance that would be expected from a typical building, built to City standards (over and above the minimum of Alberta Building Code 2006), but without being designed and constructed to achieve LEED™ certification. Scenario B compares the buildings at LEED™ Gold certification level to those same buildings if built to LEED™ Silver standards. In other words, while the City recognizes the value in building and operating sustainably, and would always pursue some level of sustainability in its buildings, it is seeking to meticulously determine the incremental value of LEED™ certification on specific facilities.

This report documents the methodology of the analysis, inputs used in the model, evaluation metric results, and the risk-adjusted probability curves of the key metrics, as well as background information, general comments, and conclusions. In this case, HDR's analysis indicates that in aggregate, the additional rigour and costs that come with certifying at LEED™ Silver is a worthwhile pursuit as compared to the standard construction building, and also that in aggregate, LEED™ Gold is worthwhile as compared to LEED™ Silver. The analysis demonstrates these outcomes both financially, through lifecycle operating and maintenance cost savings, and from a triple bottom line view from the lens of economic, social, and environmental impacts which have also been monetized.

The City of Edmonton's Sustainable Building Policy targets a LEED™ Silver level of certification for new construction and major renovations that exceed 40% of the existing gross floor area and targets 30% or greater energy efficiency than the Model National Energy Code for Buildings. The City's Policy framework also positions the City "….to lead and support the delivery of public and industry education campaigns, provide incentives and engage in capacity building activities and use its authority in land use planning and development approvals to transform the local green building market"[1]. During the April 22, 2013 Audit Committee meeting, a motion was made for Administration to provide a detailed breakdown of costs and benefits of LEED™ certification and the appropriateness of application on City projects. The City wishes to undertake this analysis to directly answer the aforementioned motion and inform any potential changes in its Sustainable Building Policy.

A central piece of this analysis was to determine the possible incremental performance differences between the various LEED™ certification levels, and the standard level of construction for the case study buildings. A hypothetical, not-certified case for each building was created by identifying those credits specifically linked with each of the Silver or Gold LEED™ certification levels; these credits were then used as the basis for the determination of any incremental benefits and costs for each case study facility.

[1] The City of Edmonton, Green Building Policy, Policy Number C567, adopted June 20, 2012.

The analysis consisted of a review of three case studies of City of Edmonton buildings completed in recent years that are targeting or have achieved LEED™ certification. To ensure consistency of comparative variables, the projects reviewed were all greenfield, new construction, and all used the LEED™ Canada NC 1.0 rating system. The buildings were selected to represent different facility types and sizes across the City. The buildings analyzed are as follows:

1. **Ellerslie Fire Station No. 27** is a 17,900ft^2 (1,660m^2) fire rescue services facility located in Edmonton's Southern neighbourhood of Ellerslie. The facility includes training and administrative space, living accommodations and a fire truck garage, employing 38 full time (equivalent) fire rescue staff. Ellerslie fire station is currently in the advanced stages of review by the Canadian Green Building Council and anticipates a LEED™ 'Gold' rating.

2. **Fort Edmonton Park Administration Building** is a 7,000ft^2 (650m^2) facility located in Edmonton's South-Central neighbourhood of Brander Gardens. The facility provides administrative and meeting/conference space to Community Recreation Facilities employees and houses approximately 20 full time (equivalent) employees. Fort Edmonton Park Admin was awarded a LEED™ 'Silver' rating in 2013.

3. **South West Edmonton Police Services** is a 60,000ft^2 (5,575m^2) police services facility located Edmonton's South-West neighbourhood of Ambleside. The facility provides a variety of integrated services for both staff and the community including administrative, vehicle maintenance, holding cells, community outreach and officer training facilities. The facility employees 350 full time staff and services the entirety of the South-West division neighbourhoods. The project is in the early stages of review by the Canada Green Building Council and anticipates a LEED™ 'Silver' rating.

To undertake the LEED™ certification analysis HDR used its Sustainable Return on Investment (SROI) methodology. SROI is an enhanced form of a cost-benefit analysis (CBA) - a systematic process for calculating and comparing the benefits and costs of a project or policy, and is generally conducted to justify an investment or compare projects. The SROI process builds on best practices in cost-benefit and financial analysis methodologies complemented by advanced risk analysis. The framework identifies the significant impacts of a given investment, and makes every attempt to credibly value them in monetary terms. HDR utilized a multi-disciplined team of architects and economists to produce the analysis, and collaborated with key City staff throughout the process.

Green buildings are often regarded as having defined costs for construction, operations, and maintenance as well as defined benefits in any utility or life cycle cost savings that are provided by upgraded materials or components. However, there are also less tangible benefits to building users, larger society, and the environment that are realized when sustainable design and construction practices are implemented. In addition to accounting for the forecasted financial costs and benefits to LEED™ certification, this analysis monetized those non-cash benefits and costs including impacts related to greenhouse gases, criteria air contaminants, stormwater, potable water, health and productivity, and transportation. In other words, through SROI, HDR was able to quantify and monetize those impacts typically assessed only qualitatively, allowing for an apples to apples comparison of various sustainability investments. Economic viability is determined on the basis of whether the long-term benefits exceed the costs and whether the rate of return is adequate.

Results:

A central piece of this analysis was to determine the possible incremental performance differences between the various LEED™ certification levels, and the standard level of construction for the case study buildings.

Scenario A compares a LEED™ Silver facility to the same building if it were hypothetically built to Edmonton's standard construction level. It is anticipated that while there would be initial capital cost savings realized in foregoing LEED™ (certification and registration fees and consultant premiums, sustainable building strategies and technologies) the green design ambitions, efficiency innovations, and structured verification metrics required to achieve LEED™ Silver standing would result in a facility that performs at incrementally higher levels of optimization relating to water use, energy consumption, and occupant productivity, amongst others. Scenario B compares a LEED™ Silver facility to the same building if it were to achieve a LEED™ Gold rating. The difference between LEED Gold and LEED silver in the instance of the 3 case studies was 8 - 10 credits. As such, additional funds, design strategies, and incrementally higher levels of performance would then be required.

The results tables that are generated from the SROI analysis provide a summary of the study's financial results, shown as the Net Present Value (NPV), Benefit-Cost Ratio (BCR), and Discounted Payback Period (DPP) for each of the alternatives.

- NPV is defined as the present value of total benefits over the life of the investment minus the present value of total costs over the same period. NPV is the principal measure of a capital investment's economic worth. A positive value means that the investment would furnish benefits to the region whose total economic value exceeds the capital costs and operating funds needed to build and run the system.
- The BCR highlights the overall "value for money" of a project, expressed as the ratio of the benefits of a project relative to its costs, with both expressed in present-value monetary terms.
- Finally, the DPP is the period of time required for the return on an investment to recover the sum of the original investment on a discounted cash flow basis.

The following section provides the results from the SROI analysis. Outputs are split into two perspectives: Financial Return on Investment (FROI), and Sustainable Return on Investment (SROI).

- Financial Return on Investment (FROI) includes only the cash impacts to the owner of the building (City of Edmonton) - highlighted in blue font
- Sustainable Return on Investment (SROI) adds the external non-cash impacts which affect society to the FROI (items such as greenhouse gases (GHG's) and criteria air contaminants (CAC's)) - highlighted in green font, additive to the FROI

The results for the two scenarios are all risk-adjusted - HDR took into account the inherent uncertainty in the inputs, used probability distributions, and ran a probabilistic simulation to produce the expected outcomes.

Table ES 1. Summary of Results (Mean Risk-Adjusted Values)

	Scenario A: LEED Silver vs Standard Construction SROI Analysis - Impacts & Results: 30 Year Study Period	Ellerslie Fire Station	Fort Edmonton Administration	Edmonton Police Service SW Division Station	Aggregate Results		
Discounted Cost and Benefit Categories	Social Benefit of Reduced Potable Water Use	$2	$2	$90	*$95*		SROI
	GHG Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$251,887	$57,939	$790,415	*$1,100,242*		SROI
	CAC Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$155,584	$32,239	$518,087	*$705,909*		SROI
	O&M Cost Savings (Including Energy) at Water/Wastewater Treatment Plants	$218	$247	$9,734	*$10,199*		SROI
	Social Benefit of Enhanced Productivity from Indoor Environmental Quality Improvements	$179,663	$81,055	$1,089,901	*$1,350,620*		SROI
	GHG Social Benefits from Reduced Truck & Car Distance Travelled	$0	$1,847	$0	*$1,847*		SROI
	CAC Social Benefits from Reduced Truck & Car Distance Travelled	$0	$357	$0	*$357*		SROI
	Vehicle Operating Cost Savings from Reduced Truck & Car Distance Travelled	$0	$34,023	$0	*$34,023*		SROI
	Reduced Social Cost of Accidents from Reduced Truck & Car Distance Travelled	$0	$2,402	$0	*$2,402*		SROI
	Reduced Social Cost of Pavement Damage from Reduced Truck & Car Distance Travelled	$0	$331	$0	*$331*		SROI
	Reduced Social Cost of Traffic Noise from Reduced Truck & Car Distance Travelled	$0	$212	$0	*$212*		SROI
	Reduced Social Cost of Traffic Congestion from Reduced Truck & Car Distance Travelled	$0	$10,786	$0	*$10,786*		SROI
	Capital & Soft Costs - Incremental Total For All Credits	($261,400)	($163,390)	($617,950)	*($1,042,740)*	FROI	SROI
	Net O&M Cost Impacts (Non-Energy and Water)	$135,266	$67,660	$489,364	*$692,290*	FROI	SROI
	Potable Water Cost Savings	$6,496	$7,916	$280,939	*$295,351*	FROI	SROI
	Energy Cost Savings (Electricity & Natural Gas)	$562,693	$113,979	$1,963,365	*$2,640,037*	FROI	SROI
	Capital Replacement Costs Savings and Residual Value of Investment	$0	$52,866	$65,818	*$118,684*	FROI	SROI
Discounted Results	FROI Net Present Value	**$443,054**	**$79,032**	**$2,181,537**	***$2,703,622***	FROI	
	FROI Benefit Cost Ratio	**2.7**	**1.5**	**4.5**	***3.6***	FROI	
	FROI Discounted Payback Period	**10 y 2 m**	**25 y 7 m**	**6 y 5 m**	***8 y***	FROI	
	SROI Net Present Value	**$1,030,409**	**$300,472**	**$4,589,764**	***$5,920,645***	SROI	
	SROI Benefit Cost Ratio	**4.9**	**2.8**	**8.4**	***6.7***	SROI	
	SROI Discounted Payback Period	**6 y 1 m**	**11 y 1 m**	**3 y 11 m**	***4 y 9 m***	SROI	

The results herein include only the incremental costs and benefits identified when comparing specific buildings involving a hypothetical determination of incremental credits in two build situations: in this case comparing the net benefits of LEED Silver vs Standard Construction (over and above ABC 2006).

Summary of Results: Scenario A - LEED™ Silver vs Standard Construction Building

- **The aggregate results comparing LEED™ Silver versus Standard Construction are positive**
    - Each building generates positive financial returns from a cash-only (FROI) perspective:
        - Over the study period, the combination of utility savings from reduced electricity, natural gas, and water use, as well as other operating & maintenance (O&M) costs and avoided replacement costs savings exceeds the addition capital costs (including LEED™ consultant, registration and certification costs) and any additional O&M costs incurred related to the incremental credits for Ellerslie Fire Station, Fort Edmonton Administration, and Edmonton Police Service SW Division. However, each building shows varying degrees of magnitude of positive outcomes.
        - The aggregate financial results are overwhelmingly positive: pursuing LEED™ Silver versus standard construction generates 3.6 times more lifecycle benefits than costs, pays for its costs within 8 years, and generates roughly $2.7M in net financial benefits to the facility owners.
    - Each building generates positive returns from a triple bottom line (economic, social, and environmental) perspective:
        - The aggregate triple bottom line SROI results are overwhelmingly positive: pursuing LEED™ proves to generate 6.7 times more lifecycle benefits than costs, pays for the costs within 4 years and 9 months, and generates roughly $5.9M in net benefits.
- **Building to LEED™ Silver versus Standard Construction generates positive externalities to society**
    - The net social and environmental impacts monetized in this analysis are positive:
        - The triple bottom line - economic, social, and environmental - perspective output metrics (SROI) from each building are superior than the cash-only metrics (FROI)
        - In aggregate, the buildings generate roughly $3.2M in net positive monetized benefits to society resulting from: reduced electricity, natural gas, and potable water consumption; improved thermal comfort and toxins/irritants control; and reduced car and truck distances travelled from carpooling and regionally sourced materials.

Table ES 2. Summary of Results (Mean Risk-Adjusted Values)

Scenario B: LEED Gold vs LEED Silver SROI Analysis - Projected Impacts & Results: 30 Year Study Period		Ellerslie Fire Station	Fort Edmonton Administration	Edmonton Police Service SW Division Station	Aggregate Results	
Discounted Cost and Benefit Categories	Social Benefit of Reduced Potable Water Use	$2	$4	$56	$62	SROI
	GHG Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$32,319	$13,247	$290,631	$336,196	
	CAC Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$19,954	$7,101	$190,531	$217,586	
	O&M Cost Savings (Including Energy) at Water/Wastewater Treatment Plants	$247	$373	$6,025	$6,645	
	Stormwater Management Benefits (TSS Reduction)	$309,971	$0	$581,242	$891,213	
	Social Benefit of Enhanced Productivity from Indoor Environmental Quality Improvements	$141,810	$73,435	$752,120	$967,365	
	Urban Park/Tree Benefits	$37,447	$46,809	$96,081	$180,336	
	FSC Wood Benefits (Commensurate with Costs)	$0	$1,675	$0	$1,675	
	GHG Social Benefits from Reduced Truck & Car Distance Travelled	$0	$0	$152	$152	
	CAC Social Benefits from Reduced Truck & Car Distance Travelled	$0	$0	$234	$234	
	Vehicle Operating Cost Savings from Reduced Truck & Car Distance Travelled	$0	$0	$1,387	$1,387	
	Reduced Social Cost of Accidents from Reduced Truck & Car Distance Travelled	$0	$0	$47	$47	
	Reduced Social Cost of Pavement Damage from Reduced Truck & Car Distance Travelled	$0	$0	$218	$218	
	Reduced Social Cost of Traffic Noise from Reduced Truck & Car Distance Travelled	$0	$0	$38	$38	
	Reduced Social Cost of Traffic Congestion from Reduced Truck & Car Distance Travelled	$0	$0	$219	$219	
	Capital & Soft Costs - Incremental Total For All Credits	($69,386)	($134,520)	($469,399)	($673,305)	FROI
	Net O&M Costs - Incremental Total For All Credits	$0	$0	$0	$0	
	Net O&M Cost Impacts (Non-Energy and Water)	($2,128)	$134,312	($8,454)	$123,730	
	Potable Water Cost Savings	$7,368	$11,966	$173,900	$193,235	
	Energy Cost Savings (Electricity & Natural Gas)	$72,124	$25,358	$721,311	$818,793	
Discounted Results	FROI Net Present Value	**$7,979**	**$37,116**	**$417,358**	***$462,454***	FROI
	FROI Benefit Cost Ratio	**1.1**	**1.3**	**1.9**	***1.7***	
	FROI Discounted Payback Period	**27 y**	**22 y 10 m**	**14 y 8 m**	***16 y 7 m***	
	SROI Net Present Value	**$549,730**	**$179,759**	**$2,336,337**	***$3,065,826***	SROI
	SROI Benefit Cost Ratio	**8.7**	**2.3**	**5.9**	***5.5***	
	SROI Discounted Payback Period	**3 y 9 m**	**11 y 9 m**	**5 y 1 m**	***5 y 5 m***	

The results herein include only the incremental costs and benefits identified when comparing specific buildings involving a hypothetical determination of incremental credits in two build situations: in this case comparing the net benefits of LEED Gold vs LEED Silver

Summary of Results: Scenario B - LEED™ Gold vs LEED™ Silver

- **The aggregate results in building to LEED™ Gold versus LEED™ Silver are positive, although specific buildings generate unique results**
  - Each building generates positive financial returns from a cash-only (FROI) perspective:
    - Over the study period, the combination of utility savings from reduced electricity, natural gas, and water use, as well as other operating & maintenance (O&M) costs and avoided replacement costs savings exceeds the addition capital costs and any additional O&M costs incurred related to the incremental credits for Ellerslie Fire Station, Fort Edmonton Administration, and Edmonton Police Service SW Division.
    - The aggregate financial results are positive: pursuing LEED™ Gold versus LEED™ Silver generates 1.7 times more lifecycle benefits than costs, pays for its costs within 16 years and 7 months, and generates roughly $462K in net financial benefits to the facility owners.
  - Each of the buildings generate positive returns from a triple bottom line (economic, social, and environmental) perspective:
    - The aggregate triple bottom line SROI results are overwhelmingly positive: pursuing LEED™ Gold vs LEED™ Silver proves to generate 5.5 times more lifecycle benefits than costs, pays for the costs in under 5 years and 5 months, and generates roughly $3M in net benefits.
- **Building to LEED™ Gold versus LEED™ Silver generates positive externalities to society**
  - The net social and environmental impacts monetized in this analysis are positive:
    - The triple bottom line - economic, social, and environmental - perspective output metrics (SROI) from each building are superior than the cash-only metrics (FROI)
    - In aggregate, the buildings generate roughly $2.6M in net positive monetized benefits to society resulting from: reduced electricity, natural gas, and potable water consumption; improved thermal comfort, toxins/irritants control, and reduced communicable diseases; FSC Certified wood; stormwater runoff management; urban parks/trees; and reduced car and truck distances travelled from carpooling and regionally sourced materials.

While the SROI analysis identifies the economic outcomes of building to higher levels of sustainability within the LEED™ NC 1.0 framework, the tables below identify the proportion that upfront costs related to different levels of LEED™ make up of the total construction value of each building. The first two tables below identify the actual incremental upfront costs associated with the two LEED™ levels versus standard building construction for each building as a proportion of the actual total build costs. In these two cases, the upfront costs include LEED™ consultant premiums, LEED™ registration & certification costs, and total capital cost premiums (related to the capital costs associated with the LEED™ credits deemed as being incremental); these are all incremental costs over and above the standard construction scenarios. In the third table, the LEED™ Gold vs LEED™ Silver perspective is taken – in this case, the numbers are framed as being only incremental to Gold at the Silver level. Here, we include in the upfront costs only the total capital cost premiums and any LEED™ consultant premiums; however, no LEED™ registration & certification costs are included as these would be paid in both levels of certification and therefore impose no additional incremental costs.

Table ES 3. Scenario A: LEED™ Silver vs Standard Construction Upfront Cost Premiums

Total Upfront LEED Silver vs Standard Construction Cost Premiums

	LEED Professional Premiums*	LEED Registration & Certification Costs	Total Capital Cost Premiums	Total LEED Premium	Total Construction Value**	Total LEED Silver Costs as a % of Total Construction Value
Ellerslie Fire Station	$88,500 (1.05%)	$7,500 (0.09%)	$165,400 (1.97%)	$261,400 (3.1%)	$8,405,214	3.1%
Fort Edmonton Administration	$22,500 (0.87%)	$4,200 (0.16%)	$136,690 (5.26%)	$163,390 (6.3%)	$2,600,000	6.3%
Edmonton Police Service SW Division Station	$172,800 (0.80%)	$7,200 (0.03%)	$437,950 (2.04%)	$617,950 (2.9%)	$21,500,000	2.9%

* In Scenario B: Gold versus Silver, it is expected that additional LEED™ consulting fees would apply due to the increased amount of documentation and design work on behalf of the consultant teams. City of Edmonton staff provided an incremental value per additional credit, based upon recent pricing received within the Edmonton market, for a City of Edmonton project. This pricing regime is considered to be reflective of local market conditions, building typology and client expectations. The incremental value per credit is multiplied by the number of additional credits needed to achieve hypothetical Gold to determine an incremental premium for additional consulting fees. As such, the Silver scenario for Ellerslie has also been adjusted to remove the additional premium if it had been designed to Silver standards.

** Adjusted for LEED™ Rating: Ellerslie was designed for LEED™ Gold; as such the total costs have been adjusted by the capital cost premium to reflect the hypothetical build at a LEED™ Silver rating; the inverse holds true for Fort Edmonton and Police Service SW Division Station.

Table ES 4. Scenario B: LEED™ Gold vs Standard Construction Upfront Cost Premiums

	Total Upfront LEED Gold vs Standard Construction Cost Premiums					
	LEED Professional Premiums*	LEED Registration & Certification Costs	Total Capital Cost Premiums	Total LEED Premium	Total Construction Value**	Total LEED Gold Costs as a % of Total Construction Value
Ellerslie Fire Station	$96,500 (1.12%)	$7,500 (0.09%)	$234,786 (2.72%)	$338,786 (3.9%)	$8,640,000	3.9%
Fort Edmonton Administration	$30,500 (1.07%)	$4,200 (0.15%)	$263,210 (9.19%)	$297,910 (10.4%)	$2,863,210	10.4%
Edmonton Police Service SW Division Station	$181,800 (0.81%)	$7,200 (0.03%)	$898,349 (4.01%)	$1,087,349 (4.9%)	$22,398,349	4.9%

Table ES 5. Scenario B: LEED™ Gold vs LEED™ Silver Upfront Cost Premiums

	Total Upfront LEED Gold vs LEED Silver Construction Cost Premiums					
	LEED Professional Premiums*	LEED Registration & Certification Costs	Total Capital Cost Premiums	Total LEED Premium	Total Construction Value**	Total LEED Gold vs Silver Costs as a % of Total Construction Value
Ellerslie Fire Station	$8,000 (0.09%)	$0	$69,386 (0.80%)	$77,386 (0.9%)	$8,640,000	0.9%
Fort Edmonton Administration	$8,000 (0.28%)	$0	$126,520 (4.42%)	$134,520 (4.7%)	$2,863,210	4.7%
Edmonton Police Service SW Division Station	$9,000 (0.04%)	$0	$460,399 (2.06%)	$469,399 (2.1%)	$22,398,349	2.1%

1.0 INTRODUCTION

This report provides a comprehensive economic business case, utilizing HDR's Sustainable Return on Investment (SROI) analysis methodology, for the City of Edmonton with respect to different levels of LEED™ certification.

The report is organized as follows:

- **Section 2** provides a review of related studies, a description of the methodology that was followed in determining the incremental credits used in the cost-benefit analysis and the corresponding inputs, as well as a description of the SROI approach used and social/environmental factors.
- **Section 3** provides the key results at an aggregate level and at a building by building level, including a risk analysis section showing probability of returns for each building, as well as conclusions.
- **Appendix A** contains the inputs used in the analysis. Back-up calculations and values can be found in Appendix C.
- **Appendix B** contains a summary of the methodology HDR used in determining the incremental LEED™ credits, as well as notes on the specific incremental impacts of each to be included in the SROI analysis for each building.
- **Appendix C** lists the detailed breakdown of the capital costs, operating and maintenance costs, energy use, water consumption, vehicle distances traveled, amongst others which act as inputs for the SROI model.
- **Appendix D** contains Structure and Logic (S&L) diagrams. S&Ls graphically represent the methodology used to calculate the benefits and cost of each LEED™ credit.
- **Appendix E** provides an in-depth overview of the Sustainable Return on Investment (SROI) analysis methodology.
- **Appendix F** provides a glossary of key terms used throughout the analysis.

2.0 METHODOLOGY

HDR undertook a stepwise approach in its methodology:

1. Literature Review & Data Discovery: reviewing recently published LEED™ related industry information applicable to this analysis, as well as reviewing all CaGBC submissions for each building.
2. *Incremental Credit Determination*: The analysis involved incremental credit determination exercises for two different scenarios:
    - Scenario A: Silver vs. Standard Construction

      Scenario A focused on identifying the specific LEED™ credits obtained for each building that might not have been achieved if LEED™ were not pursued, and instead the building was constructed to the baseline standard of construction. Input from city project mangers, design professionals and other city staff was the basis of this exercise.
    - Scenario B: Hypothetical Gold vs. Silver

      Scenario B identified additional credits that may have been achieved if the LEED™ Silver Buildings (Fort Ed. and SWEPS) were to have expended additional funds and pursued a LEED™ Gold rating. In the case of Ellerslie, which does anticipate LEED Gold, an inverse approach was taken in which targeted credits were identified that may not have pursued if the project team had elected to only pursue LEED™ Silver.
3. Cost & Benefit Categorization: proposing categories of costs and benefits to be monetized, based on credits specifically linked with LEED™ certification and the availability of supporting literature to monetize impacts.
4. Develop Model Logic: for each credit under examination, HDR developed model logic using Structure & Logic diagrams to estimate incremental costs and benefit associated with LEED™ certification. These diagrams depict the variables and cause and effect relationships that underpin the analysis.
5. Determine Input Values: values for each input variable in the model logic were assigned through working with the CaGBC submission documentation, City staff, project managers, the design team, contractors, and other sources. Upper and lower estimates for each input variable were also developed based on expert opinion as to the potential variability in each estimate.
6. SROI Model Creation and Risk Analysis: coding an Excel-based cost-benefit model which incorporated the prescribed approach to each cost and benefit category and generated the results using risk analysis and probabilistic simulation techniques to account for any uncertainty in both the input values and model parameters.

2.1 Literature Review

As an initial step toward quantification, HDR undertook a literature review of related studies in order to provide: (i) context around the cost and benefits of LEED™ certification and (ii) to provide values for select parameter estimates that may be missing from specific LEED™ project information. This section provides a brief overview on the findings of the literature review.

Canada:

The Canada Green Building Council (CaGBC) recently published a resource called the Canadian LEED™ Policy Database.[2] This is an evolving collection of municipal, provincial, and federal government policies that reference a green building policy in some capacity, be it either through LEED™ or another system. To note from the database (as of December 2013):

Table 1: Canadian Municipal Green Building Policies

Policy	Number of Municipalities
Total Municipalities with LEED™ or another Sustainable Policy	
Green Building Policy (requiring some level of LEED™)	47
Green Building Policy (another Sustainable Building Policy outside of LEED™)	64
Total (either LEED™ or another Sustainable Building Policy)	**111**
Municipalities with LEED™ Certification Requirement: Out of the 47 Identified Above	
LEED™ Certification Requirement - Both Government Owned & Private Development	1
LEED™ Certification Requirement - Government Owned Only	26
LEED™ Certification Requirement - Private Development Only	20

We can see that there is a greater number of municipal Green Building Policies where LEED™ certification is not a mandate (64), than where it is (47). We can also see that, marginally, LEED™ certification requirements are more prevalent on government owned buildings (26) than on privately developed buildings (20).

United States:

There are several US cities that require LEED™ certification on municipal buildings. The US Green Building Council (USGBC) publishes a public policy database allowing users to search which government entities require a commitment to building LEED™.[3] Searches on this database can be defined by government entity (federal, state, county, city, village/town, and school), certification level, and policy path used to require or encourage LEED™ certification (regulatory, legislative, and executive). To gage the prominence of LEED™ certification as a city policy, we examined city-level, government owned or supported LEED™ NC requirements. The results are shown below (as of December 2012):

[2] http://www.cagbc.org/Content/NavigationMenu/Programs/SmartGrowth/CanadianLEED™PolicyDatabase/default.htm

[3] USGBC. Public Policy Search. http://www.usgbc.org/PublicPolicy/SearchPublicPolicies.aspx?PageID=1776

Table 2: City-Level LEED™ NC Requirements in the US

	Total
Certified	30
Silver	45
Gold	8
Platinum	0

Table 2 shows legislation is the most popular path to mandate LEED™ certification at a municipal level, followed by executive and regulatory approaches respectively. LEED™ Silver is the most popular level of LEED™ certification required by 45 cities, followed by LEED™ Certified with 30 cities, and finally LEED™ Gold with 8 cities. There are currently no cities in the US requiring LEED™ Platinum on government owned or supported projects. One should not conclude from this table that governments in the US have chosen the level of requirement based solely on outcomes from cost-benefit analysis; arbitrary decisions, as well as those framed by the political process would likely be prevalent.

Post-Construction Impacts:

We have reviewed studies which examine the investment value and performance of LEED™ buildings post-construction. These studies contain general information with respect to the longer term benefits of building sustainably or at LEED™ levels, as opposed to providing a cost-only comparison to different levels of certification as do many other studies that exist.

While it was out of scope to conduct a full meta-analysis on the enhanced value of a LEED™ certified building or the public relations value that certain building codes can generate for a municipality, there is some evidence to support such claims. There have been a limited number of well regarded studies that lend empirical evidence to the enhanced value of sustainable, or green, commercial buildings. While it can be difficult to compare diverse facilities in different regions directly, there is growing evidence to suggest that achieving increased tenant attraction, retention, and rents, as well as higher sales prices can be an outcome of a green building. It appears that, in general, outcomes from the literature are overwhelmingly positive with respect to conservation outcomes and building value.

Included in these studies in the table below is information on general energy savings of LEED™ buildings compared with non- LEED™ buildings, rental and sales premiums commanded by LEED™ buildings, and benefit-cost ratios of building LEED™ versus non-LEED™. To note: the USGBC has recently published a white paper called *High Performance Building Benefits and Investment Costs*[4], Spring 2014, incorporating a literature review aggregation of evidence-based studies covering: expert knowledge synthesis; population-based studies; project-based studies, and market-based value studies.

[4] http://www.usgbc.org/sites/default/files/GBIG%20Research%20Anthology-High%20Performance%20Building%20Benefits%20and%20Investment%20Costs-02.24.14.pdf

Table 3: LEED™ Performance and Investment Value Studies

Study	Description
New Buildings Institute. Energy Performance of LEED™ for New Construction Buildings. March 2008.	This report provides a comprehensive view of post-occupancy energy performance of LEED™ buildings, providing a critical link between intention and outcome for LEED™ projects. This study analyzes measured energy performance for 121 LEED™ NC USGBC buildings. The only requirement for inclusion in the study was the ability to provide at least one full year of measured post-occupancy energy usage data for the entire LEED™ project. The measured performance results show that on average LEED™ buildings are saving energy, on average 25-30% better than the US national average.
U.S. General Services Administration. Green Building Performance: A Post-Occupancy Evaluation of 22 GSA Buildings. August 2011.	In this white paper, the General Services Administration - the US's largest landlord - conducted a post-occupancy analysis on 22 LEED™ or ENERGY STAR buildings. The evaluation was comprehensive, measuring environmental performance, financial metrics, and occupant satisfaction. The results of the study confirmed that, on average, GSA's sustainably designed aggregated portfolio findings including 25% less energy use, 19% lower operational costs, 36% lower CO_2 emissions, and 27% higher occupant satisfaction.
Journal of Real Estate Portfolio Management. Norm Miller, Jay Spivey and Andy Florance. Does Green Pay Off? 2008.	CoStar, a leading real estate data provider, combined with UC San Diego developed the industry's first systematic study based on the entire CoStar US database of over 2.8 million properties. Using LEED™ and ENERGY STAR certified buildings, they compared these assets to similar buildings filtering based on Class A multi-tenant assets >200,000 SF standing over five stories built since 1970. The authors found the green buildings consistently achieved higher rental rates, occupancy rates, and sales prices. Survey results also showed a $0.50/SF operating cost advantage, a 50 basis point cap rate differential, and evidence of faster market absorption rates.
Greg Katz. Greening Our World – Costs, Benefits, and Strategies. 2010.	This book analyzes 171 green buildings worldwide, with detailed financial analysis regarding costs and outcomes of sustainable investments. According to the study, green buildings cost roughly 2% more to build than conventional buildings and provide a wide range of financial, health and social benefits. The analysis also determined that with that 2% cost premium, green buildings reduce energy use by an average of 33%.
SBW Consulting, Inc. Achieving Silver LEED®: Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities. April 2003.	This study determines the incremental costs and benefits of actions taken, beyond standard practices and the Seattle Energy Code, to obtain LEED™ credits. The financial effects of these impacts were calculated for each of the six LEED™ credit categories for both projects, using City-supplied economic parameters, over a 25-year period. From a citywide perspective, the BCR for both projects is 1.19 to 1.72; indicating that overall, LEED™ certification for these two projects has been cost-effective to the City.

RICS Research. Sustainability and the Dynamics of Green Building: New Evidence on the Financial Performance of Green Office Buildings in the USA. October 2010.	This paper analyzes the economic significance of trends in green building upon the private market for commercial office space. Investments improving the energy efficiency or sustainability of real capital may have implications for competition in the market for commercial space. While rigorously controlling for differences in quality, they found that LEED™ certified properties command higher rental premiums at 5.8 percent and that the transaction price of LEED™ certified "green" buildings is higher by 11.1 percent as compared to conventional properties. However, they also found that the energy efficiency premium decays over time: for every year of "label decay", the rental premium decreases by 0.4 percent, and the transaction premium decreases by 1.7 percent per year.
Sustainability and the Dynamics of Green Building. Maastricht University and University of California, Berkley. April 2010.	The authors estimate separately the increment to market rents and asset values enjoyed by buildings which have been certified by the two major rating agencies – the U.S. Green Building Council and U.S. Department of Environmental Protection. The authors relate the estimated premiums for green buildings to the particulars of the rating systems that underlie certification. The analysis of samples of more than 27,000 buildings confirms that the attributes rated for both thermal efficiency and sustainability contribute to increases in rents and asset values. Their analysis showed an average 3% rental rate premium, 8% effective rental rate premium, and sales premium of 13% for ENERGY STAR or LEED™ certified buildings versus standard buildings.

HDR has compiled a list of various sources that have been useful in providing context for this analysis. In addition to the sources above, which provide some outcomes-based evidence on post-construction benefits, the references below include a list of those studies which provide cost-based evidence on construction and operations. The generalized cost of building LEED™ studies compare the construction costs, on a LEED™ credit basis, of LEED™ certification to similar buildings with no level of LEED™ certification. The building types include: commercial, academic, laboratories, libraries, community centres, and ambulatory care facilities. The metrics provided in these studies, usually as a '$/sq ft differential'. An additional group of references compare the actual cost of building LEED™ based on real reference projects. The sources, study descriptions, and key information can be found below:

Table 4: Costs and Outcomes LEED™ Studies

Literature	Study Description	Key Study Information
BuildingGreen LLC. The Cost of LEED™: A Report on Cost Expectations to Meet LEED™ 2009 for New	This study estimates the cost of sustainable strategies based on the USGBC LEED™ NC v2009 rating system. This analysis utilizes a generic commercial or institutional building as a benchmark, except where otherwise noted. Provides credit specific costing	**LEED Credit Costs:** Provides credit specific cost metrics on a per sq.ft. basis, sample calculations as well as cost synergies between other related credits. **Number of Bldgs Analyzed:** not specified

Construction and Major Renovations (NC v2009). 2010.	information for all LEED™ NC v2009 credits.	**Type of Use:** modeled as generic LEED NC building
Davis Langdon. Cost of Green Revisited: Reexamining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption. July 2007.	This study compares construction costs of buildings where LEED™ certification was a primary goal to similar buildings where LEED™ was not considered during design. The building types analyzed include - academic buildings, laboratories and libraries, community centers and ambulatory care facilities. All costs were normalized for time and location in order to ensure consistency for the comparisons. The overall conclusion is that comparing the average cost per square foot for one set of buildings to another does not provide any meaningful data for any individual project to assess what – if any – cost impact there might be for incorporating LEED™ and sustainable design. The normal variations between buildings are sufficiently large that analysis of averages is not helpful; buildings cannot be budgeted on averages.	**LEED Credit Costs:** Provides credit specific cost metrics on a per sq.ft. basis, sample calculations as well as credit feasibility **Construction Costs:** Cost per square foot was compared between all projects – LEED-seeking and non-LEED. The cost per square foot information is provided by building type. A key study outcome is LEED Gold is often at the lower range of cost per square foot. **Number of Bldgs Analyzed:** 221 **Type of Use:** academic, laboratories, libraries, community centres, and ambulatory care
New Buildings Institute. Energy Performance of LEED for New Construction Buildings. March 2008.	This report provides a comprehensive view of post-occupancy energy performance of LEED™ buildings, providing a critical link between intention and outcome for LEED™ projects. This study analyzes measured energy performance for 121 LEED™ NC USGBC buildings. The only requirement for inclusion in the study was the ability to provide at least one full year of measured post-occupancy energy usage data for the entire LEED™ project. The measured performance results show that on average LEED™ buildings are saving energy, on average 25-30% better than the US national average.	**Energy Use Data:** Study provides good general LEED™ data on Energy Use Intensity (EUI) by LEED™ certification level and number of EAc1 credits achieved. **Number of Bldgs Analyzed:** 121 **Type of Use:** various NC buildings

SBW Consulting, Inc. Achieving Silver LEED™: Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities. April 2003.	The purpose of this study was to evaluate the impacts of the Sustainable Building Policy on two projects nearing completion in early 2003: the Seattle Justice Center and Marion Oliver McCaw Performance Hall. Study objectives include (a) enumerating the costs and benefits of LEED™ Silver certification, (b) calculating life-cycle benefit-cost ratios for each project within data constraints, and (c) providing early feedback on the effects of the Sustainable Building Policy.	**Methodological Approach:** Analysis involved first determining the incremental costs and benefits of actions taken, beyond standard practices and the Seattle Energy Code, to obtain LEED™ credits. Any actions that were so deemed as baseline were not included in the analysis. Major impacts, such as energy savings and occupant productivity improvements, were quantified using the best available information and calculation approaches. The financial effects of these impacts were calculated for each of the six LEED credit categories for both projects, using City-supplied economic parameters, over a 25-year period. **Number of Bldgs Analyzed:** 2 **Type of Use:** Justice Centre and Performance Hall
RICS Research. Sustainability and the Dynamics of Green Building: New Evidence on the Financial Performance of Green Office Buildings in the USA. October 2010.	This paper analyzes the economic significance of trends in green building upon the private market for commercial office space. Investments improving the energy efficiency or sustainability of real capital may have implications for competition in the market for commercial space: tenants may enjoy pecuniary and non-pecuniary benefits (e.g. lower utility bills, higher employee productivity) and there may be economic benefits to investors (e.g. higher rents, lower risk premiums).	**Methodological Approach:** This study gathers and analyzes a panel of certified green buildings and nearby control buildings. These buildings were matched to detailed hedonic and financial information maintained about these buildings. **Impact of LEED on Rental Rates:** While rigorously controlling for differences in quality, they found that LEED™ certified properties command slightly higher rental premiums of 5.8 percent, but the effective rental premium is not significantly more than that at 5.9 percent. The transaction price of LEED™certified "green" buildings is higher by 11.1 percent as compared to conventional properties. However, they also found that the energy efficiency premium decays over time: for every year of "label decay", the rental premium decreases by 0.4 percent, and the transaction premium decreases by 1.7 percent per year.

DNV. LEED™ Compliance Methods: Cost and Return on Investment.	Outline on additional construction costs for LEED™ certification as well as expected utility savings. Provides rule of thumb average additional costs and payback for LEED™ which may be useful to help benchmark future studies.	**Construction Cost Data:** A typical rule of thumb is to budget 3% for hard costs and 1 - 1.5% for soft costs for LEED Certification, where soft costs include LEED™-Specific Design Costs and LEED™ Documentation Costs. Additional construction cost for LEED™: Certified building = 2.5% LEED™ Silver = 3.5% LEED™ Gold = 3-5% **Payback Period:** The most common payback period for LEED™ Silver is stated to be between 3-7 years. For large complicated projects types, the payback period can be 10 years in the extreme cases
Deloitte. LEED™ Gold Certification Cost Analysis: Alberta Infrastructure. April 2009.	The focus of this analysis is to identify the specific costs and benefits associated with moving a project from current baseline level to LEED™ Silver and LEED™ Gold certification levels. The building analyzed is Holy Trinity Academy, a senior high school in Alberta. Considers project capital cost as well as lifecycle costs including: periodic replacement costs, maintenance costs and energy costs over a 30-year period.	**Methodological Approach:** This study takes a similar approach to HDR by removing LEED™ points to create a hypothetical LEED™ Silver building from a LEED™ Gold building. Results are presented as absolute cost and percent increase above baseline cost for the HTA reference building. However, little detail is provided on LEED™ credit specifics.
GSA. LEED™ Cost Study Final Report. October 2004.	The report provides a detailed and structured review of both the hard cost and soft cost implications of achieving Certified, Silver, and Gold LEED™ ratings for two GSA building types, using GSA's established design standards as the point of comparison.	**Building Types Analyzed:** - A new mid-rise federal Courthouse (five stories, 262,000 GSF, including 15,000 GSF of underground parking; base construction cost is approximately $220/GSF) - A mid-rise federal Office Building modernization (nine stories, 306,600 GSF, including 40,700 GSF of underground parking; base construction cost is approximately $130/GSF). Information from the Office Building may be relevant to Water Centre.

Ceres. Energy Efficiency and Real Estate: Opportunities for Investors. 2010.	This report outlines the business case, in qualitative terms, that investing in energy efficiency enhances value in real estate portfolios. It is targeted towards property investment companies and real estate equity and funds investors. The report concludes taking the steps to reduce energy use makes financial sense. The report lays out the steps investors can take to improve energy efficiency, and presents best practices for different types of investments.	**Construction Cost Data:** USGBC data show that achieving its LEED™ standard accounts for between only 0 and 7 percent of total costs (depending on certain factors such as the level of certification and building size).
Mapp, C. et al. The cost of LEED™: An Analysis of the Construction Costs of LEED and Non-LEED™ Banks. November 2011.	This study is an analysis of the initial building costs for two LEED™ banks and eight non- LEED™ banks with similar building types and sizes located in western Colorado. The purpose of this study was to compare the costs of these banks, and to assess costs directly associated with LEED™ certification. The analysis examines total building costs, square footage costs, soft costs, and hard costs. The study finds that the building costs of the LEED™ banks are similar to and within the same ranges as non- LEED™ banks. Additionally, the direct cost associated with seeking LEED™ certification is estimated to be below 2% of the total project cost.	**Construction Cost Data:** Provides comparison of hard costs and soft costs per sq.ft. However, the location of the projects and building type limit the relevance of the data.
KEMA. Managing the Cost of Green Buildings. October 2003.	Explores general cost-saving strategies for green building, and explores the cost issues associated with four specific building types in the context of the green building rating systems most commonly used for that sector.	**Building Types Analyzed:** K-12 schools, Laboratories, Libraries, Multi-family Affordable Housing. Details specific cost saving measures for the building types identified. However, there is no credit specific information.
Weber, C. et al. Cost-Benefit Analysis of LEED™ Silver Certification for New House Residence Hall at Carnegie Mellon University. Department of Civil and Environmental Engineering:	The project assessed and quantified the intangible benefits to the university arising from the LEED™ Certification and the benefits to the residents through a combination of expert elicitation and surveying. For the purpose of quantification, the benefits were classified into four groups: informal education of the residents, publicity benefits to the university, building performance benefits, and direct student health and performance	**Methodological Approach:** WTP survey related to use of green building. In this case living in the Carnegie Mellon residence. Potential to use the framework to formulate our questionnaire, however its topic is likely too specific.

Carnegie Mellon. 2004.	benefits. A fifth group of benefits was added by two of the experts—internal education and pride amongst students and staff of Carnegie Mellon.	
Corps, Chris. Green Value: The Value of Sustainability. Asset Strategics Ltd. May 25, 2006.	General presentation on the value of green building from an asset management, acquisition, disposition, and development view point. Limited information on LEED™ and valuation of LEED™ credits or other LEED™ elements.	**Recommendation on Green Valuation Methodologies:** - Direct comparison: difficult or impossible to properly adjust - Income approach: most suitable but difficult to use - Cost approach: potentially harmful to correct life cycle valuation - Alternate approaches: triple bottom line, full cost accounting, etc.
Industry Canada. A Business Case for Green Buildings in Canada. March 2005.	The purpose of this document is to clearly and holistically define the state of the green building industry in Canada, and to provide a basis for recognizing the many unique and tangible benefits a green building might offer, as well as the challenges and barriers facing the Canadian industry. This Business Case reflects an extensive search of published and unpublished papers and studies focusing on the nature and benefits of green buildings.	**Methodological Approach:** The Business Case reflects an extensive search of published and unpublished papers and studies focusing on the nature and benefits of green buildings. Most of the referenced information is from North America, although a few selected European studies and papers were also included. All of the information was assessed in terms of its relevance to Canada, and only those studies and sources considered applicable, or relevant, have been included.
Lawrence Berkeley National Laboratory. The Cost-Effectiveness of Commercial-Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States. December 2004.	Designed as a "meta-analysis," this report compiles and synthesizes extensive published and unpublished data from buildings commissioning projects undertaken across the United States over the past two decades, establishing the largest available collection of standardized information on commissioning experience.	**Methodological Approach:** We develop a detailed and uniform methodology for characterizing, analyzing, and synthesizing the results. For existing buildings, we found median commissioning costs of $0.27/ft2, whole-building energy savings of 15 percent, and payback times of 0.7 years. For new construction, median commissioning costs were $1.00/ft2 (0.6 percent of total construction costs), yielding a median payback time of 4.8 years **Number of Bldgs Analyzed:** 224

Sustainability and the Dynamics of Green Building. Maastricht University and University of California, Berkley. April 2010.	The authors estimate separately the increment to market rents and asset values enjoyed by buildings which have been certified by the two major rating agencies – the U.S. Green Building Council and U.S. Department of Environmental Protection. The authors relate the estimated premiums for green buildings to the particulars of the rating systems that underlie certification. The analysis of samples of more than 27,000 buildings confirms that the attributes rated for both thermal efficiency and sustainability contribute to increases in rents and asset values.	**Methodological Approach:** We employ an analogous research design to document precisely the very substantial economic returns to energy efficiency and sustainability in commercial property markets using a large cross section of office buildings which had been "certified" by independent rating agencies. Their analysis showed an average 3 percent rental rate premium, 8 percent effective rental rate premium, and sales premium of 13 percent for Energy Star or LEED certified buildings versus standard buildings. **Number of Bldgs Analyzed:** >20,000

2.2 Incremental Credit Determination & Determining Input Values

HDR Architecture Associates Inc. engaged in an analysis to determine the possible incremental and binary performance differences between the LEED™ designated case study buildings, and the alternate scenarios A and B, in which the same buildings would hypothetically be constructed to the level of construction deemed to be "standard" (Scenario A) or hypothetically constructed to LEED™ Gold standards (Scenario B).

Scenario A: Compares a LEED™ Silver facility to the same building if it were hypothetically built to the standard level construction that would be expected for a commercial/institutional building in the city of Edmonton. It should be noted that the City of Edmonton would never really build a code minimum building and would always strive for some degree of sustainability. As such, while the term "*standard construction"* is used throughout this report to describe the alternate case in Scenario A, the minimum expected industry and best-practice factors are considered in the incremental credit analysis and are included in this term. It is anticipated that while there would be initial capital cost savings realized in foregoing LEED™ (certification and registration fees and consultant premiums, sustainable building strategies and technologies) the green design ambitions, efficiency innovations, and structured verification metrics required to achieve LEED™ Silver standing would result in a facility that performs at incrementally higher levels of optimization relating to water use, energy consumption, and occupant productivity, amongst others. Scenario A seeks to determine which LEED™ requirements would not have been pursued in the Standard Construction alternative building, due to budget, schedule or, technical challenges and the cost-benefit analysis of achieving those specific credits.

Scenario B: Compares a LEED™ Silver facility to the same building if it were to achieve a LEED™ Gold rating. The difference between LEED Gold and LEED silver in the instance of the 3 case studies was 8 - 10 credits. As such additional funds, design strategies, and incrementally higher levels of performance would then be required to gain an additional 8 - 10 credits and increase the building's standing to the LEED™ Gold level. A structured analysis of historical CaGBC data consisting of the following steps reveals a pattern that indicates which credits are most commonly achieved by LEED™ Gold facilities that are not achieved by LEED Silver facilities:

1. Obtained data from the CaGBC providing the average number of projects achieving each credit type by rating level (LEED™ Certified, LEED™ Silver, LEED™ Gold, and LEED™ Platinum).
2. Calculated the difference between the percent of LEED® Gold and LEED® Silver projects that achieved each credit type.
3. Rank ordered the credit types by highest to lowest credit differential. Those credits with the highest differentials are the most likely credits to be achieved in LEED™ Gold buildings, while not being attained in LEED™ Silver buildings.

The top 10 credits from this list were selected as the basis for the incremental Silver versus Gold comparison. Where not appropriate to the facility, already achieved by the facility, or otherwise found invalid through additional project specific research, alternative credits from the list of high-differential credits were removed. The Fort Edmonton Park Administration building and the South-West Edmonton Police Station both achieved/anticipate a LEED™ Silver rating, and the incremental credit determination was as per the above. Ellerslie Fire Station however, anticipates achieving a LEED™ Gold rating, which necessitated an inverse approach (of the above methodology) to determine which 8 credits, corresponding to the list of high-differential credits, would have *not* been pursued resulting in a hypothetical LEED™ Silver facility.

The term 'incremental' is used throughout this report in the context that a particular credit affected by the LEED™ certification level realized a non-binary result. In some instances, the impact would be considered binary; either a bicycle rack was installed or it was not. In other instances however, such as energy and water savings or use of recycled content the marginal increase in performance (e.g. 40% savings versus 30% savings) is referred to as an 'incremental' difference.

The analysis consisted of a review of three case studies of City of Edmonton projects completed in recent years that achieved or are currently targeting LEED™ certification. The three projects were selected from a list of five projects identified in the April 22nd 2013 Audit Committee report titled "Project Cost Drivers for the City of Edmonton. To ensure consistency of comparative variables, the projects reviewed were all greenfield, new construction, and all used the LEED™ Canada NC 1.0 rating system.

The analysis conducted by HDR Architecture Associates, Inc. was a three-stage approach. Stages 1 & 2 are illustrated below, while stage 3 is detailed in section 2.4 of this report.

Stage 1: Meta Analysis

In the analysis of Scenario A: Silver versus Standard Construction, the consultant team compiled a list of all LEED™ credits achieved or anticipated by each of the case study projects in a single matrix. The team assessed the commonalities across all projects, and in leveraging experience, expertise, and preliminary input from City of Edmonton staff, and project design teams, ruled out credits that likely would have still been achieved (with no incremental performance difference) in a typically constructed building. HDR reviewed this preliminary list of remaining credits, and analyzed the identified credits individually for each project to determine the approach the project teams had taken, what was achieved, and what may have been done differently if the project teams were not pursuing LEED™ certification. A final matrix was generated based on this analysis to determine which credits would realistically show an incremental or binary performance difference in the absence of LEED™. In other words, this list is referring to which credits would have been impacted, realized differently, or not realized at all if LEED™ was not pursued. A summary of the incremental credits is as follows:

Table 5: Incremental LEED™ NC Credits - Scenario A: Silver vs. Standard Construction

LEED™ Credit	Name
SSc4.4	**Alternative Transportation:** Parking Capacity
SSc7.2	**Heat Island Effect: Roof**
WEc3.2	**Water Use Reduction:** 30%
EAc1	**Optimize Energy Performance**
EAc3	**Best Practice Commissioning**
MRc5	**Regional Materials:** 20%
EQc3.2	**CIAQ Management:** Pre-Occupancy
EQc4.4	**Low Emitting Materials:** Composite Wood & Laminates
EQc5	**Indoor Pollutant Control**
EQc6.2	**Controllability of Systems:** Non-Perimeter
EQc8.1	**Day lighting:** Daylight 75% of Spaces
EQc8.2	**Views:** Views for 90% of Spaces

IDc1.1	**Green Furniture**
IDc2	**LEED AP**

In the analysis of Scenario B: Gold vs. Silver, the consultant team applied the meta-analysis methodology described above; reviewing historical CaGBC data and generating a list of high-differential credits between LEED™ Silver and LEED™ Gold buildings. Using this list as a starting point, the consultant team cross-referenced the case study projects and eliminated credits that had already been achieved, or are targeted at the Silver level, or that appeared to be consistent with the building's concept design and typology and not evidently influenced by the LEED™ standard. A final matrix was generated indicating which credits were not achieved or targeted at LEED™ Silver level, but could have been achieved at a hypothetical LEED™ Gold level. As noted, for Ellerslie Fire Station, rather than determining which additional credits might have been achieved the exercise consisted of determining which credits would *not* have been targeted if the project had only attempted a LEED™ Silver rating. A summary of the incremental credits is as follows:

Table 5a: Incremental LEED™ NC Credits - Scenario B: Gold vs. Silver

LEED™ Credit	Name
SSc5.1	**Reduced Site Disturbance:** Protect/Restore Open Space
SSc6.1	**Stormwater Management:** Rate & Quantity
SSc6.2	**Stormwater Management:** Treatment
WEc2	**Innovative Waste Water**
EAc1	**Optimize Energy Performance** (beyond results at Silver level)
EAc5	**Measurement & Verification**
MRc5	**Regional Materials:** 20%
MRc7	**Certified Wood**
EQc1	**Carbon Dioxide (CO2) Monitoring**
EQc2	**Ventilation Effectiveness**
EQc6.2	**Controllability of Systems:** Perimeter Spaces
IDc1.2	**Exceptional Performance:** WEc3: Water Use Reduction (40%+)

Stage 2: Interviews & Research

Upon completion of a finalized credit matrix, and thorough reviews of the LEED™ documentation for each project provided by the Client, the consultants developed a list of probable incremental performance differences relating to each of the credits that were identified as those that would have been impacted, realized differently, or not realized at all if LEED™ was not pursued.

Assumptions made in stage 1 were clarified via interview questions with each of the project teams, as well as City of Edmonton project managers. Credits previously thought to be incremental that project teams suggested were not, were re-reviewed and removed from the credit matrix if appropriate.

Additionally, the consultants undertook a literature review of 3rd party analyses relating to the identified credits, and compared the findings of these studies with the assumptions made in stage 1, and the reinforcing information provided in stage 2. Where inconsistencies existed, the assumptions were re-examined, and in some cases deemed inappropriate/not applicable, while in others expanded rationale was developed to address the project specific context. The information derived from the literature review provides strong support in determining the inputs for the cost benefit analysis in stage 3 (described in the Input Values section, 2.4, below).

Ultimately, it was determined through these two stages that the credits analyzed for each building are as follows, with the number of credits listed for each applicable category:

Table 6: Incremental Credits Valued – Scenario A: Silver vs. Standard Construction

LEED™ Credits Included in the SROI Analysis Scenario A: Silver vs. Standard Construction		Ellerslie Fire Station No. 27	Fort Edmonton Park Admin	S-W Edmonton Police Services
Sustainable Sites				
Credit 4.4	**Alternative Transportation: Parking Capacity**		1	
Credit 7.2	**Heat Island Effect: Roof**	1		1
Water Efficiency				
Credit 3.2	**Water Use Reduction**: 30%	1	1	1
Energy & Atmosphere				
Credit 1	**Optimize Energy Performance**	4	3[1]	6
Credit 3	**Best Practice Commissioning**	1	1	1
Materials & Resources				
Credit 5	**Regional Materials:** 20% Extracted and Manufactured Regionally		1	
Indoor Environmental Quality				
Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1	1	1
Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1	1	1
Credit 5	**Indoor Pollutant Control**	1	1	1
Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces		1	
Credit 8.1	**Daylighting & Views:** Daylight 75% of Spaces	1	1	1
Credit 8.2	**Daylighting & Views:** Views for 90% of Space	1	1	1
Innovation & Design Process				
Credit 1	**Green Furniture**		1	1
Credit 2	**LEED AP**	1	1	1
Number of LEED™ Credits Analyzed and Achieved at Silver Level		**Ellerslie Fire Station No. 27**	**Fort Edmonton Park Admin**	**S-W Edmonton Police Services**

Incremental Credits Included in SROI Analysis	10	13	11
Total Credits Achieved (or Targeted if not yet Achieved)	38	36	35

[1] Under LEED™ NC v1.0 the metric used for EAc1 scoring is energy *cost* savings. The project team for Fort Edmonton elected to use 'market' electricity costs rather than LEED™ defaults and as such achieved 6 points under EAc1. However, due to the valuation methodologies utilized in this analysis, Energy Consumption values must be evaluated for calculation purposes. As such, the number of points indicated above (3) is the adjusted value corresponding to the energy consumption savings and the number of points that would have been achieved had the team used standard default LEED™ energy cost values.

Scenario B: The credits analyzed for each building, deemed to be of an incremental or binary difference to the alternate case, both those actually achieved at Gold level and, in the case of Fort Edmonton and SWEPS, those hypothetically achieved at Gold level are as follows, with the number of credits received in each applicable category. These do not represent all the credits earned by the building towards certification.

* All credits for Fort Edmonton and SWEPS are hypothetical at LEED Gold Level. Credits indicated for Ellerslie Fire Station are credits actually achieved, deemed to be beyond the LEED Silver scenario.

Table 6a: Incremental Credits Valued – Scenario B: Gold vs. Silver

LEED™ Credits Included in the SROI Analysis Scenario B: Gold vs. Silver		Ellerslie Fire Station No. 27	Fort Edmonton Park Admin	S-W Edmonton Police Services
Sustainable Sites				
Credit 5.1	**Reduced Site Disturbance:** Protect or Restore Open Space	1	1	1
Credit 6.1	**Stormwater Management:** Rate & Quantity	1		1
Credit 6.2	**Stormwater Management:** Treatment	1		1
Water Efficiency				
Credit 2	**Innovative Wastewater Technology**	1	1	1
Energy & Atmosphere				
Credit 1	**Optimize Energy Performance**	7	6[1]	9
Credit 5	**Measurement & Verification**		1	
Materials & Resources				
Credit 5	**Regional Materials:** 20% Extracted and Manufactured Regionally			1
Credit 7	**Certified Wood**		1	
Indoor Environmental Quality				
Credit 1	**Carbon Dioxide (CO2) Monitoring**		1	

Credit 2	**Increase Ventilation Effectiveness**	1	1	1
Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1		1
Innovation & Design Process				
Credit 1.2	**Exceptional Performance:** WEc3: Water Use Reduction	1	1	1
Number of LEED™ Credits Analyzed and Achieved at Gold Level		**Ellerslie Fire Station No. 27**	**Fort Edmonton Park Admin**	**S-W Edmonton Police Services**
Incremental Credits Included in SROI Analysis		8	8	9
Total Credits Achieved (or Targeted if not yet Achieved)		46	43	44

[1] Under LEED™ NC v1.0 the metric used for EAc1 scoring is energy *cost* savings. The project team for Fort Edmonton elected to use 'market' electricity costs rather than LEED™ defaults and as such achieved 6 points under EAc1 at Silver. However, due to the valuation methodologies utilized in this analysis, Energy Consumption values must be evaluated for calculation purposes. As such, the number of points indicated above (6) is the adjusted value corresponding to the projected increase in energy consumption savings at Gold level and the number of points that would have been achieved had the team used standard default LEED™ energy cost values.

2.3 Develop Model Logic

The methodology for the various benefits and costs is presented graphically in the form of a flow chart called a "structure and logic model" (S&L). Such models provide a graphical illustration of how the various inputs combine to determine the benefit or cost evaluated. They are intended to provide a transparent record of how each impact is calculated for each LEED™ credit. These can be found in Appendix D.

2.4 Determine Input Values

The triple bottom line valuation methodology and inputs are described in the following section of this report, while this section focuses exclusively on the base data from which the inputs used in the cost-benefit model are derived. This exercise was completed by HDR Architecture, and relies on several variables and methodologies of numeration which are illustrated below:

Table 1. Variables and Methodologies

Variables	Resources/Methodologies
A: Capital Costs	1: Quantity Estimation & Costing
B: Non-Energy O&M Costs/Savings	2: 3rd Party Literature
C: Electricity & Natural Gas Savings	3: LEED™ Submittal Data
D: Potable Water Savings	4: Project Team/Client Information
E: Tree Benefits	5: Consultant Rationale
F: Storm Water Management Benefits	
G: Reduced Truck Miles	
H: Reduced SOV Miles	
I: Lifecycle Benefits	

As described in section 2.2, while various credits may be impacted by LEED™ certification in a binary fashion (Eg. bicycle racks) the impacts on others such as energy and water savings or the use of recycled content in buildings materials are impacted in a more marginal sense. While a project designed to the Standard Construction level may have achieved 20% water savings, simply due to best practice designs, the added incentive of achieving a LEED™ rating may have resulted in that facility achieving 30% water savings instead. An energy savings of 30% over the model national energy code in a LEED™ Silver scenario, may have increased to 40% in a building designed to meet LEED™ Gold. This marginal difference between the two scenarios is referred to as an 'incremental' impact. Each credit identified as realizing an incremental or binary impact, is analysed in the project specific context of each case study. Each variable is assigned a monetary or numeric value for each credit, leveraging one or more of the above resources and methodologies. The general application of the above methodologies and resources can be summarized as follows:

A. <u>Capital Costs</u>

1. **Quantity Estimation & Costing:** Standard construction quantity surveying and estimation techniques are utilized to quantify and price project specific design elements that may have been omitted in the alternative case scenarios. Where available, real project costs (schedule of values) are leveraged, or in instances where schedules of values are insufficiently detailed, standard catalogue cost data (RS Means) is used as supplemental information.
2. **3rd Party Literature:** 3rd party literature is leveraged to identify industry averaged cost

premiums associated with certain LEED™ credits. Major works relied upon are referenced in section 2.0 of this document.

3. **Project Team/Client Information**: In instances where additional services are required by the LEED™ certification process, IE. Consultant fees for enhanced commissioning or LEED™ consulting, costs have been provided directly by the project teams or the Client.
4. **Consultant Rationale:** Where insufficient Client/project team or 3rd party data exists, the consultant has averaged the related *known* costs for the other case studies, and extrapolated the value on per square foot basis for the projects missing the relevant information.

B. Non-Energy O&M Costs/Savings

1. **Quantity Estimation & Costing**: Project specific O&M impacts relating to increased maintenance (costs) resulting from certain features, or decreased maintenance (savings) resulting from others are calculated on a per item or per square foot basis utilizing data from proxy facilities managed by the City of Edmonton or Industry averages where local data is not available. The sum of the costs and benefits results in a net monetary outcome in the Non-Energy O&M costs.
2. **Project Team/Client Information**: The City of Edmonton has provided information on real maintenance related costs, for each credit where relevant or in many cases confirmed there is no operating cost premium.
3. **3rd Party Literature:** 3rd party literature is leveraged to identify industry averaged cost premiums or savings associated with certain LEED™ credits. Major works relied upon are referenced in section 2.0 of this document.
4. **Consultant Rationale:** In some instances where 3rd party or project specific data is not available the consultant has drawn upon professional experience and knowledge of material science (as verified by experience of City of Edmonton's project managers) to determine a reasonably anticipated incurred maintenance cost resulting from the premature failure of systems and assemblies, such as the delamination of custom casework due to the less robust nature of water based adhesives.

C. Electricity & Natural Gas Savings

1. **3rd Party Literature:** 3rd party literature is leveraged to identify industry averaged energy cost savings (as a %) associated with certain LEED™ credits and then multiplied by project energy data derived from LEED™ submittals.
2. **LEED™ Submittal Data**: Energy modelling data provided as part of LEED™ submittal package is analysed and attributed to components of the project energy strategy. Technologies and envelope components determined to result in incremental performance differences from the alternate case scenarios are removed from the modelled data and the difference is described as the potential incremental performance benefit.
3. **Project Team/Client Information**: In some instances, the LEED™ submittal data was incomplete and insufficient for energy model analysis. To address this shortfall, real building utility data provided by the the City of Edmonton was used instead to determine the real-case performance scenario, and adjusted by the total projected energy savings to establish a hypothetical baseline using LEED™ default values. Essentially, HDR completed a similar LEED™ submittal exercise to that which the project team will be completing themselves, except in reverse. Where not immediately apparent from submittal data, or City of Edmonton information, the project teams have indicated via interviews what technologies were recommended earlier in the design process, that may have not been approved/implemented had the project not pursued LEED™ due to time and cost saving measures. Similarly to the above, these technologies, systems and components can be attributed to portions of the modelled performance and subtracted from

the data to determine the performance benefit.

D. Water Savings

1. **LEED™ Submittal Data**: Projected water use data provided as part of LEED™ submittal package is analysed and attributed to water saving fixtures and technologies used as part of the project water conversation strategy. The difference is realized as water savings exceeding 20% water use reduction (over LEED™ defined baseline). 20% water use savings is considered the alternate case for the purposes of this report due to the ubiquity of 'low-flow' water saving fixtures which would have likely been installed regardless of LEED™ requirements.
2. **Consultant Rationale:** Similarly to shortfalls in submittal data regarding energy performance, water savings performance was found to be incomplete as well in one instance. A complete set of working drawings was provided by the City of Edmonton, including mechanical drawings which provided a schedule of fixtures, and all required information on other water savings strategies. Despite missing information, HDR was able to use the known number of FTE's, the known number of fixtures and their respective flow ratings, and the expected volumes provided by rainwater harvesting to complete the LEED™ submittals and arrive at the projected water savings, in accordance with LEED™ baseline case default values.

E. Tree Benefits

1. **Quantity Estimation & Costing:** Tree benefits are a category exclusive to sustainable sites related credits, and are monetized under SSc5: Protect/Restore Open space. As such, these benefits are only realized in the Scenario B analysis. For Ellerslie Fire Station, the actual landscape drawings can be utilized to determine the quantity and types of trees. In the case of Fort Edmonton and SWEPS, a hypothetical planting scenario was developed (see 'consultant rationale' below).
2. **3rd Party Literature:** The benefit monetization for project trees relied primarily on the paper 'Municipal Forest Benefits and Costs in Five US Cities' (McPherson et Al). This paper, published in the Journal of Forestry leverages an urban forest management tool, developed by the US Forestry Service titled 'STRATUM'. This tool provides ranged monetary cost and benefit values for various sizes of trees, capturing myriad benefits in a broad scope context. The STRATUM model is the successor of the popular 'STREETS' model that the City of Edmonton has used in the past and as such, uses the same inventory data.
3. **Consultant Rationale:** As this tree benefits category is exclusive to scenario B analysis, hypothetical planting schemes were developed for Fort Edmonton and SWEPS. While this credit is distinct from Stormwater management, the implementation of on-site storm water management strategies, and the inclusion of project trees work in concert together as part of the general landscape. The planting density of the bioswale feature included in Ellerslie was extrapolated on a square foot basis to determine a hypothetical number of trees that would be included had SWEPS and Fort Edmonton included swales, or otherwise attempted to achieve credit SSc5 through the creation of natural habitat. A detailed description of the hypothetical landscape scenarios can be found in Appendix B of this report.

F. Stormwater Management Benefits

1. **3rd Party Literature:** Data on annual precipitation was made available by Environment Canada and is Edmonton specific. Data regarding concentrations of total suspended solids, typical of various run-off surfaces (parking lot, grass, roadway, etc.) was taken from a variety of sources and included as a range to account for variability. Proxy data regarding the cost of low-impact storm facilities was leveraged from a previous study done for the City of Calgary by HDR.
2. **Project Team/Client info:** The numeration of Storm water management benefits is driven by the reduction in annual flow (L/Yr). This, in turn, can be used to determine several other factors

including total suspended solids, total phosphorous, nitrogen and other containments. In facilities that incorporated storm water management strategies, drawings provided by the Client could be used to determine size, volume and using annual precipitation calculations noted above, total diversion capacity of management features, and surface areas from which the flow is diverted.

3. **Consultant Rationale:** Similarly to tree benefits, the stormwater management benefit category is exclusive to the analysis of Scenario B. As such, a hypothetical storm management scenario was developed for SWEPS, which is described in greater detail in Appendix B of this report. Fort Edmonton's location and current storm flow dynamics limit the practicability of implementing on-site stormwater management system. It was determined that these credits would not be pursued in a hypothetical scenario due to the relatively little expected return as the majority of stormwater is already infiltrated on-site, just not within the project boundaries as defined in the LEED™ submittal.

G. Truck Miles Saved

1. **LEED™ Submittal Data**: LEED™ credit MRc5 relates to regionally sourced materials. The benefit of this practice can be monetized by assessing the potential reduction in trucking distances and the associated triple bottom line impacts. The LEED™ submittal data provided indicates distances from which each of the major materials has been sourced. This data is used to determine total truck Km related to project materials.

2. **Consultant Rationale:** LEED™ requires the project team to determine the distance from the point of extraction of a raw material to the project site and the distance from the point of manufacture to the project site. However, LEED™ does not require an evaluation of the distance *between* the point of extraction and the point of manufacture. To address this gap in the available data, the consultants elected to look exclusively at distances between the point of manufacture and the project site. To determine the potential incremental difference in mileage resulting from large proportions of building materials being regionally sourced, the consultant undertook a comparative review of four classifications of materials across each of the projects in which the submittal data was available:
   - **a.** High Value Added: Pre-fabricated phenolic toilet partitions
   - **b.** Medium Value Added: Polyisocyanurate Insulation
   - **c.** Medium Value Added: Roofing membranes
   - **d.** Commodity: Steel

   For each of the material categories, the specified product was compared to the next largest manufacturer of the same material. The distances between the project site and the manufacturing location for the specified products compared to the distance between the project site and the manufacturing location of the competing products were averaged to determine an incremental distance saved as a percentage value. This percentage is then applied to the project specific truck mileage derived from the LEED™ submittal data. In instances where project specific data on truck mileage was insufficient, a $/km value was determined using *known* data from the other projects and extrapolated to complete the missing information.

H. Single Occupant Vehicle (SOV) Miles Saved

1. **Project Team/Client Information:** Fort Edmonton, in pursuit of credit SSc4.4: Alternative Transportation: Parking Capacity implemented a carpooling program in which staff who elected to carpool together would be given access to premium parking spot. Additionally, building management would provide a sign-up sheet and encourage staff to consider carpooling. Email correspondence with building managers showed that two employees did begin carpooling

together after the program was announced. While the premium parking spot wasn't necessarily the incentive, the management announcement and sign-up sheet induced a behavioural change, resulting in these co-workers discussing carpooling and modifying their mode of commute. The distance saved per day was provided directly by the employee in question.

I. Lifecycle Benefits

1. **Quantity Estimation & Costing:** Life cycle benefits derived from the use of more robust materials are estimated as the difference between the replacement costs for the installed components versus the replacement costs of what would likely be installed in the alternative scenario, over the study period, plus the remaining residual value beyond the study period to the end of the building lifecycle. The benefits are either realized as avoid replacement capital, or as residual value in the useful life of the component.

The general application of methodologies as described above was used to determine all project specific inputs to generate the base data required to complete the SROI model. The methodologies indicated above were applied to each project and each credit as illustrated in the following data matrix:

Table 2. Credit Evaluation Matrix – Ellerslie Fire Station

Ellerslie Fire Station (All Credits: Scenario A + B)		
Credit	**Variable**	**Methodology/Source**
SSc5	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	3rd Party Literature
	Tree Benefits	3rd Party Literature
SSc6	Capital Costs	Included in SSc5 Cost
	Storm Water Mgmt	3rd Party Literature
WEc2	Capital Costs	3rd Party Literature
	Non-Energy O&M	3rd Party Literature
	Water Savings	LEED Submittal Data
WEc3.2	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	3rd Party Literature
	Water Savings	LEED Submittal Data
EAc1	Capital	Quantity Estimation/Costing
		3rd Party Literature
	Non-Energy O&M	Client Information
	Electricity & Gas	3rd Party literature
		LEED Submittal Data
EAc3	Capital Costs	Client Information
	Non-Energy O&M	3rd Party literature
	Electricity & Gas	3rd Party literature
EQc2	Capital Costs	Negligible
	Non-Energy O&M	Captured under EAc1
	Electricity & Gas	Negligible w/ Heat Recovery
EQc3.2	Capital Costs	Building Flush Out (Schedule impact)
	Electricity	Negligible Fan energy

EQc4.4	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	Consultant Rationale
EQc5	Capital	Quantity Estimation/Costing
	Non-Energy O&M	Insufficient information to quantify
EQc6.1	Capital	Quantity Estimation/Costing
EQc8	Capital	Quantity Estimation/Costing
	Non-Energy O&M	3rd Party Literature
	Electricity & Gas	Captured under EAc1
IDc1.2 (WEc3)	Capital	Captured Under WEc3/WEc2
	Non-Energy O&M	Captured Under WEc3/WEc2
	Water Savings	LEED Submittal Data
IDc2	Capital	Client Information

Table 3. Credit Evaluation Matrix – Fort Edmonton Park Administration

Fort Edmonton Park Administration Building (All Credits: Scenario A + B)		
Credit	**Variable**	**Methodology/Source (#)**
SSc4.4	Reduced SOV Miles	Client Information
SSc5	Capital Costs	Quantity Estimation/Costing Consultant Rationale
	Non-Energy O&M	3rd Party Literature
	Tree Benefits	3rd Party Literature
SSc7.2	Capital	Quantity Estimation/Costing
	Non-Energy O&M	3rd Party Literature
	Lifecycle Benefits	Quantity Estimation/Costing
WEc2	Capital Costs	3rd Party Literature
	Non-Energy O&M	3rd Party Literature
	Water Savings	LEED Submittal Data
WEc3	Capital Costs	3rd Party Literature
	Non-Energy O&M	3rd Party Literature
	Water Savings	LEED Submittal Data
EAc1	Capital Costs	Quantity Surveying/Costing 3rd Party Literature
	Non-Energy O&M	Client information
	Electricity & Gas	LEED Submittal Data
EAc3	Capital Costs	Client Information
	Non-Energy O&M	3rd Party Literature
	Electricity & Gas	3rd Party Literature
EA5	Capital Costs	3rd Party Literature
	Non-Energy O&M	3rd Party Literature
	Electricity & Gas	Captured under EAc1
MRc5	Capital Costs	Negligible
	Reduced Truck Miles	LEED Submittal Data Consultant Rationale

MRc7	Costs = Benefits (No Impact)	
EQc1	Capital Costs	3rd Party Literature
	Non-Energy O&M	3rd Party Literature
EQc2	Capital Costs	Negligible
	Non-Energy O&M	Captured under EAc1
	Electricity & Gas	Captured under EAc1
EQc3.2	Capital Costs	Building Flush Out (Schedule impact)
	Electricity	Negligible Fan energy
EQc4.4	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	Consultant Rationale
EQc5	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	Insufficient information to quantify
EQc6.2	Capital Costs	3rd Party Literature
	Non-Energy O&M	Insufficient information to quantify
EQc8	Capital Costs	Quantity Surveying/Costing
IDc1.1	Capital Costs	Negligible
IDc1.2 (WEc3)	Capital Costs	Captured under WEc2/WEc3
	Non-Energy O&M	Captured under WEc2/WEc3
	Water Savings	LEED Submittal Data
IDc2	Capital Costs	Client Information

Table 4. Credit Evaluation Matrix – South-West Edmonton Police Services

South-West Edmonton Police Services		
Credit	**Variable**	**Methodology/Source (#)**
SSc5	Capital Costs	Quantity Estimation/Costing Consultant Rationale
	Non-Energy O&M	3rd Party Literature Consultant Rationale
	Tree Benefits	3rd Party Literature Consultant Rationale
SSc6	Capital Costs	Quantity Estimation/Costing Consultant Rationale
	Non-Energy O&M	Captured under SSc5
	Stormwater Benefits	3rd Party Literature
SSc7.2	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	3rd Party Literature
	Electricity & Gas	3rd Party Literature
	Lifecycle Benefits	Quantity Estimation/Costing
WEc2	Capital Costs	3rd Party Literature
	Non-Energy O&M	3rd Party Literature
	Water Savings	Consultant Rationale
WEc3	Capital Costs	3rd Party Literature
	Non-Energy O&M	3rd Party Literature

	Water Savings	Consultant Rationale
EAc1	Capital	Quantity Surveying/Costing 3rd Party Literature
	Non-Energy O&M	Client information
	Electricity & Gas	Consultant Rationale
EAc3	Capital Costs	Client Information
	Non-Energy O&M	3rd Party Literature
	Electricity & Gas	3rd Party Literature
MRc5	Capital Costs	Negligible
	Reduced Truck Miles	LEED Submittal Data Consultant Rationale
EQc2	Capital Costs	Negligible
	Non-Energy O&M	Captured under EAc1
	Electricity & Gas	Negligible w/ Heat Recovery
EQc3.2	Capital Costs	3rd Party Literature
EQc4.4	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	Consultant Rationale
EQc5	Capital Costs	Quantity Estimation/Costing
	Non-Energy O&M	Insufficient Information to Quantify
EQc6.1	Capital Costs	Quantity Estimation/Costing
EQc8	Capital Costs	Quantity Estimation/Costing 3rd Party Literature
	Non-Energy O&M	3rd Party Literature
	Electricity & Gas	Captured in EAc1
IDc1.1	Capital Costs	Negligible
IDc1.2 (WEc3)	Capital Costs	Achieved via WEc2 & WEc3 Cumulative Impact
	Non-Energy O&M	
	Water Savings	
IDc2	Capital Costs	Client Information

While the above matrices provide a high-level summary on the qualitative approach taken to each credit, the strategies, technologies and design approaches implemented in each case study are unique to the project. Appendix B provides additional information on individual design approaches, strategies and technologies deemed to have an incremental or binary impact on project cost, operations and performance. Detailed calculations resulting from each of these individual impacts are provided in Appendix ‘C’ of this report.

2.5 Monetized Social Values

All inputs (utility rates, consumption rates, etc) related to the financial impacts of energy consumption (natural gas and electricity), as well as potable water consumption, and other related impacts can be found in Appendix A.

As previously discussed, this study also incorporated the valuation of social and environmental impacts (in addition to financial impacts). In order to develop a triple-bottom line perspective, the economic value from changes in capital costs, energy consumption/production, staff productivity, material transportation distance, carpooling impacts, stormwater management, potable water use, and other non-energy impacts must be taken into account; the background information on these social valuations is included below. A complete breakdown of the social value input information as well as financial inputs can be found in the Structure and Logic diagrams (S&L's) in Appendix D and the input tables of Appendix A.

To note, many sources for the monetized factors HDR uses in this analysis originate from U.S. This may be a reflection of the much broader scale of studies conducted in the U.S., as compared to Canada (and the rest of the world), and the seemingly strong interest of the U.S. Government to conduct cost-benefit analysis for regulatory decision making. HDR has reviewed a significant body of existing peer-reviewed research from around the world for this analysis and believes the inputs are highly applicable to a Canadian study.

Electricity and Natural Gas Changes (Social Value):

In this analysis, greenhouse gases (GHGs) consist of carbon dioxide (CO_2) equivalents (includes methane (CH_4), and nitrous oxide (N_2O)). Criteria Air Contaminants (CACs) consist of mono-nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM), and volatile organic compounds (VOCs). Reductions in these pollutants occur because of a reduction in electricity and natural gas consumption. Offsetting power from the grid has implications to the quantity of GHG and CAC emissions emitted. In other words, by using less power, that electricity grid produces less energy and subsequently produces fewer emissions. In order to assess the change in emissions for each building, one must first know the amount of pollutant emitted for every unit of energy generated by the electricity grid in Alberta.

To convert the generation profile into emissions, we used emission inventories published by Environment Canada and other sources to derive a tonne/megawatt hour (MWh). The overall emission conversion factors are shown below, with changing intensities over time to account for the cleaner grid. The 2014 grid conversion factors are shown below, as are the emissions factors for natural gas, which are less location specific than that of electricity and are based on a tonne/mega joule (MJ)[5].

[5] Environment Canada's National Inventory (2011) was used for CAC's produced from electricity. The U.S. Environmental Protection Agency's AP-42 Emission factor report was used to determine CAC's conversion factors for natural gas, while http://www.epa.gov/climateleadership/documents/emission-factors.pdf was used for CO^2 equivalents.

Table 1. GHG Conversion Factors

Variable Name	Unit	Value			Source
		Median	Low	High	
CO2 Equivalents - Electricity	Tonnes/MWh	0.863363	0.647522	1.079203	Environment Canada. National Inventory Report (2011). +/- 25% for High/Low
CO2 Equivalents - Natural Gas	Tonnes/MJ	0.000052046	0.00003903	0.00006506	Environment Canada. National Inventory Report (2011). +/- 25% for High/Low

Table 2. CAC Conversion Factors

Variable Name	Unit	Value			Source
		Median	Low	High	
NOx - Electricity	Tonnes/MWh	0.001355	0.001016	0.001693	Environment Canada. National Inventory Report (2011). +/- 25% for High/Low
SO2 - Electricity	Tonnes/MWh	0.001802	0.001351	0.002252	
PM - Electricity	Tonnes/MWh	0.000049	0.000036	0.000061	
VOC - Electricity	Tonnes/MWh	0.000011	0.000008	0.000014	
NOx - Natural Gas	Tonnes/MJ	0.0000000211	0.0000000158	0.0000000263	U.S. Environmental Protection Agency. AP-42 (Updated 2011). +/- 25% for High/Low
SO2 - Natural Gas	Tonnes/MJ	0.0000000003	0.0000000002	0.0000000003	
PM - Natural Gas	Tonnes/MJ	0.0000000032	0.0000000024	0.0000000040	
VOC - Natural Gas	Tonnes/MJ	0.0000000023	0.0000000017	0.0000000029	

CO_2 Methodology:

As with all inputs used in its studies, HDR uses a probability distribution to represent the potential value for a tonne of CO_2. In order to define this distribution we require three key data points: an expected median or 50th percentile value, a low value representing the minimum realistic value and a high value representing the highest realistic value. In order to determine which would be the most appropriate data point, a meta-analysis of over 150 recent scientific estimates of the social cost of CO_2 was conducted.

For the upper and lower bounds, we used two well-established yet extreme views of the theoretical impact on the planet of an incremental tonne of CO_2; the median value was generated under the auspices of several US Federal departments to assist agencies in regulatory impact analysis.

These values are based on the calculation of the expected damage caused by climate change including not only impacts on market outputs like food and forestry but also estimates of losses from non-market impacts (where a good is not traded, and where its value is not obvious). The most comprehensive damage studies include such factors as the greater intensity of hurricanes, impacts of changes in temperature and precipitation on food production, ecosystem services, recreation, and the increased burdens of disease. The estimates also include adjustments for the risk of low-probability, high-consequence events such as abrupt climate change. The primary difference between these estimates is in the discount rate used to value future impacts.

This value is then escalated annually using rates derived from the US Federal Interagency Working Group on Social Cost of Carbon. The values, listed in 2014 dollars, are found below.

Table 3. Social Cost of Greenhouse Gases (GHGs)

Greenhouse Gases	Expected Mean Value	Probability Distribution	$/Metric Ton (2014 $)	Source
Carbon Dioxide **CO2e**	**$49.26**	Median	$40.46	Interagency Working Group on Social Cost of Carbon (2013)
		Low	$14.79	Nordhaus (2008)
		High	$118.94	Stern Review (2006)

CAC Methodology:

The basis for monetizing the social impacts of criteria air contaminants is to use the results from three reputable studies by the U.S. Department of Transportation (US DOT), the European Commission, and Yale University. As with many other social impact quantification initiatives, the varying methodologies for each study yielded a wide array of results. Furthermore, some studies included certain compounds such as Ozone or Nitrogen Dioxide while others did not. For the purpose of consistency, only overlapping compounds were analyzed. The results from each study were ranked into a lower, median, and upper range and then analyzed with a Project Evaluation and Review Techniques (PERT) distribution to obtain a mean expected value. The main criteria air contaminants analyzed were Nitrogen Oxide (NOx), Volatile Organic Compounds (VOCs), Particulate Matter (PM), and Sulfur Dioxide (SO2). The expected values of each CAC and the respective sources are listed below.

The compounds are further split and categorized into Rural and Urban, as the impacts from CACs are localized and the more dense the population, the greater the impacts. After a review of the fossil fuel generating stations that are currently operational in Alberta, it was determined that 66.7% of the fossil fuel derived electricity is generated in an urban context. This value was determined by calculating the weighted average of fossil fuel generating station capacity within the province, outside of urban areas with high population densities. All values below are in 2014 CAD dollars per ton, and urban values are listed only.

Table 4. Social Cost of Criteria Air Contaminants (CACs)

Air Pollutants	Expected Mean Value	Probability Distribution	$/Metric Tonne (2013 $)	Source
Nitrogen Oxide **NO_x**	**$7,127**	Median	$6,029.62	US DOT /NHSTA (2010)
		Low	$462.72	Muller et al. (2007)
		High	$18,178.76	ECDG/ AEA Technology (2005)
Volatile Organic Compounds **VOCs**	**$1,645**	Median	$1,478.96	US DOT /NHSTA (2010)
		Low	$771.21	Muller et al. (2007)
		High	$3,181.28	ECDG/AEA Technology (2002)
Particulate Matter - Urban **PM 2.5**	**$286,821**	Median	$329,922.86	US DOT /NHSTA (2010)
		Low	$5,089.97	Muller et al. (2007)
		High	$396,145.44	ECDG/AEA Technology (2002)
Sulfur Dioxide - Urban **SO_2**	**$36,572**	Median	$35,267.62	US DOT /NHSTA (2010)
		Low	$2,313.62	Muller et al. (2007)
		High	$76,047.81	ECDG Environment (2002)

Specific studies:

- Yale University, Muller et al. (2007): Measuring the damages of air pollution in United States
- US DOT NHTSA Final Regulatory Impact Analysis (2010)
- European Commission Directorate-General Environment (2005): Damages per tonne emission of PM2.5, NH3, SO2, NOx and VOCs from each EU25 Member State (excluding Cyprus) and surrounding seas.
- ECDG (2002), Estimates of the marginal external costs of air pollution in Europe: city 1,000,000; EU average.

Potable Water (Social Value):

Marginal Economic Value of Streamflow:

HDR monetized the social value of water quantity using a widely-known report on the marginal economic value of stream flow for valuing water, from the US Forest Service (Brown 2004)[6]. That paper proposes that the aggregate marginal value of stream flow from a national forest (raw water) is equal to the sum of the values in the different in-stream, off-stream, and hydroelectric uses from the point source of water to its journey to sea. Brown values these uses based on benefits transfers from: water

[6] Brown, Thomas C., US Forest Service, The Marginal Economic Value of Streamflow From National Forests, 12-28-2004

market rights and lease transactions in the US; avoided cost savings to produce peaking power generation via hydroelectric versus thermoelectric; and Frederick et al. (1996) meta-analysis values for in-stream and off-stream use. In this case, the in-stream value is only used, as downstream water is returned at Gold Bar. Brown segments values into 18 water resource regions (WRRs).

To determine the WRR Edmonton would fall under, HDR calculated the *Water Withdrawal to Supply Ratio* of all 50 states as well as Alberta. This ratio was used as a gauge for water scarcity, measuring the volume of water used against the supply of water. Alberta's ratio fell amongst the top 4% of least scarce regions when compared to the 50 States. The least scarce Water Resource Region in the United States, WRR 8 – Lower Mississippi, was thus used for valuation purposes.

A risk adjusted value of $ $0.000005/L of water reclaimed is utilized in this analysis. To note, if this study was completed in a region with a scarce water supply, the value would be much more significant. For instance, in the Lower Colorado region (WRR 15) a value of $0.00004419/L is used, roughly nine times the value assigned to Alberta.

Table 5. Social Value of Water

Value Component	Unit	Static Value ($2014/Litre)
Economic Value of Potable Water	$2014/Litre	$0.000005

Productivity

To determine the productivity benefits associated with indoor environmental quality improvements one widely used approach relates to the productivity changes of building occupants.

The IEQ credits can be segmented into related productivity outcomes, for instance productivity improvements from IEQ 1 and 2 can be associated to reductions in communicable diseases, while IEQ 3.2, 4.4, and 5 (as well as green furniture) can be linked to a reduction in toxins/irritants, and IEQ 6.1, 6.2, 8.1, and 8.2, can be related to enhanced comfort. Each of these IEQ credit groupings can be monetized in a similar fashion; however, with a distinct approach.

Productivity Gain from Reductions in Communicable Diseases:
For example, for illness related impacts, HDR first determined the annual number of employee work-days lost due to illness (based off of Canadian workplace averages[7]). The average annual salary of an employee on a per diem basis was then multiplied by the number of days lost, and the number of full-time equivalent employees (FTE's) to calculate the annual productivity loss (in dollar terms) due to illness. A factor was then used to calculate the proportion of the productivity loss that would be recovered (due to the amount of employee days recovered) causal to indoor air quality improvement.[8] This is based off of the number of LEED™ credits attained in this productivity category.

[7] http://www.statcan.gc.ca/pub/75-001-x/2012002/tables-tableaux/11650/tbl-4-eng.htm
[8] SBW Consulting, Inc. Achieving Silver LEED™: Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities. April 2003.

Table 6: Productivity Gain from Toxins/Irritants Control

Variable Name	Unit	Ellerslie Fire Station	Fort Edmonton	SW Police Service	Source/Notes
# of FTE's	#	38	20	350	City of Edmonton
Average Salary Per FTE (fully loaded)	%	$110,366	$46,993	$106,926	City of Edmonton
Average Absence Days Due to: Illness	Days	7.7			Statistics Canada, 2011 Workplace Illness Analysis
Number of Respiratory Disease Credits Earned (Only in Scenario B)	#	1	2	2	HDR/City of Edmonton
Absence Days Reduction Factor, per credit	% per credit	5.5%			SBW Consulting, Inc; 50% of value for conservatism

Ellerslie and SW Police Service Station received 50% of the benefit, due to the frequent out-of-office duties performed by employees in those facilities.

Productivity Gain from Toxins/Irritants Control:

For example, for toxins/irritants related impacts, HDR first determined the annual number of employee work-days lost due to allergies or asthma (based off of existing averages in North America[9]). The average annual salary of an employee on a per diem basis was then multiplied by the number of days lost to calculate the annual productivity loss (in dollar terms) due to allergies and asthma. A factor was then used to calculate the proportion of the productivity loss that would be recovered (due to the amount of employee days recovered) causal to indoor air quality improvement.[10] This is based off of the number of LEED™ credits attained in this productivity category.

Table 7: Productivity Gain from Toxins/Irritants Control

Variable Name	Unit	Value			Source/Notes
		Median	High	Low	
% of FTE With Allergies	%	27.90%	33.48%	22.32%	SBW Consulting, Inc. Achieving Silver LEED™: Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities. April 2003.
% of FTE With Asthma	%	5.20%	6.24%	4.16%	Same as above. SBW Consulting, Inc
Average Absence Days Due to: Allergies	Days	3.3	4.0	2.6	SBW Consulting, Inc

[9] SBW Consulting: SBW Consulting, Inc. Achieving Silver LEED™: Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities. April 2003.

[10] This factor ranges from a low of 0% to a high of 3%. Factor determined from a study of LEED™ buildings conducted by SBW Consulting: SBW Consulting, Inc. Achieving Silver LEED™: Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities. April 2003.

Average Absence Days Due to: Asthma	Days	3.4	4.1	2.7	SBW Consulting, Inc
Reduction in Loss of Productivity Due to IAQ Management, Low Emitting Laminates, or Low Emitting Furniture	% per credit	0.25%	0.5%	0%	HDR/SBW Consulting, Inc

Ellerslie and SW Police Service Station received 50% of the benefit, due to the frequent out-of-office duties performed by employees in those facilities.

Productivity Gain from Thermal Comfort:
The incremental productivity benefit associated with credits IEQ 6.1, 6.2, 8.1, and 8.2 was determined as follows: the number of full-time employees is multiplied by the average employee salary which is then multiplied by a factor to determine the incremental productivity gain from lighting/heating controls (in dollar terms).[11]

Table 8: Productivity Gain from Thermal Comfort

Variable Name	Unit	Value			Source/Notes
		Median	High	Low	
Percentage gain in productivity	% per credit	0.25%	0.50%	0.00%	Sustainable Building Task Force, The Costs and Financial Benefits of Green Buildings. 2003.

Edmonton Paramedic HQ received 50% of the benefit, due to the frequent out-of-office duties performed by employees in that facility.

Forest Stewardship Council (FSC) Wood

After an in-depth literature review of the impacts associated with FSC wood, it was found that minimal information exists on the quantifiable impacts/benefits of FSC wood use. As such, it was assumed that the social benefits of FSC practices would be offset by the market premium on FSC wood. That is, the social benefit is assumed to be fully factored into the market price of FSC wood, resulting in a net social benefit of $0.

Non-energy Cost Reductions

Non-energy cost reductions resulting from best practice commissioning are attributable to improvements in facility safety, equipment operations and lifespan, indoor air quality, thermal comfort, and a reduction in change orders over the course of the project. With all factors considered, a median incremental benefit of $0.39 per square foot was determined based on a study by Lawrence Berkeley National Laboratory.[12] This $/sq ft value is multiplied by the area of the building to determine a total *Non-energy Cost* reduction. The values are based off of an analysis for 44 new construction projects in

[11] A study conducted by the California Sustainable Building Task Force determined that there is typically a 0.5% difference in productivity between LEED™ Gold and LEED™ Silver buildings attributable to these credits. However, HDR only conservatively used a factor of 0.25% for each credit. Source: Task Force, The Costs and Financial Benefits of Green Buildings. 2003.
[12] Lawrence Berkeley National Laboratory, The Cost-Effectiveness oF Commercial-Buildings Commissioning, 2004.

the US, with information compiled on 95 non-energy benefits, which the major benefits attributed to those categories listed above.

For a comprehensive breakdown of the methodology, inputs, sources and assumptions used in the calculation of the financial and social impacts associated with each credit please see Appendix A and C.

Regional Materials - Trucking Impacts:

The reduction in truck miles from obtaining the regional materials credit has additional benefits associated with it from a societal perspective, including reduced emissions from fuel, accidents, traffic congestion, noise pollution, and pavement wear costs. The US Department of Transportation has published extensive research on these costs to society, and as such HDR uses these recommendations frequently in cost-benefit modelling. The emission conversion factors for truck miles travelled are derived from the US Environmental Protection Agency Motor Vehicle Emission Simulator (MOVES) database; 4-axel 40 kip transport truck emissions were used as a proxy for a typical sized truck.

The values used in this study include (values are based on miles and converted to KM in the model):

Table 9: Emissions Factors for Truck Vehicle Miles (2014 Only, Varies Annually)

Metrics		Median	Comment
CO_2	Tons/Mile	0.00222849	EPA Motor Vehicle Emission Simulator (MOVES) Model
NOx	Tons/Mile	0.00001023	
SO2	Tons/Mile	0.00000002	
PM	Tons/Mile	0.00000040	
VOC	Tons/Mile	0.00000041	

Table 10: Transportation Impact Factors

Category	Metric	Median	Low	High	Comment
Congestion Cost per mile of Travel	2014$/VMT	$0.12	$0.03	$0.36	Federal Highway Cost Allocation Study, U.S. DOT, Federal Highway Administration, May 2000.
Accident Cost per mile of Travel	2014$/VMT	$0.03	$0.01	$0.08	
Noise Cost per mile of Travel	2014$/VMT	$0.02	$0.01	$0.06	
Highway Pavement Cost per mile of Travel	2014$/VMT	$0.15	$0.07	$0.22	

Alternative Transportation - Carpooling:

The reduction in the number of commuter vehicles resulting from priority parking spaces for carpooling has additional benefits associated with it from a societal perspective, including reduced emissions from fuel combustion, vehicle operating costs, accidents, traffic congestion, noise pollution, and pavement wear costs. The US Department of Transportation has published extensive research on these costs to society, and as such HDR uses these recommendations frequently in cost-benefit modelling. The emission conversion factors for car/light truck miles travelled are derived from the US Environmental Protection Agency Motor Vehicle Emission Simulator (MOVES) database; a combination of car/light truck emissions were used as a proxy for a typical sized commuting vehicle.

The values used in this study include (values are based on miles and converted to KM in the model):

Table 11: Emissions Factors for Car/Light Truck Vehicle Miles (2014 Only, Varies Annually)

Metrics		Median	Comment
CO_2	Tons/Mile	0.000385208	EPA Motor Vehicle Emission Simulator (MOVES) Model
NOx	Tons/Mile	0.000000273	
SO2	Tons/Mile	0.000000006	
PM	Tons/Mile	0.000000004	
VOC	Tons/Mile	0.000000052	

Table 12: Transportation Impact Factors

Category	Metric	Median	Low	High	Comment
Congestion Cost per mile of Travel	2014$/VMT	$0.086	$0.022	$0.245	Federal Highway Cost Allocation Study, U.S. DOT, Federal Highway Administration, May 2000.
Accident Cost per mile of Travel	2014$/VMT	$0.018	$0.010	$0.054	
Noise Cost per mile of Travel	2014$/VMT	$0.002	$0.000	$0.004	
Highway Pavement Cost per mile of Travel	2014$/VMT	$0.001	$0.001	$0.002	

Protect/Restore Open Space – Tree Value:

Tree benefits are a category exclusive to sustainable sites related credits, and are monetized under SSc5: Protect/Restore Open space. The ‘value’ of trees has been studied at length; one widely used resource is a valuation tool called STREETS created by the US Forest Service. This tool monetizes varied impacts related to a tree, such as energy savings, CO_2 reductions, air quality benefits, stormwater runoff reductions, and aesthetics. For this analysis, because the SS 5 credit is included predominantly in the hypothetical cases, a generic tree benefit valuation was utilized. The benefit monetization for project trees relied primarily on the paper ‘Municipal Forest Benefits and Costs in Five US Cities’ (McPherson et Al). This paper, published in the Journal of Forestry leverages an urban forest management tool, developed by the US Forestry Service titled ‘STRATUM’. The STRATUM model is the successor of the aforementioned ‘STREETS’ model that the City of Edmonton has used in the past, and as such, uses the same inventory data. The generic value of a tree is multiplied by the planting density (number of trees) identified in the hypothetical build cases for this analysis.

Table 13: Tree Valuation

Category	Metric	Median	Low	High	Comment
Proxy Value of a Generic Tree	2014$/Tree	$22	$19	$25	McPherson, et. Al: Journal of Forestry; Dec 2005

Stormwater Management Benefits – Avoided TSS Reduction Costs:

Reduced stormwater runoff is valued using an avoided public cost approach; a widely used ecosystem valuation methodology. If stormwater runoff is reduced, then the incremental cost of a public stormwater treatment facility (e.g. rain gardens, engineered wetlands, or detention ponds) might be avoided. This can be used as the proxy value for the stormwater management improvements under credits SS 6.1 & SS 6.2. Total suspended solids (TSS) reduction is generally accepted as the central objective of stormwater management, and as such, the proxy value of the stormwater management credits are related directly to avoided public TSS reduction costs. For this analysis, HDR obtained a '$/KG of TSS' cost for public rain garden installations recently built by the City of Calgary, and used such values as a proxy for similar projects in Edmonton. Edmonton actively invests in TSS reduction measures across the city, but such detailed calculations were not available at this time.

Where applicable, HDR calculated TSS amounts captured for each facility (described in-depth in Section 2.4). This amount was multiplied by the value of avoided public stormwater management costs described above.

Table 14: Stormwater Management Benefits

Category	Metric	Median	Low	High	Comment
Proxy Value of Avoided TSS Costs	2014$/KG TSS/Year	$0.53	$1.35	$2.17	McPherson, et. Al: Journal of Forestry; Dec 2005

3.0 RESULTS

A central piece of this analysis was to determine the possible incremental performance differences between the various LEED™ certification levels, and the standard level of construction for the case study buildings. All monetary values were converted to constant 2014 CAD dollars using the Consumer Price Index (CPI) and relevant discount factors; this conversion ensures meaningful comparison of dollar streams over the project lifecycle. The SROI model is 31 years in length, based on a 30 year analysis of the project's impacts, and a one year period to have the building designed, built and fully operational. In this case, the study period is related to the typical useful life for the majority of the capital expenditures analyzed. For the sake of comparability, the assumption is that each building was constructed in 2014 and is operational at the start of 2015. The model assumes inflation of 2% per annum based on the midpoint of the Bank of Canada's target range of 1 to 3 percent. The real discount rate is 2%, consistent with the City's 4% nominal discount rate used for internal analyses. The electricity and natural gas utility rates were escalated based on forecasts from the National Energy Board of Canada (NEB), these are specific to Alberta, and vary annually. The water utility escalation rates are based off of City of Edmonton growth estimates. The emissions factors for electricity impacts are based off of the Alberta grid, and the factors are adjusted over time to account for the future transition to a cleaner grid. The delivery of this SROI analysis included the facilitation of key City-staff stakeholders to reach consensus on input data values and calculations to be used in the model.

The results tables that are generated from the SROI analysis provide a summary of the study's financial results, shown as the Net Present Value (NPV), Benefit-Cost Ratio (BCR), and Discounted Payback Period (DPP) for each of the alternatives.

- NPV is defined as the present value of total benefits over the life of the investment minus the present value of total costs over the same period. NPV is the principal measure of a capital investment's economic worth. A positive value means that the investment would furnish benefits to the region whose total economic value exceeds the capital costs and operating funds needed to build and run the system.
- The BCR highlights the overall "value for money" of a project, expressed as the ratio of the benefits of a project relative to its costs, with both expressed in present-value monetary terms.
- Finally, the DPP is the period of time required for the return on an investment to recover the sum of the original investment on a discounted cash flow basis.

The following section provides the results from the SROI analysis. Outputs are split into two perspectives: Financial Return on Investment (FROI), and Sustainable Return on Investment (SROI).

- Financial Return on Investment (FROI) includes only the cash impacts to the owner of the building (City of Edmonton) - highlighted in blue font
- Sustainable Return on Investment (SROI) adds the external non-cash impacts which affect society to the FROI (items such as greenhouse gases (GHG's) and criteria air contaminants (CAC's)) - highlighted in green font, additive to the FROI

Table 1 provides a summary of the present value of the incremental costs and benefits (LEED™ Silver relative to the Standard Construction, along with the NPV, BCR, DPP of each of the three buildings, as well as an aggregation of all three. Table 2 provides a summary of the LEED™ Gold relative to LEED™ Silver analysis.

SROI SUSTAINABLE RETURN ON INVESTMENT HDR — THE CITY OF Edmonton

Table 1. Summary of Results (Mean Risk-Adjusted Values)

	Scenario A: LEED Silver vs Standard Construction SROI Analysis - Impacts & Results: 30 Year Study Period	Ellerslie Fire Station	Fort Edmonton Administration	Edmonton Police Service SW Division Station	Aggregate Results		
Discounted Cost and Benefit Categories	Social Benefit of Reduced Potable Water Use	$2	$2	$90	*$95*		SROI
	GHG Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$251,887	$57,939	$790,415	*$1,100,242*		SROI
	CAC Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$155,584	$32,239	$518,087	*$705,909*		SROI
	O&M Cost Savings (Including Energy) at Water/Wastewater Treatment Plants	$218	$247	$9,734	*$10,199*		SROI
	Social Benefit of Enhanced Productivity from Indoor Environmental Quality Improvements	$179,663	$81,055	$1,089,901	*$1,350,620*		SROI
	GHG Social Benefits from Reduced Truck & Car Distance Travelled	$0	$1,847	$0	*$1,847*		SROI
	CAC Social Benefits from Reduced Truck & Car Distance Travelled	$0	$357	$0	*$357*		SROI
	Vehicle Operating Cost Savings from Reduced Truck & Car Distance Travelled	$0	$34,023	$0	*$34,023*		SROI
	Reduced Social Cost of Accidents from Reduced Truck & Car Distance Travelled	$0	$2,402	$0	*$2,402*		SROI
	Reduced Social Cost of Pavement Damage from Reduced Truck & Car Distance Travelled	$0	$331	$0	*$331*		SROI
	Reduced Social Cost of Traffic Noise from Reduced Truck & Car Distance Travelled	$0	$212	$0	*$212*		SROI
	Reduced Social Cost of Traffic Congestion from Reduced Truck & Car Distance Travelled	$0	$10,786	$0	*$10,786*		SROI
	Capital & Soft Costs - Incremental Total For All Credits	($261,400)	($163,390)	($617,950)	*($1,042,740)*	FROI	SROI
	Net O&M Cost Impacts (Non-Energy and Water)	$135,266	$67,660	$489,364	*$692,290*	FROI	SROI
	Potable Water Cost Savings	$6,496	$7,916	$280,939	*$295,351*	FROI	SROI
	Energy Cost Savings (Electricity & Natural Gas)	$562,693	$113,979	$1,963,365	*$2,640,037*	FROI	SROI
	Capital Replacement Costs Savings and Residual Value of Investment	$0	$52,866	$65,818	*$118,684*	FROI	SROI
Discounted Results	**FROI Net Present Value**	**$443,054**	**$79,032**	**$2,181,537**	***$2,703,622***	FROI	
	FROI Benefit Cost Ratio	**2.7**	**1.5**	**4.5**	***3.6***	FROI	
	FROI Discounted Payback Period	**10 y 2 m**	**25 y 7 m**	**6 y 5 m**	***8 y***	FROI	
	SROI Net Present Value	**$1,030,409**	**$300,472**	**$4,589,764**	***$5,920,645***	SROI	
	SROI Benefit Cost Ratio	**4.9**	**2.8**	**8.4**	***6.7***	SROI	
	SROI Discounted Payback Period	**6 y 1 m**	**11 y 1 m**	**3 y 11 m**	***4 y 9 m***	SROI	

The results herein include only the incremental costs and benefits identified when comparing specific buildings involving a hypothetical determination of incremental credits in two build situations: in this case comparing the net benefits of LEED Silver vs Standard Construction (over and above ABC 2006).

Summary of Results: Scenario A - LEED™ Silver vs Standard Construction Building

- **The aggregate results comparing LEED™ Silver versus Standard Construction are positive**
  - Each building generates positive financial returns from a cash-only (FROI) perspective:
    - Over the study period, the combination of utility savings from reduced electricity, natural gas, and water use, as well as other operating & maintenance (O&M) costs and avoided replacement costs savings exceeds the addition capital costs (including LEED™ consultant, registration and certification costs) and any additional O&M costs incurred related to the incremental credits for Ellerslie Fire Station, Fort Edmonton Administration, and Edmonton Police Service SW Division. However, each building shows varying degrees of magnitude of positive outcomes.
    - The aggregate financial results are overwhelmingly positive: pursuing LEED™ Silver versus standard construction generates 3.6 times more lifecycle benefits than costs, pays for its costs within 8 years, and generates roughly $2.7M in net financial benefits to the facility owners.
  - Each building generates positive returns from a triple bottom line (economic, social, and environmental) perspective:
    - The aggregate triple bottom line SROI results are overwhelmingly positive: pursuing LEED™ proves to generate 6.7 times more lifecycle benefits than costs, pays for the costs within 4 years and 9 months, and generates roughly $5.9M in net benefits.
- **Building to LEED™ Silver versus Standard Construction generates positive externalities to society**
  - The net social and environmental impacts monetized in this analysis are positive:
    - The triple bottom line - economic, social, and environmental - perspective output metrics (SROI) from each building are superior than the cash-only metrics (FROI)
    - In aggregate, the buildings generate roughly $3.2M in net positive monetized benefits to society resulting from: reduced electricity, natural gas, and potable water consumption; improved thermal comfort and toxins/irritants control; and reduced car and truck distances travelled from carpooling and regionally sourced materials.

SROI | SUSTAINABLE RETURN ON INVESTMENT HDR — THE CITY OF Edmonton

Table 2. Summary of Results (Mean Risk-Adjusted Values)

Scenario B: LEED Gold vs LEED Silver SROI Analysis - Projected Impacts & Results: 30 Year Study Period	Ellerslie Fire Station	Fort Edmonton Administration	Edmonton Police Service SW Division Station	Aggregate Results	
Discounted Cost and Benefit Categories					
Social Benefit of Reduced Potable Water Use	$2	$4	$56	*$62*	SROI
GHG Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$32,319	$13,247	$290,631	*$336,196*	SROI
CAC Social Benefit from Reduced Energy Use (Electricity & Natural Gas)	$19,954	$7,101	$190,531	*$217,586*	SROI
O&M Cost Savings (Including Energy) at Water/Wastewater Treatment Plants	$247	$373	$6,025	*$6,645*	SROI
Stormwater Management Benefits (TSS Reduction)	$309,971	$0	$581,242	*$891,213*	SROI
Social Benefit of Enhanced Productivity from Indoor Environmental Quality Improvements	$141,810	$73,435	$752,120	*$967,365*	SROI
Urban Park/Tree Benefits	$37,447	$46,809	$96,081	*$180,336*	SROI
FSC Wood Benefits (Commensurate with Costs)	$0	$1,675	$0	*$1,675*	SROI
GHG Social Benefits from Reduced Truck & Car Distance Travelled	$0	$0	$152	*$152*	SROI
CAC Social Benefits from Reduced Truck & Car Distance Travelled	$0	$0	$234	*$234*	SROI
Vehicle Operating Cost Savings from Reduced Truck & Car Distance Travelled	$0	$0	$1,387	*$1,387*	SROI
Reduced Social Cost of Accidents from Reduced Truck & Car Distance Travelled	$0	$0	$47	*$47*	SROI
Reduced Social Cost of Pavement Damage from Reduced Truck & Car Distance Travelled	$0	$0	$218	*$218*	SROI
Reduced Social Cost of Traffic Noise from Reduced Truck & Car Distance Travelled	$0	$0	$38	*$38*	SROI
Reduced Social Cost of Traffic Congestion from Reduced Truck & Car Distance Travelled	$0	$0	$219	*$219*	SROI
Capital & Soft Costs - Incremental Total For All Credits	($69,386)	($134,520)	($469,399)	*($673,305)*	FROI / SROI
Net O&M Costs - Incremental Total For All Credits	$0	$0	$0	*$0*	FROI / SROI
Net O&M Cost Impacts (Non-Energy and Water)	($2,128)	$134,312	($8,454)	*$123,730*	FROI / SROI
Potable Water Cost Savings	$7,368	$11,966	$173,900	*$193,235*	FROI / SROI
Energy Cost Savings (Electricity & Natural Gas)	$72,124	$25,358	$721,311	*$818,793*	FROI / SROI
Discounted Results					
FROI Net Present Value	**$7,979**	**$37,116**	**$417,358**	***$462,454***	FROI
FROI Benefit Cost Ratio	**1.1**	**1.3**	**1.9**	***1.7***	FROI
FROI Discounted Payback Period	**27 y**	**22 y 10 m**	**14 y 8 m**	***16 y 7 m***	FROI
SROI Net Present Value	**$549,730**	**$179,759**	**$2,336,337**	***$3,065,826***	SROI
SROI Benefit Cost Ratio	**8.7**	**2.3**	**5.9**	***5.5***	SROI
SROI Discounted Payback Period	**3 y 9 m**	**11 y 9 m**	**5 y 1 m**	***5 y 5 m***	SROI

The results herein include only the incremental costs and benefits identified when comparing specific buildings involving a hypothetical determination of incremental credits in two build situations: in this case comparing the net benefits of LEED Gold vs LEED Silver

Summary of Results: Scenario B - LEED™ Gold vs LEED™ Silver

- **The aggregate results in building to LEED™ Gold versus LEED™ Silver are positive, although specific buildings generate unique results**
    - Each building generates positive financial returns from a cash-only (FROI) perspective:
        - Over the study period, the combination of utility savings from reduced electricity, natural gas, and water use, as well as other operating & maintenance (O&M) costs and avoided replacement costs savings exceeds the addition capital costs and any additional O&M costs incurred related to the incremental credits for Ellerslie Fire Station, Fort Edmonton Administration, and Edmonton Police Service SW Division.
        - The aggregate financial results are positive: pursuing LEED™ Gold versus LEED™ Silver generates 1.7 times more lifecycle benefits than costs, pays for its costs within 16 years and 7 months, and generates roughly $462K in net financial benefits to the facility owners.
    - Each of the buildings generate positive returns from a triple bottom line (economic, social, and environmental) perspective:
        - The aggregate triple bottom line SROI results are overwhelmingly positive: pursuing LEED™ Gold vs LEED™ Silver proves to generate 5.5 times more lifecycle benefits than costs, pays for the costs in under 5 years and 5 months, and generates roughly $3M in net benefits.
- **Building to LEED™ Gold versus LEED™ Silver generates positive externalities to society**
    - The net social and environmental impacts monetized in this analysis are positive:
        - The triple bottom line - economic, social, and environmental - perspective output metrics (SROI) from each building are superior than the cash-only metrics (FROI)
        - In aggregate, the buildings generate roughly $2.6M in net positive monetized benefits to society resulting from: reduced electricity, natural gas, and potable water consumption; improved thermal comfort, toxins/irritants control, and reduced communicable diseases; FSC Certified wood; stormwater runoff management; urban parks/trees; and reduced car and truck distances travelled from carpooling and regionally sourced materials.

ASSUMPTIONS, RISK FACTORS AND CONSIDERATIONS:

- This analysis used a unique combination of site-specific costs, utility rates, electricity grid composition, water availability, employee counts, wages, and other assumptions that will prevent these results from being transferable to other jurisdictions.
- The three facilities used in this analysis should not necessarily be construed as indicative of every individual LEED™ building in the City of Edmonton, as individual idiosyncrasies exist from one building to the next that will impact the results greatly.
- The Canada Green Building Council (CaGBC) guidelines are ever changing and may affect future project outcomes and results. Thus the definition of credits and how they are achieved may change over time.
- The task of identifying the specific LEED™ credits obtained for each building that could be deemed as being incrementally different if the facilities obtained or targeted LEED™ Silver or Gold certification, or were built to the Standard level of Construction, was led by HDR's Architects. The outcome of this task identified which credits were eligible for inclusion within the cost-benefit analysis conducted by HDR's Economists. While rigorous in its approach, this determination represents a hypothetical situation whereby best estimates we used and actual outcomes may have differed from reality. To the extent that these assumptions do not reflect what actually would have been done in reality, certain costs/benefits may be over or under represented. To mitigate this effect, HDR conducted risk analysis on all input variables.
- The CaGBC is a national organization that administers the LEED™ Canada program. In addition to the review and oversight of the rating system, they are also a hub of knowledge and centre for the advocacy for sustainable design and construction. The intent of LEED™ is to act as a transformative force in the industry and as such the rating system is regularly updated. Contrary to some popular perceptions, LEED™ is not a sustainable building *code*. While there are some prescriptive requirements relating to minimum best practices, LEED™ is a rating system in which objectives are established and the individual approaches, strategies and technologies selected by project teams are unique to each individual project. The process of LEED™ itself, in encouraging (often requiring) various disciplines to meet and develop designs that will meet the objectives at the very early stages of concept design in an integrated manner has been observed as correlative to greater design innovation, and ultimately higher performing buildings. That being said, one can also say this is an outcome of other sustainable rating systems as well.
- The SROI model attributes different values to criteria air contaminants depending on the location of the emissions as effects are typically quite localized and higher density areas (e.g. urban) would carry much more serious implications than lower density areas (e.g. rural). HDR considered the location of all major providers to the power grid and valued CAC emissions accordingly.
- In consideration of Alberta's initiatives to reduce emissions through carbon capture and storage as well as gradually retiring coal plants and targeting renewable sources of energy, the intensity factors of the power grid were gradually reduced throughout the study. Correspondingly, HDR applied this gradual shift in energy sources to the urban and rural split affecting the CAC emissions. The result was a shift towards a cleaner power grid, but a higher relative dependence on natural gas facilities in urban environments.
- Edmonton is not a water scarce region, and as such, the social benefit applied to reduce potable water use is relatively low, as dictated by the literature used in its valuation.
- Within the impact categories listed above, seven are attributed to changes in truck transportation distances (credit MRc2) or reduced auto distances travelled due to carpooling (credit SS 4.4), where

applicable: GHG & CAC Social Benefits from Reduced Truck/Car Distances Travelled, Vehicle Operating Cost Savings, as well as Reduced Social Cost of Accidents, Pavement Damage, Traffic Noise, and Congestion.

- Any potential delays relating to a LEED™ certification designation on a specific facility is not included in the analysis.
- While public perception, increased real-estate values, and tenant attraction/retention could all be considered net benefits of LEED™ certification, it is believed that attempting to monetize these benefits would overlap with benefits already monetized elsewhere in the analysis. For example, real-estate value may increase because the operating costs are lower and the lower operating costs are already captured within the cost benefit analysis and should not be double-counted.
- Some benefits to sustainable design and construction, while certainly valid, are difficult to monetize in a credible manner. The literature does not exist in some instances to support benefits that are widely accepted as having positive impacts on health and enjoyment but not easily quantifiable; for example, the health impacts of low VOC products on transient or casual users of facilities. "Productivity", in the context of the research used for the valuation methodology for the Indoor Environmental Quality credits, is related only to efficiency gains to workers (less sick days and/or increased output). As no salary is attributable to transient/casual users, "productivity" benefits can not be monetized in the same way as full time employees. Sufficient literature does not currently exist to credibly support an argument that the marginal health and wellness benefits would have direct impacts on productivity outside of the building.
- It must be acknowledged that LEED™ buildings impart both additional costs and cost reductions to both operations and maintenance operations. While HDR has quantified these impacts wherever possible, the majority of literature that currently exists is aimed more toward capital costs and utility savings rather than non-utility operations (maintenance) costs. Several potential areas of impacts were identified but could not be quantified. The specific credits in which operational impacts are anticipated, but not quantified are described in greater detail in Appendix A of this report.

While the SROI analysis identifies the economic outcomes of building to higher levels of sustainability within the LEED™ NC 1.0 framework, the tables below identify the proportion that upfront costs related to different levels of LEED™ make up of the total construction value of each building. The first two tables below identify the actual incremental upfront costs associated with the two LEED™ levels versus standard building construction for each building as a proportion of the actual total build costs. In these two cases, the upfront costs include LEED™ consultant premiums, LEED™ registration & certification costs, and total capital cost premiums (related to the capital costs associated with the LEED™ credits deemed as being incremental); these are all incremental costs over and above the standard construction scenarios. In the third table, the LEED™ Gold vs LEED™ Silver perspective is taken – in this case, the numbers are framed as being only incremental to Gold at the Silver level. Here, we include in the upfront costs only the total capital cost premiums and any LEED™ consultant premiums; however, no LEED™ registration & certification costs are included as these would be paid in both levels of certification and therefore impose no additional incremental costs.

Table 3. Scenario A: LEED™ Silver vs Standard Construction Upfront Cost Premiums

	Total Upfront LEED Silver vs Standard Construction Cost Premiums					
	LEED Professional Premiums*	**LEED Registration & Certification Costs**	**Total Capital Cost Premiums**	**Total LEED Premium**	**Total Construction Value****	**Total LEED Silver Costs as a % of Total Construction Value**
Ellerslie Fire Station	$88,500 (1.05%)	$7,500 (0.09%)	$165,400 (1.97%)	$261,400 (3.1%)	$8,405,214	3.1%
Fort Edmonton Administration	$22,500 (0.87%)	$4,200 (0.16%)	$136,690 (5.26%)	$163,390 (6.3%)	$2,600,000	6.3%
Edmonton Police Service SW Division Station	$172,800 (0.80%)	$7,200 (0.03%)	$437,950 (2.04%)	$617,950 (2.9%)	$21,500,000	2.9%

* In Scenario B: Gold versus Silver, it is expected that additional LEED™ consulting fees would apply due to the increased amount of documentation and design work on behalf of the consultant teams. City of Edmonton staff provided an incremental value per additional credit, based upon recent pricing received within the Edmonton market, for a City of Edmonton project. This pricing regime is considered to be reflective of local market conditions, building typology and client expectations. The incremental value per credit is multiplied by the number of additional credits needed to achieve hypothetical Gold to determine an incremental premium for additional consulting fees. As such, the Silver scenario for Ellerslie has also been adjusted to remove the additional premium if it had been designed to Silver standards.

** Adjusted for LEED™ Rating: Ellerslie was designed for LEED™ Gold; as such the total costs have been adjusted by the capital cost premium to reflect the hypothetical build at a LEED™ Silver rating; the inverse holds true for Fort Edmonton and Police Service SW Division Station.

Table 4. Scenario B: LEED™ Gold vs Standard Construction Upfront Cost Premiums

Total Upfront LEED Gold vs Standard Construction Cost Premiums

	LEED Professional Premiums*	LEED Registration & Certification Costs	Total Capital Cost Premiums	Total LEED Premium	Total Construction Value**	Total LEED Gold Costs as a % of Total Construction Value
Ellerslie Fire Station	$96,500 (1.12%)	$7,500 (0.09%)	$234,786 (2.72%)	$338,786 (3.9%)	$8,640,000	3.9%
Fort Edmonton Administration	$30,500 (1.07%)	$4,200 (0.15%)	$263,210 (9.19%)	$297,910 (10.4%)	$2,863,210	10.4%
Edmonton Police Service SW Division Station	$181,800 (0.81%)	$7,200 (0.03%)	$898,349 (4.01%)	$1,087,349 (4.9%)	$22,398,349	4.9%

Table 5. Scenario B: LEED™ Gold vs LEED™ Silver Upfront Cost Premiums

Total Upfront LEED Gold vs LEED Silver Construction Cost Premiums

	LEED Professional Premiums*	LEED Registration & Certification Costs	Total Capital Cost Premiums	Total LEED Premium	Total Construction Value**	Total LEED Gold vs Silver Costs as a % of Total Construction Value
Ellerslie Fire Station	$8,000 (0.09%)	$0	$69,386 (0.80%)	$77,386 (0.9%)	$8,640,000	0.9%
Fort Edmonton Administration	$8,000 (0.28%)	$0	$126,520 (4.42%)	$134,520 (4.7%)	$2,863,210	4.7%
Edmonton Police Service SW Division Station	$9,000 (0.04%)	$0	$460,399 (2.06%)	$469,399 (2.1%)	$22,398,349	2.1%

The graphs below provide a snapshot of the relative values the specific cost and benefit categories which make up the NPV for the aggregated scenarios over the study period.

Figure 1. Discounted Cost & Benefits for the Aggregate Scenario A

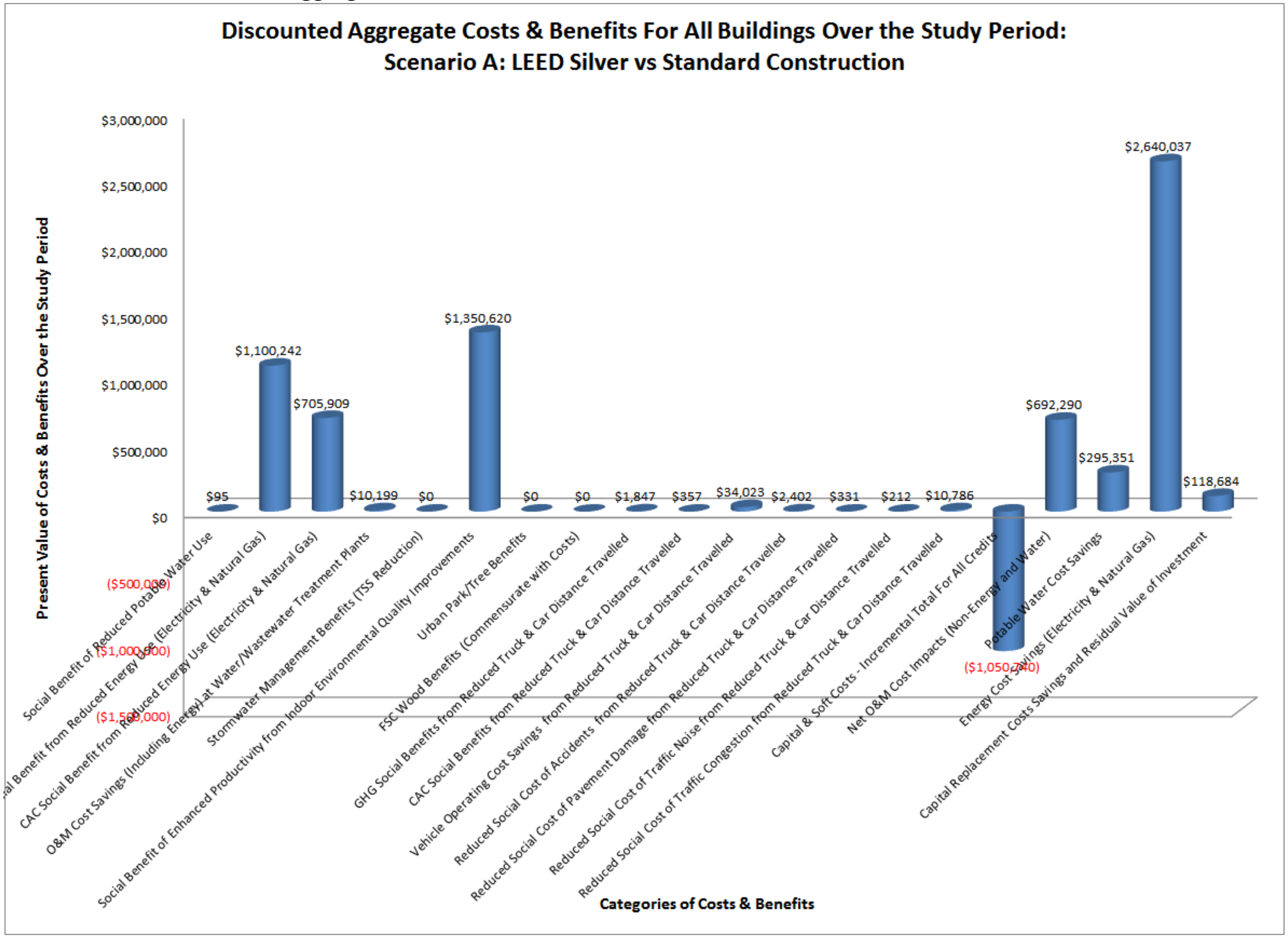
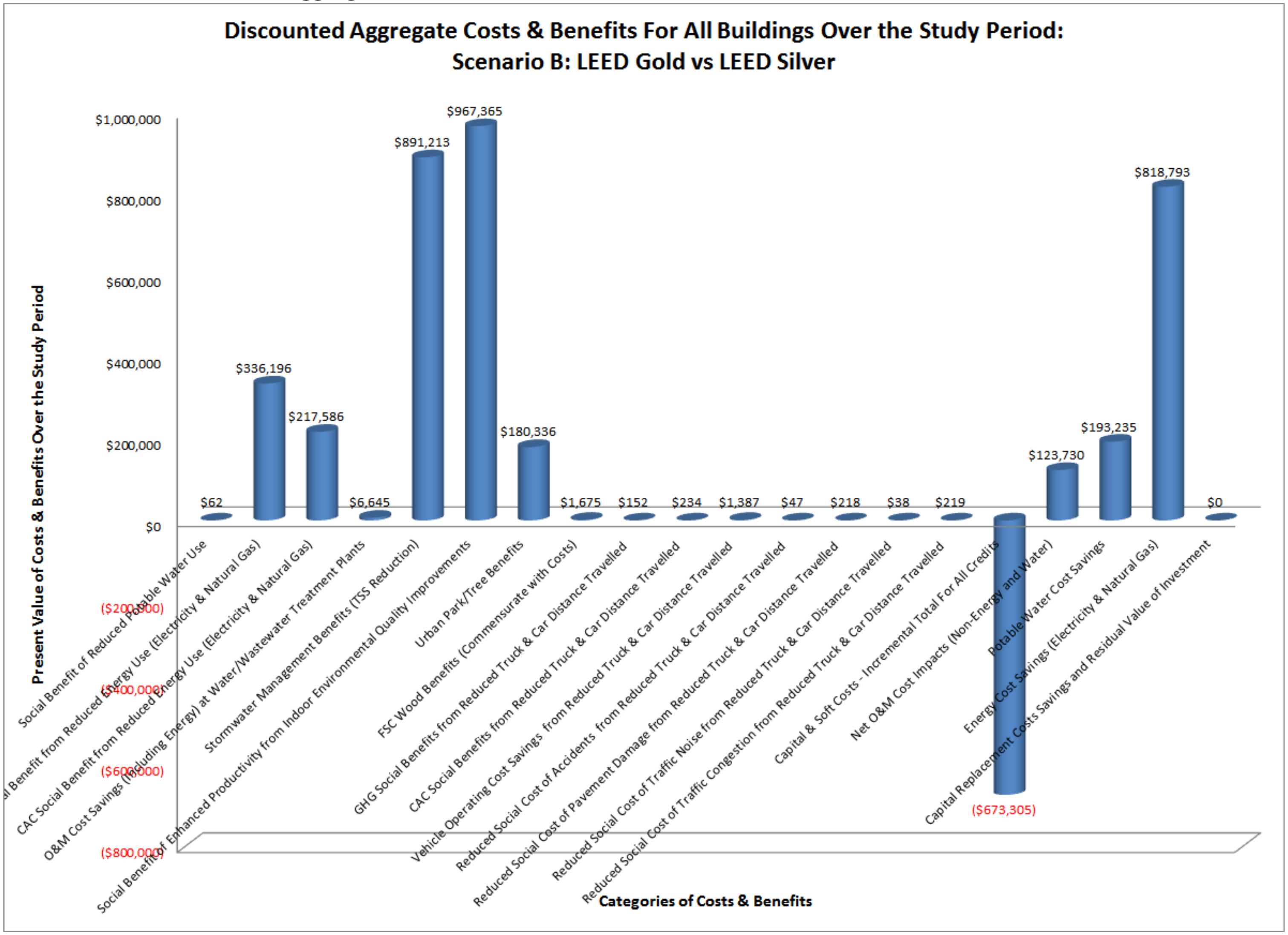


Figure 2. Discounted Cost & Benefits for the Aggregate Scenario B



3.1 Risk Analysis Results

The figures below provide risk-adjusted information (in the form of Sustainability S-curves) with regards to the Net Present Value (NPV) from both the FROI and SROI perspectives for the analysis. The S-Curves identify the probability distributions from each perspective in a cumulative manner and are synthesized into an intuitive risk analysis model. The results are stacked from worst to best, and the 50th percentile is the most likely value. The curves are generated using a 10,000 iteration probabilistic simulation as produced by the risk-analysis software add-on to Excel called @Risk. The difference between the two curves is the monetized social & environmental values; the purpose of the S-Curves is to show the range of possibilities, expected outcomes, and their probability of occurrence.

SCENARIO A: Aggregate Results

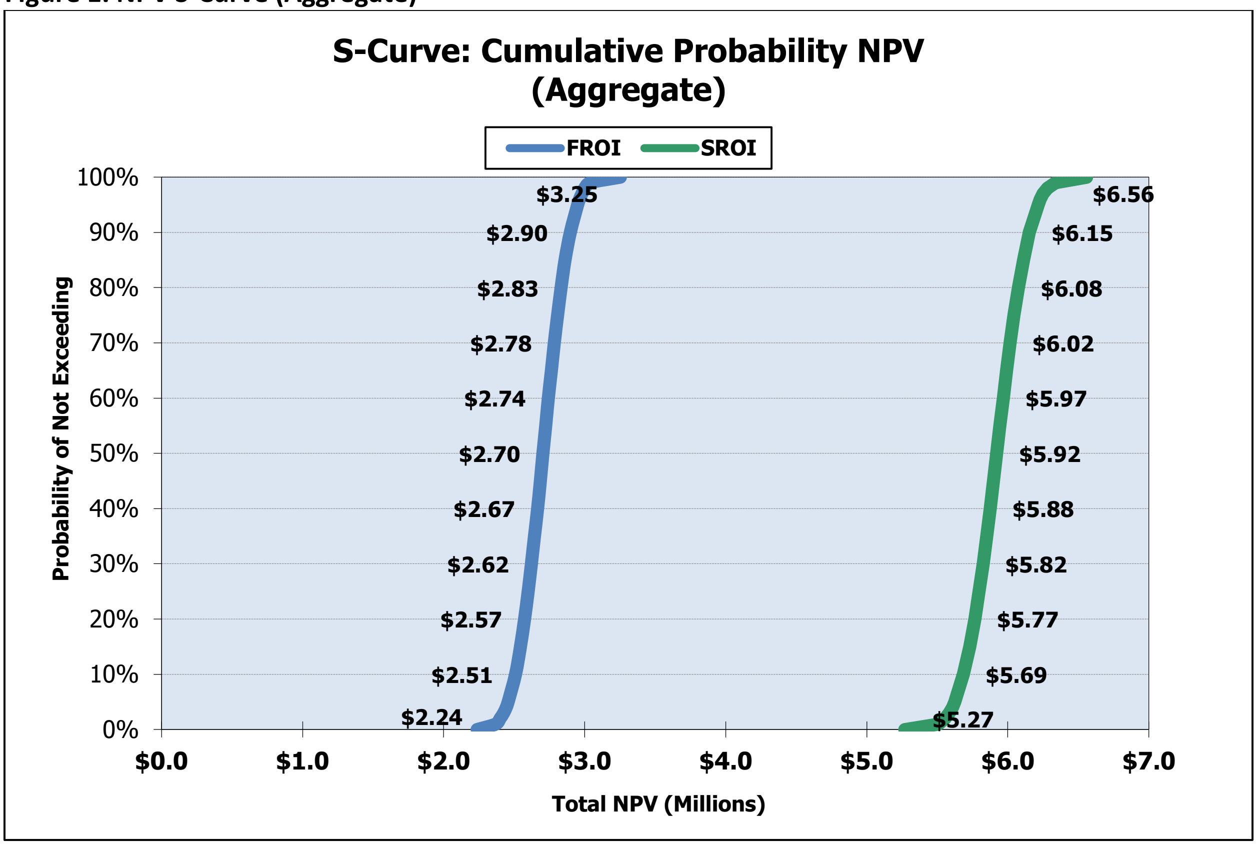
FROI

- The FROI NPV S-Curve shows a most-likely NPV of $2.7M (median); we can say that with 80% confidence, the NPV will fall between $2.51M and $2.90M.

SROI

- The SROI NPV S-Curve shows a most-likely NPV of $5.92M (median); we can say that with 80% confidence, the NPV will fall between $5.69M and $6.15M. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $3.22M.

Figure 1. NPV S-Curve (Aggregate)



In aggregate, there is a zero percent probability of the three buildings together (relative to standard construction) yielding a negative NPV with respect to both FROI and SROI. However, the aggregate results presented are not necessarily representative of every individual building in Edmonton. That is, individual project variations do exist. Results specific to each building are presented below.

SCENARIO A: Ellerslie Fire Station

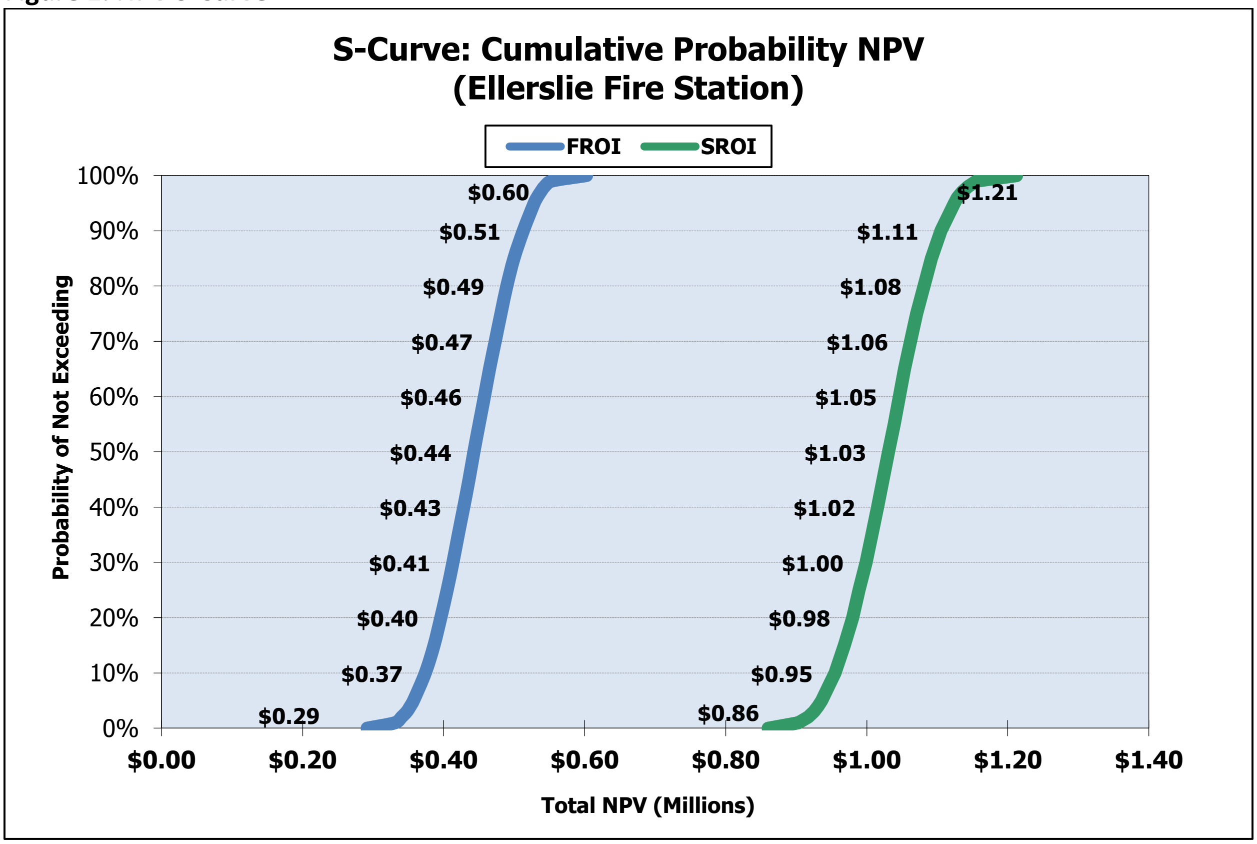
FROI

- The FROI NPV S-Curve shows a most-likely NPV of $0.44M (median); we can say that with 80% confidence, the NPV will fall between $0.37M and $0.51M.

SROI

- The SROI NPV S-Curve shows a most-likely NPV of $1.03M (median); we can say that with 80% confidence, the NPV will fall between $0.95M and $1.11M. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $0.59M.

Figure 2. NPV S-Curve



Therefore with Ellerslie, there is a 0% chance of a negative FROI or SROI NPV.

SCENARIO A: Fort Edmonton Administration

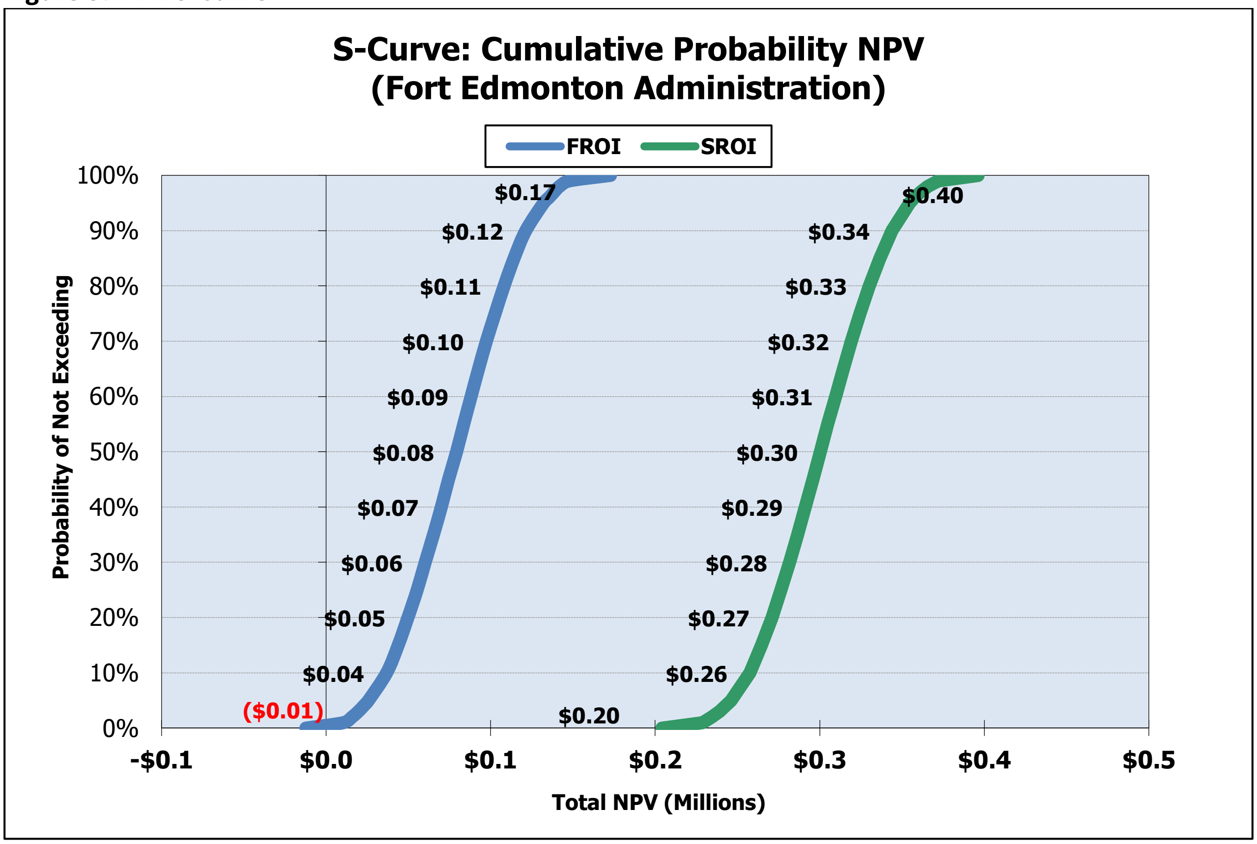
FROI

- The FROI NPV S-Curve shows a most-likely NPV of $80K (median); we can say that with 80% confidence, the NPV will fall between $40K and $120K.

SROI

- The SROI NPV S-Curve shows a most-likely NPV of $300K (median); we can say that with 80% confidence, the NPV will fall between $260K and $340K. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $220K.

Figure 3. NPV S-Curve



There is roughly a 2% percent probability of Fort Edmonton Administration yielding a slightly negative NPV with respect to FROI, but no chance with respect to SROI.

SCENARIO A: Edmonton Police Service SW Division Station

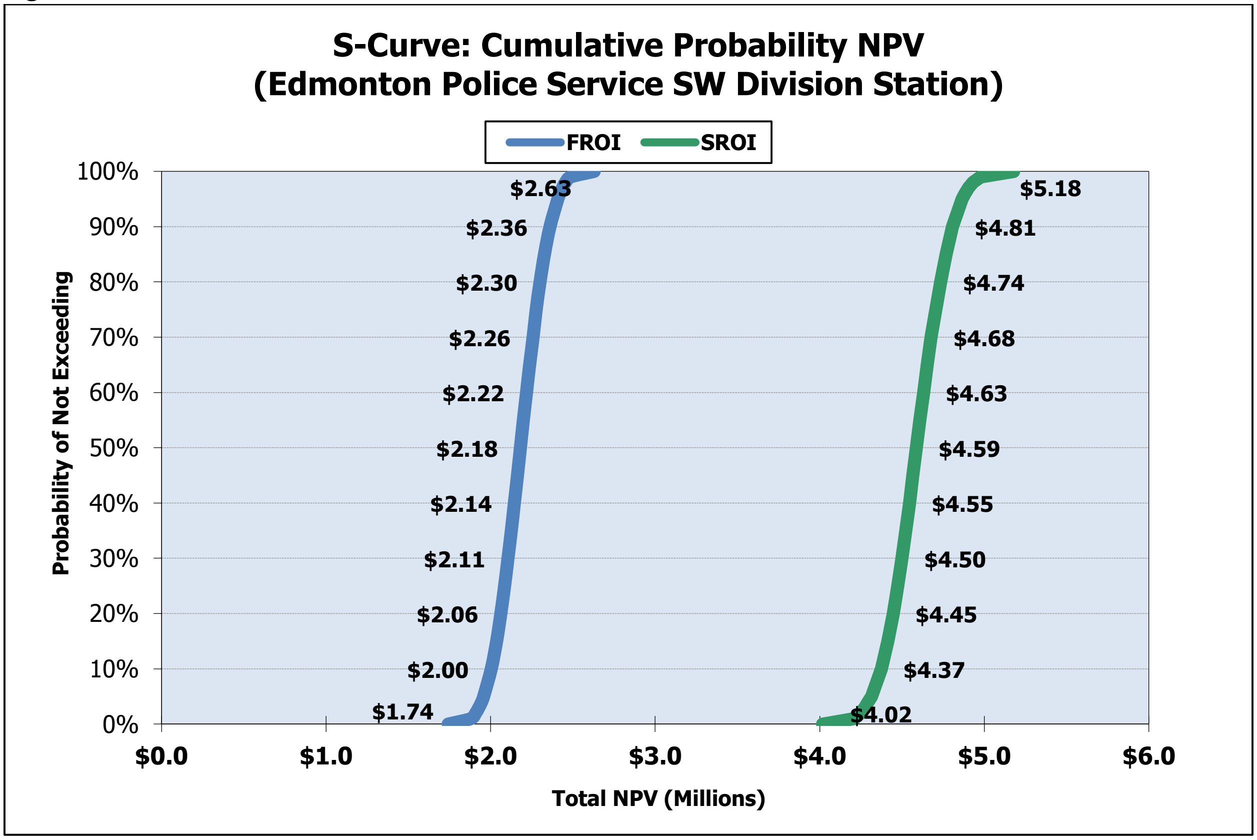
<u>FROI</u>

- The FROI NPV S-Curve shows a most-likely NPV of $2.18M (median); we can say that with 80% confidence, the NPV will fall between $2M and $2.36M.

<u>SROI</u>

- The SROI NPV S-Curve shows a most-likely NPV of $4.59M (median); we can say that with 80% confidence, the NPV will fall between $4.37M and $4.81M. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $2.41M.

Figure 4. NPV S-Curve



There is a zero percent probability of SW Police Service Division Station yielding a negative NPV with respect to both FROI and SROI.

SCENARIO B: Aggregate

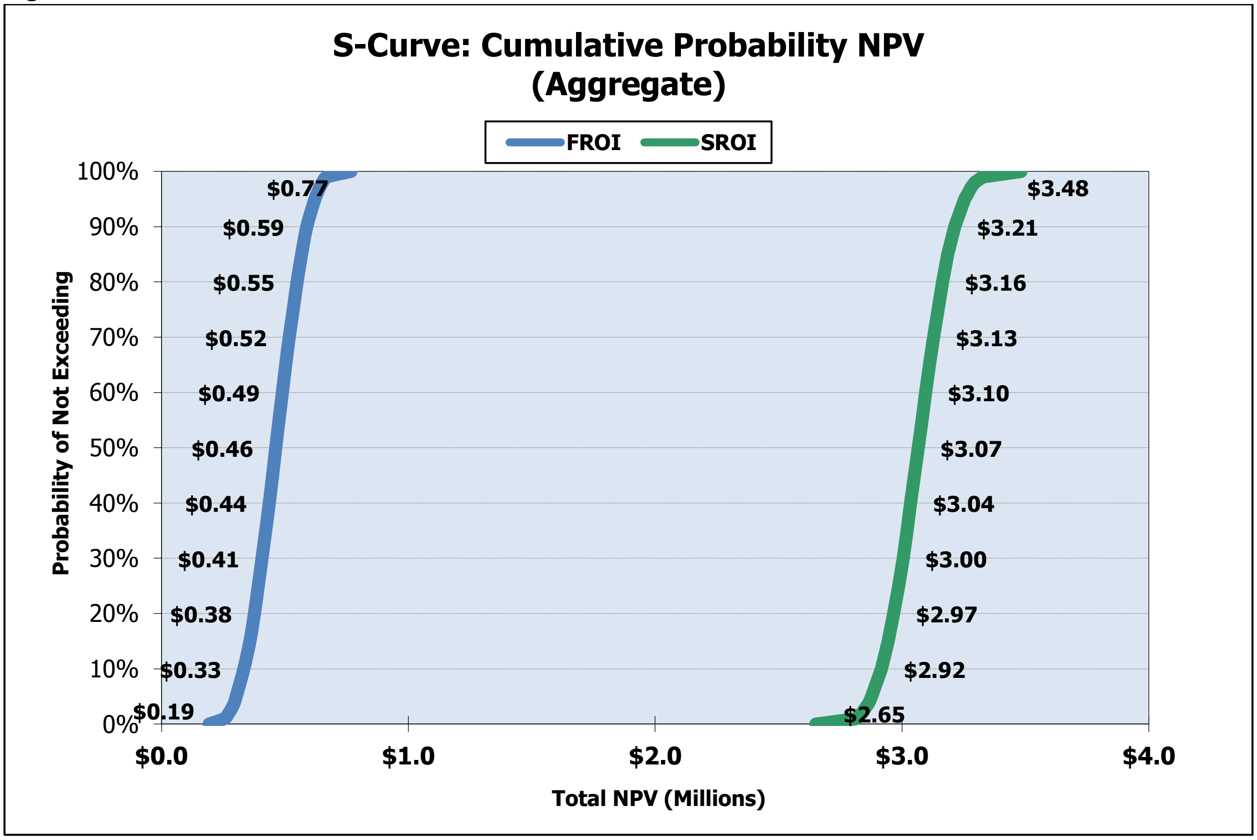
FROI

- The FROI NPV S-Curve shows a most-likely NPV of $0.46M (median); we can say that with 80% confidence, the NPV will fall between $0.33M and $0.59M.

SROI

- The SROI NPV S-Curve shows a most-likely NPV of $3.07M (median); we can say that with 80% confidence, the NPV will fall between $2.92M and $3.21M. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $2.61M.

Figure 5. NPV S-Curve



There is a zero percent probability of the aggregate Gold vs Silver scenario yielding a negative NPV with respect to both FROI and SROI.

SCENARIO B: Ellerslie Fire Station

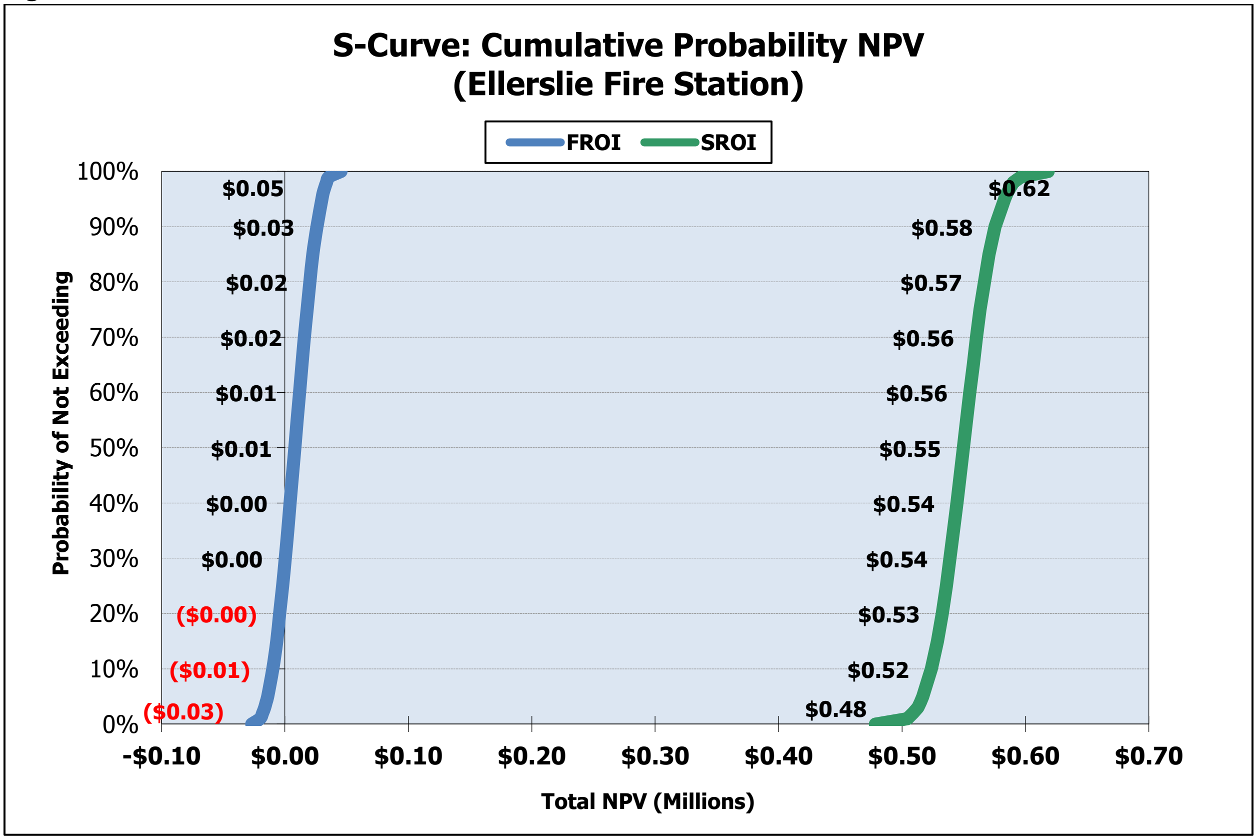
FROI

- The FROI NPV S-Curve shows a most-likely NPV of $-10K (median); we can say that with 80% confidence, the NPV will fall between $-10K and $30K.

SROI

- The SROI NPV S-Curve shows a most-likely NPV of $550K (median); we can say that with 80% confidence, the NPV will fall between $520K and $580K. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $540K.

Figure 6. NPV S-Curve



There is roughly a 20% percent probability of Ellerslie yielding a negative NPV with respect to FROI and zero chance with respect to SROI.

SCENARIO B: Fort Edmonton Administration

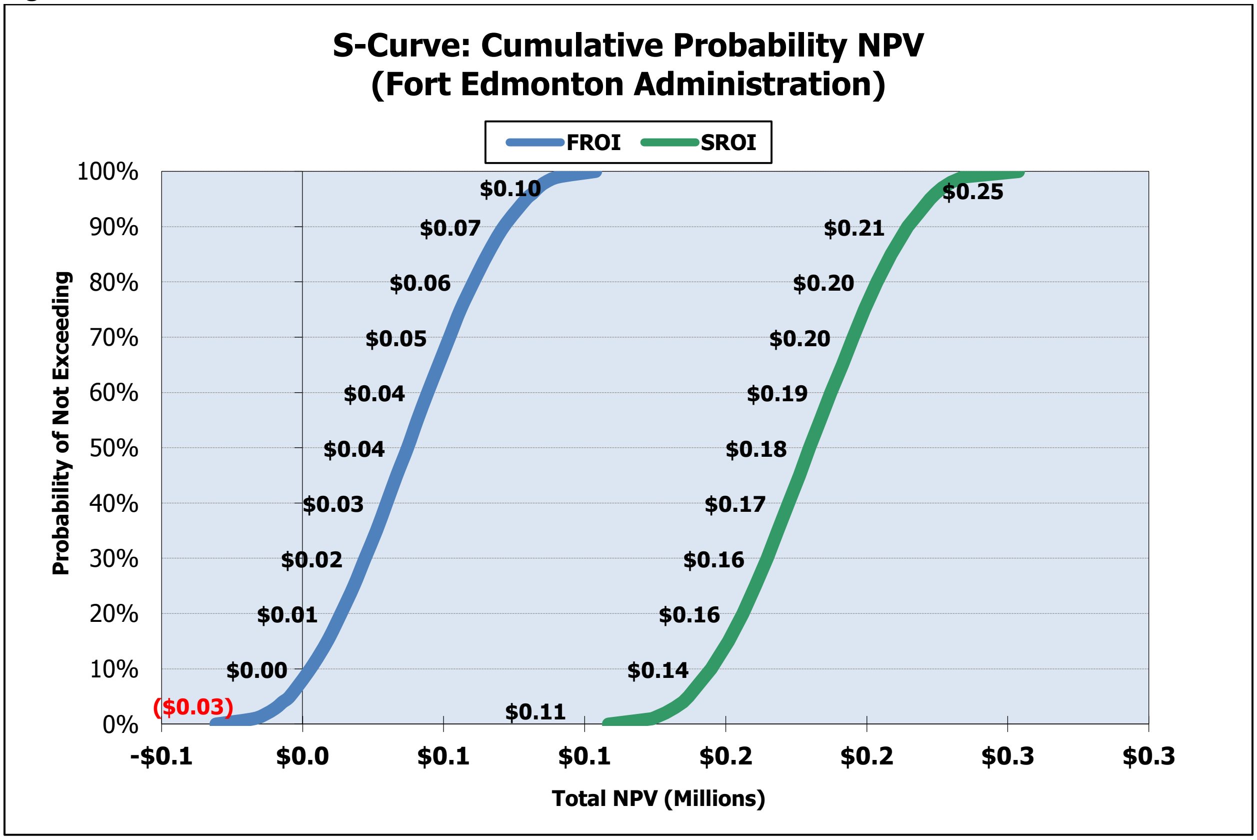
FROI

- The FROI NPV S-Curve shows a most-likely NPV of $40K (median); we can say that with 80% confidence, the NPV will fall between $3K and $70K.

SROI

- The SROI NPV S-Curve shows a most-likely NPV of $180K (median); we can say that with 80% confidence, the NPV will fall between $140K and $210K. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $150K.

Figure 7. NPV S-Curve



There is roughly a 7% percent probability of Fort Edmonton Administration yielding a negative NPV with respect to FROI and zero chance with respect to SROI.

SCENARIO B: Edmonton Police Service SW Division Station

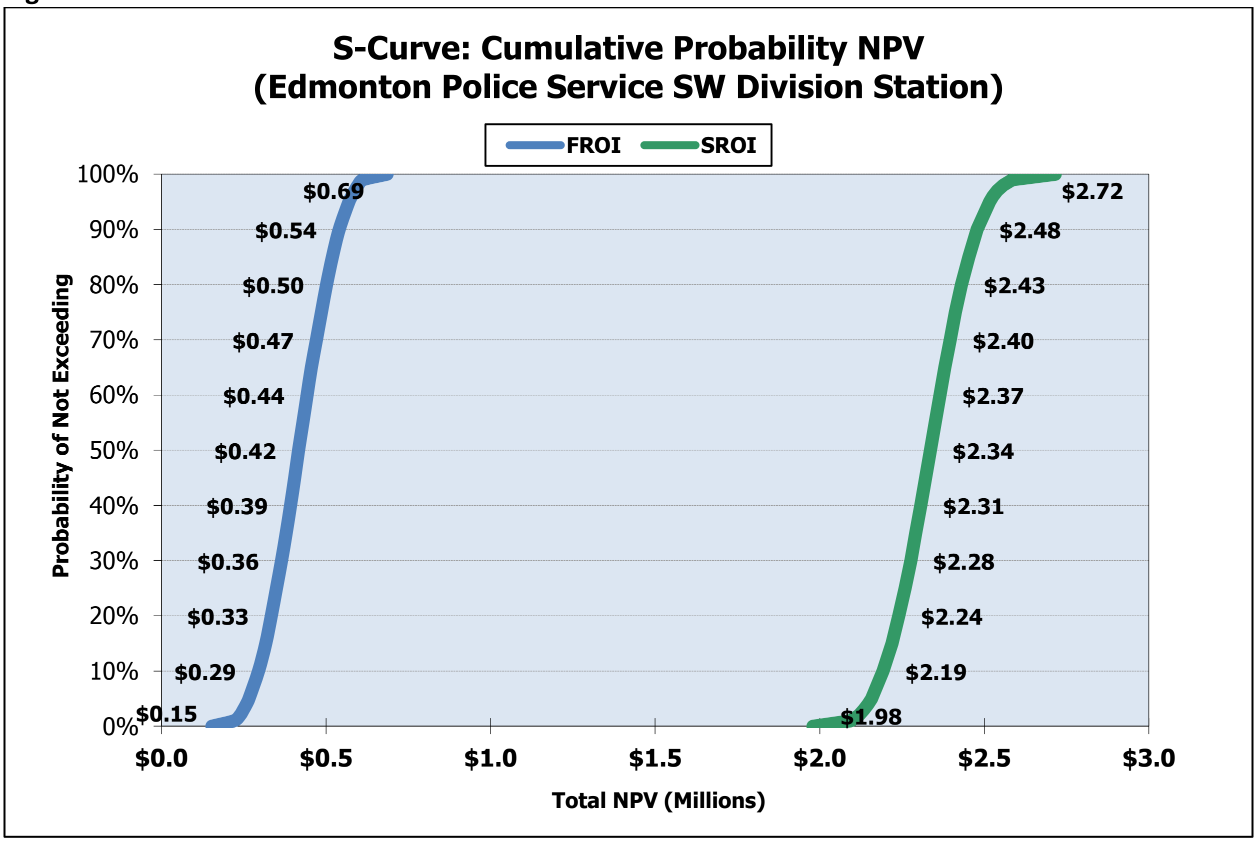
FROI

- The FROI NPV S-Curve shows a most-likely NPV of $0.42M (median); we can say that with 80% confidence, the NPV will fall between $0.29M and $0.54M.

SROI

- The SROI NPV S-Curve shows a most-likely NPV of $2.34M (median); we can say that with 80% confidence, the NPV will fall between $2.19M and $2.48M. The SROI S-Curve is to the right of the FROI S-Curve, and shows additional social & environmental benefits of approximately $1.92M.

Figure 8. NPV S-Curve



There is a zero percent probability of SW Police Service Division yielding a negative NPV with respect to both FROI and SROI.

APPENDIX A: INPUTS AND ASSUMPTIONS

Table 1. General Model Parameters

Variable Name	Parameter
Base Date	2014
Study Period	31 Years
Location	Edmonton, AB

Table 2. General Inputs

Variable Name	Unit	Value	Source/Notes
		Median	
Discount Rate (Real)	%	2%	HDR
Ellerslie Fire Station - Average Salary - Fully Loaded	2014 $	$53,692	HDR Calculated from City of Edmonton
Fort Edmonton Administration - Average Salary - Fully Loaded	2014 $	$87,435	HDR Calculated from City of Edmonton
Edmonton Police Service SW Division Station - Average Salary - Fully Loaded	2014 $	$70,096	HDR Calculated from City of Edmonton
Ellerslie Fire Station	# Employees	38.0	HDR Calculated from City of Edmonton
Fort Edmonton Administration	# Employees	20.0	HDR Calculated from City of Edmonton
Edmonton Police Service SW Division Station	# Employees	350.0	HDR Calculated from City of Edmonton
Ellerslie Fire Station	ft2	17,900	City of Edmonton
Fort Edmonton Administration	ft2	7000	City of Edmonton
Edmonton Police Service SW Division Station	ft2	60,000	City of Edmonton
m2 conversion to ft2	M2 to ft2	10.76391	Standard Conversion Rate
MJ conversion to MMBtu	MJ to MMBtu	0.00094701	Standard Conversion Rate

Table 3. Utilities

Variable Name	Unit	Value			Source/Notes
		Median	Low	High	
Natural Gas Utility Rate (2014): Ellerslie Fire Station	$2014/ MJ	$0.006	$0.003	$0.012	City of Edmonton. High/Low +/- 50% and escalating annually based on EIA price forecasts.
Natural Gas Utility Rate (2014): Fort Edmonton Administration	$2014/ MJ	$0.005	$0.003	$0.010	
Natural Gas Utility Rate (2014): Edmonton Police Service SW Division Station	$2014/ MJ	$0.006	$0.003	$0.012	

Electricity Utility Rate (2014): Ellerslie Fire Station	$2014/ kWh	$0.12	$0.06	$0.17	City of Edmonton. High/Low +/- 50% and escalating annually based on EIA price forecasts.
Electricity Utility Rate (2014): Fort Edmonton Administration	$2014/ kWh	$0.11	$0.06	$0.17	
Electricity Utility Rate (2014): Edmonton Police Service SW Division Station	$2014/ kWh	$0.13	$0.06	$0.19	
Potable Water Rate (2014): Ellerslie Fire Station	$2014/ L	$0.0017	$0.0009	$0.0026	City of Edmonton. High/Low +/- 50% and escalating annually based on EPCOR forecasts and inflation
Potable Water Rate (2014): Fort Edmonton Administration	$2014/ L	$0.0018	$0.0009	$0.0027	
Potable Water Rate (2014): Edmonton Police Service SW Division Station	$2014/ L	$0.0017	$0.0009	$0.0026	

Table 4. Ellerslie Fire Station Inputs

Ellerslie Fire Station: Scenario A - LEED Silver vs Standard Construction				
Benefits				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Storm Water Management Benefits (TSS): SS 6.1 & SS 6.2	$ / Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Decreased Potable Water Consumption: WE 3.2	Litres / Year	**Median**	-	18,458.00
		Low	-	13,843.50
		High	-	23,072.50
Decreased Electricity Consumption: All Credits Within EA 1	KWh/ Year	**Median**	-	168,210.00
		Low	-	126,157.50
		High	-	210,262.50
Decreased Natural Gas Consumption: All Credits Within EA 1	MJ/ Year	**Median**	-	919,298.24
		Low	-	689,473.68
		High	-	1,149,122.80
Incremental Non-Energy O&M Decrease: All Credits	$ / Year	**Median**	$0	$6,040
		Low	$0	$4,530
		High	$0	$7,550
IEQ Productivity Benefit: Toxins & Irritants Control	$ /	**Median**	$0	$138

	Year	Low	$0	$0
		High	$0	$398
IEQ Productivity Benefit: Comfort Control	$/Year	Median	$0	$7,864
		Low	$0	$0
		High	$0	$15,727
IEQ Productivity Benefit: Reduction in Communicable Respiratory Diseases	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Urban Park/Tree Benefits: Protect/Restore Open Space: SS 5	$ / Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Reduced Single Occupancy Vehicle - SS 4.4	Km / Year	Median	0.0	0
		Low	0.0	0
		High	0.0	0
Reduced Truck Hauling Distance - MR5	Km / Year	Median	0.0	0
		Low	0.0	0
		High	0.0	0
FSC Wood Benefits - MR 7 - (Commensurate with Costs)	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Avoided Future Replacement Costs - Base Case Roof	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value of Base Case Roof Replacement Costs	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value - Metal Roof (50 yr useful life)	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Costs				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Incremental Upfront Capital & Soft Costs Total - sum of all incremental capital & soft costs from each credit for each building	$	Median	$261,400	$0
		Low	$132,950	$0
		High	$489,850	$0
Annual Incremental O&M Cost Total	$/year	Median	$0	$0
		Low	$0	$0
		High	$0	$0

Table 5. Fort Edmonton Administration

Fort Edmonton Administration: Scenario A - LEED Silver vs Standard Construction				
Benefits				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Storm Water Management Benefits (TSS): SS 6.1 & SS 6.2	$ / Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Decreased Potable Water Consumption: WE 3.2	Litres / Year	**Median**	-	21,066.00
		Low	-	15,799.50
		High	-	26,332.50
Decreased Electricity Consumption: All Credits Within EA 1	KWh/ Year	**Median**	-	31,149.00
		Low	-	23,361.75
		High	-	38,936.25
Decreased Natural Gas Consumption: All Credits Within EA 1	MJ/ Year	**Median**	-	311,287.00
		Low	-	233,465.25
		High	-	389,108.75
Incremental Non-Energy O&M Decrease: All Credits	$ / Year	**Median**	$0	$3,021
		Low	$0	$2,266
		High	$0	$3,776
IEQ Productivity Benefit: Toxins & Irritants Control	$ / Year	**Median**	$0	$83
		Low	$0	$0
		High	$0	$238
IEQ Productivity Benefit: Comfort Control	$/Year	**Median**	$0	$3,524
		Low	$0	$0
		High	$0	$7,049
IEQ Productivity Benefit: Reduction in Communicable Respiratory Diseases	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Urban Park/Tree Benefits: Protect/Restore Open Space: SS 5	$ / Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Reduced Single Occupancy Vehicle - SS 4.4	Km / Year	**Median**	0.0	7,470
		Low	0.0	5,603
		High	0.0	9,338
Reduced Truck Hauling Distance - MR5	Km / Year	**Median**	0.0	2,075
		Low	0.0	1,556

		High	0.0	2,593
FSC Wood Benefits - MR 7 - (Commensurate with Costs)	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Avoided Future Replacement Costs - Base Case Roof	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value of Base Case Roof Replacement Costs	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value - Metal Roof (50 yr useful life): in year 2044	$/Year	Median	$0	$95,760
		Low	$0	$47,880
		High	$0	$143,640
Costs				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Incremental Upfront Capital & Soft Costs Total - sum of all incremental capital & soft costs from each credit for each building	$	Median	$163,390	$0
		Low	$82,955	$0
		High	$243,825	$0
Annual Incremental O&M Cost Total	$/year	Median	$0	$0
		Low	$0	$0
		High	$0	$0

Table 6. Edmonton Police Service SW Division Station

Edmonton Police Service SW Division Station: Scenario A - LEED Silver vs Standard Construction				
Benefits				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Storm Water Management Benefits (TSS): SS 6.1 & SS 6.2	$ / Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Decreased Potable Water Consumption: WE 3.2	Litres / Year	Median	-	804,891.00
		Low	-	603,668.25
		High	-	1,006,113.75
Decreased Electricity Consumption: All Credits Within EA 1	KWh/ Year	Median	-	590,526.00
		Low	-	442,894.50
		High	-	738,157.50
Decreased Natural Gas Consumption: All Credits Within EA 1	MJ/	Median		

	Year		-	2,041,960.00
		Low	-	1,531,470.00
		High	-	2,552,450.00
Incremental Non-Energy O&M Decrease: All Credits	$ / Year	**Median**	$0	$21,850
		Low	$0	$16,388
		High	$0	$27,313
IEQ Productivity Benefit: Toxins & Irritants Control	$ / Year	**Median**	$0	$1,643
		Low	$0	$0
		High	$0	$4,732
IEQ Productivity Benefit: Comfort Control	$/Year	**Median**	$0	$46,780
		Low	$0	$0
		High	$0	$93,560
IEQ Productivity Benefit: Reduction in Communicable Respiratory Diseases	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Urban Park/Tree Benefits: Protect/Restore Open Space: SS 5	$ / Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Reduced Single Occupancy Vehicle - SS 4.4	Km / Year	**Median**	0.0	0
		Low	0.0	0
		High	0.0	0
Reduced Truck Hauling Distance - MR5	Km / Year	**Median**	0.0	0
		Low	0.0	0
		High	0.0	0
FSC Wood Benefits - MR 7 - (Commensurate with Costs)	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Avoided Future Replacement Costs - Base Case Roof: in year 2034	$/Year	**Median**	$0	$135,104
		Low	$0	$67,552
		High	$0	$202,656
Residual Value of Base Case Roof Replacement Costs: in year 2044	$/Year	**Median**	$0	$27,021
		Low	$0	$13,510
		High	$0	$40,531
Residual Value - Metal Roof (50 yr useful life)	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Costs				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Incremental Upfront Capital & Soft Costs Total - sum of all incremental capital & soft costs from each credit for each building	$	**Median**	$617,950	$0
		Low	$308,975	$0
		High	$926,925	$0

Annual Incremental O&M Cost Total	$/year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0

Table 7. Ellerslie Fire Station

Ellerslie Fire Station: Scenario B - LEED Gold vs LEED Silver				
Benefits				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Storm Water Management Benefits (TSS): SS 6.1 & SS 6.2	$ / Year	**Median**	$0	$13,840
		Low	$0	$5,468
		High	$0	$22,213
Decreased Potable Water Consumption: WE 3.2	Litres / Year	**Median**	-	20,937.00
		Low	-	15,702.75
		High	-	26,171.25
Decreased Electricity Consumption: All Credits Within EA 1	KWh/ Year	**Median**	-	21,544.00
		Low	-	16,158.00
		High	-	26,930.00
Decreased Natural Gas Consumption: All Credits Within EA 1	MJ/ Year	**Median**	-	118,168.00
		Low	-	88,626.00
		High	-	147,710.00
Incremental Non-Energy O&M Decrease: All Credits	$ / Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
IEQ Productivity Benefit: Toxins & Irritants Control	$ / Year	**Median**	$0	$138
		Low	$0	$0
		High	$0	$398
IEQ Productivity Benefit: Comfort Control	$/Year	**Median**	$0	$2,621
		Low	$0	$0
		High	$0	$5,242
IEQ Productivity Benefit: Reduction in Communicable Respiratory Diseases	$/Year	**Median**	$0	$3,552
		Low	$0	$0
		High	$0	$7,105
Urban Park/Tree Benefits: Protect/Restore Open Space: SS 5	$ / Year	**Median**	$0	$1,672
		Low	$0	$1,444

		High	$0	$1,900
Reduced Single Occupancy Vehicle - SS 4.4	Km / Year	Median	0.0	0
		Low	0.0	0
		High	0.0	0
Reduced Truck Hauling Distance - MR5	Km / Year	Median	0.0	0
		Low	0.0	0
		High	0.0	0
FSC Wood Benefits - MR 7 - (Commensurate with Costs)	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Avoided Future Replacement Costs - Base Case Roof	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value of Base Case Roof Replacement Costs	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value - Metal Roof (50 yr useful life)	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Costs				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Incremental Upfront Capital & Soft Costs Total - sum of all incremental capital & soft costs from each credit for each building	$	Median	$69,386	$0
		Low	$34,693	$0
		High	$104,079	$0
Annual Incremental O&M Cost Total	$/year	Median	$0	$95
		Low	$0	$48
		High	$0	$143

Table 8. Fort Edmonton Administration

Fort Edmonton Administration: Scenario B - LEED Gold vs LEED Silver				
Benefits				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Storm Water Management Benefits (TSS): SS 6.1 & SS 6.2	$ / Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Decreased Potable Water Consumption: WE 3.2	Litres / Year	Median	-	31,843.00
		Low	-	23,882.25
		High	-	39,803.75
Decreased Electricity Consumption: All Credits Within EA 1	KWh/ Year	Median	-	6,517.00

		Low	-	4,887.75
		High	-	8,146.25
Decreased Natural Gas Consumption: All Credits Within EA 1	MJ/ Year	Median	-	78,758.00
		Low	-	59,068.50
		High	-	98,447.50
Incremental Non-Energy O&M Decrease: All Credits	$ / Year	Median	$0	$5,997
		Low	$0	$4,498
		High	$0	$7,496
IEQ Productivity Benefit: Toxins & Irritants Control	$ / Year	Median	$0	$83
		Low	$0	$0
		High	$0	$238
IEQ Productivity Benefit: Comfort Control	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
IEQ Productivity Benefit: Reduction in Communicable Respitory Diseases	$/Year	Median	$0	$3,184
		Low	$0	$0
		High	$0	$6,369
Urban Park/Tree Benefits: Protect/Restore Open Space: SS 5	$ / Year	Median	$0	$2,090
		Low	$0	$1,805
		High	$0	$2,375
Reduced Single Occupany Vehicle - SS 4.4	Km / Year	Median	0.0	0
		Low	0.0	0
		High	0.0	0
Reduced Truck Hauling Distance - MR5	Km / Year	Median	0.0	0
		Low	0.0	0
		High	0.0	0
FSC Wood Benefits - MR 7 - (Commensurate with Costs, 2014)	$/Year	Median	$1,675	$0
		Low	$1,256	$0
		High	$2,094	$0
Avoided Future Replacement Costs - Base Case Roof	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value of Base Case Roof Replacement Costs	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value - Metal Roof (50 yr useful life): in year 2044	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
Costs				

Parameter	Metrics	Year	2014	2015-2044
Incremental Upfront Capital & Soft Costs Total - sum of all incremental capital & soft costs from each credit for each building	$	Median	$134,520	$0
		Low	$67,260	$0
		High	$201,780	$0
Annual Incremental O&M Cost Total	$/year	Median	$0	$0
		Low	$0	$0
		High	$0	$0

Table 9. Edmonton Police Service SW Division Station

Edmonton Police Service SW Division Station: Scenario B - LEED Gold vs LEED Silver				
Benefits				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Storm Water Management Benefits (TSS): SS 6.1 & SS 6.2	$ / Year	Median	$0	$25,952
		Low	$0	$10,253
		High	$0	$41,652
Decreased Potable Water Consumption: WE 3.2	Litres / Year	Median	-	498,225.00
		Low	-	373,668.75
		High	-	622,781.25
Decreased Electricity Consumption: All Credits Within EA 1	KWh/ Year	Median	-	216,969.00
		Low	-	162,726.75
		High	-	271,211.25
Decreased Natural Gas Consumption: All Credits Within EA 1	MJ/ Year	Median	-	749,775.00
		Low	-	562,331.25
		High	-	937,218.75
Incremental Non-Energy O&M Decrease: All Credits	$ / Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
IEQ Productivity Benefit: Toxins & Irritants Control	$ / Year	Median	$0	$1,643
		Low	$0	$0
		High	$0	$4,732
IEQ Productivity Benefit: Comfort Control	$/Year	Median	$0	$0
		Low	$0	$0
		High	$0	$0
IEQ Productivity Benefit: Reduction in Communicable Respitory Diseases	$/Year	Median	$0	$31,698
		Low	$0	$0

		High	$0	$63,396
Urban Park/Tree Benefits: Protect/Restore Open Space: SS 5	$ / Year	**Median**	$0	$4,290
		Low	$0	$3,705
		High	$0	$4,875
Reduced Single Occupany Vehicle - SS 4.4	Km / Year	**Median**	0.0	0
		Low	0.0	0
		High	0.0	0
Reduced Truck Hauling Distance - MR5	Km / Year	**Median**	0.0	2,432
		Low	0.0	1,824
		High	0.0	3,040
FSC Wood Benefits - MR 7 - (Commensurate with Costs)	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Avoided Future Replacement Costs - Base Case Roof: in year 2034	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value of Base Case Roof Replacement Costs: in year 2044	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Residual Value - Metal Roof (50 yr useful life)	$/Year	**Median**	$0	$0
		Low	$0	$0
		High	$0	$0
Costs				
Parameter	**Metrics**	**Year**	**2014**	**2015-2044**
Incremental Upfront Capital & Soft Costs Total - sum of all incremental capital & soft costs from each credit for each building	$	**Median**	$469,399	$0
		Low	$234,700	$0
		High	$704,099	$0
Annual Incremental O&M Cost Total	$/year	**Median**	$0	$377
		Low	$0	$189
		High	$0	$566

APPENDIX B: INCREMENTAL CREDITS EVALUATION

The following credits have been identified for each project as incremental to alternate case scenario A and B for each of the three case study projects analyzed. This appendix provides additional details, insight, and information into the individual strategies technologies and design approaches taken by each of the case-study projects. Each project's individual solution, to achieve each credit, presents unique probable incremental costs and benefits corresponding to various categories indicated in Section 2.4 of this report. This appendix further lists each probable cost and benefit relating to each credit, the rationale for the result and additional notes regarding the monetization/numeration of each.

Table 1 - Ellerslie Fire Station No. 27

SSc5 – Protect/Restore Open Space		
Approach	**Cost/Benefit**	**Notes**
Provided bioswale with high-density landscaping, and native and adaptive plantings in lieu of turf-grass throughout rest of landscaped areas. Achieved at Gold level and assumed to have been not pursued at hypothetical Silver level due to cost.	Capital Costs	HDR Estimate (see Appendix C)
	Non-Energy O&M	$0.26/LF/Yr maintenance premium over standard turf. Values provided by 3rd party literature.
	Tree Benefits	HDR Calculations (values from 3rd party literature, see Appendix C).
	Reduced Storm Flows & Total Suspended Solids	Stormwater management benefits are captured in SSc6 below but capital and O&M costs relating to landscaping are included in landscape calculations done for this credit
SSc6 – Storm Water Management		
Approach	**Cost/Benefit**	**Notes**
Provided bioswale, and underground storm detention pipes. Achieved at Gold level and assumed not pursued at hypothetical Silver level.	Capital Costs	HDR Estimate (see Appendix C). Capital costs for bioswale captured under SSc5 above. Capital costs for underground storm detention captured under this credit.
	Non-Energy O&M	Landscape maintenance costs captured in SSc5 O&M costs above.
	Reduced Storm Flows & Total Suspended Solids	HDR Calculations: Flow calculated based on 600L/m2/yr from environment Canada precipitation data. TSS calculated based on aggregate concentrations for various run-off surfaces (values from 3rd party literature). Avoided costs values used as proxy from City of Calgary study completed by HDR.
WEc2 – Innovative Waste Water		
Approach	**Cost/Benefit**	**Notes**
Provided waterless urinals, dual-flush toilets, and sensored lavatory faucets to reduce potable water consumption. Achieved at Gold level and assumed not pursued at hypothetical silver level.	Capital Costs	HDR Estimate (See Appendix C)
	Non-Energy O&M	Additional maintenance costs include cleaning/repair of waterless fixtures and replacing batteries in sensored faucets. Values provided by 3rd party literature and calculated on a per fixture basis (Appendix C).
	Water Savings	Savings taken from LEED submittal data, and volume (L/YR) adjusted as beyond 30% savings over LEED defined baseline. 30% beyond LEED defined baseline was hypothesized to be the achieved value in the hypothetical Silver

		scenario. WEc2 achieved at Gold level is incremental only over what was already achieved at Silver.
WEc3.1 – Water Use Reduction: 30%		
Approach	**Cost/Benefit**	**Notes**
Provided waterless urinals, dual-flush toilets, sensored lavatory faucts and low-flow showers as per WEc2 above. Achieved at Gold level. Hypothetical Silver scenario would still achieve credit but would not use waterless urinals or dual-flush WC's. Low-flow fixtures would be used instead.	Capital Costs	HDR Estimate (see appendix C). Values provided by 3rd party literature. It is often stated there a *negligible* cost premium for these fixtures because it is so small (<50$). It is still a quantifiable value however and HDR elected to include it in the capital costs.
	Non-Energy O&M	Additional maintenance costs relate to replacing batteries in sensored fixtures. Values provided by 3rd party literature and calculated on a per fixture basis (Appendix C)
	Water Savings	Savings taken from LEED submittal data, and volume (L/YR) adjusted as beyond 20% savings over LEED defined baseline. 20% beyond LEED defined baseline was considered "standard construction" due to the ubiquity of "low-flow" fixtures in the marketplace.
EAc1 – Optimize Energy Performance		
Approach	**Cost/Benefit**	**Notes**
Provided energy efficient design features including increased thermal insulation, in-slab and perimeter radiant heating and cooling, occupancy sensors for lighting, variable frequency drives for pumps and fans and energy recovery ventilators. 7 Points achieved at Gold level. Hypothetical Silver scenario assumed to achieve 4 points based on NRCan meta-analysis of EUI at different LEED certification levels	Capital Costs	HDR Estimate (see Appendix C). Individual technologies identified with assistance of project design team and estimated based on catalogue data and 3rd party literature.
	Non-Energy O&M	Facilities maintenance identified premature failure of VFD's in existing facilities. Probable cause in the opinion of maintenance staff is under-ventilation of mechanical rooms. List of work orders-by-facility relating to VFD repairs was provided and deconstructed into a $/SF proxy value to determine annual maintenance costs. HDR identified condensing boilers as a possible maintenance cost savings, and occupancy sensors as potentially requiring additional maintenance, however could not find sufficient data on maintenance cost to quantify these variables.
	Electricity & Gas Savings	Energy savings taken from LEED energy modelling data. kWh(e) converted to MJ/YR for use in SROI model. LEED Silver hypothetical scenario adjusted LEED Gold level energy savings by corresponding percentage relative to hypothetical number of points earned based on NRCan EUI meta-analysis. Gold level incremental performance is calculated as beyond that which was achieved at Silver level.
EAc3 – Best Practice Commissioning		
Approach	**Cost/Benefit**	**Notes**

Engaged the services of a 3rd Cx agent to provide enhanced commissioning services of major building systems, ensuring proper optimization and performance of installed components. Assumed to be already achieved at Hypothetical Silver level and not incremental at Gold.	Capital Costs	Costs to hire 3rd party commissioning agent for project provided directly by Client
	Non-Energy O&M	Calculated as $0.39/SF O&M savings based on values provided by 3rd party literature finding less maintenance/adjustments are required on properly commissioned systems.
	Electricity & Gas	Calculated as 0.14kWh/SF and 0.58MJ/SF based on 3rd party literature finding that proper commissioning supports better system optimization.
EQc2 – Ventilation Effectiveness		
Approach	**Cost/Benefit**	**Notes**
Increased make-up air set points to provide 1.0 AC/H (30% beyond ASHRAE 62 recommendations). Achieved at Gold level and assumed to be not pursued at Hypothetical Silver level.	Capital Costs	Additional technologies were not required to achieve this credit. It was achieved by adjusting the operation of the HVAC system installed.
	Non-Energy O&M	Approach does not generate maintenance costs or benefits
	Electricity & Gas	Additional electricity (fan energy) and additional gas (heat loss) usage result from increased ventilation rates, they are countered with the use of VFD’s and Energy Recovery Ventilation. The net impacts are captured in the EAc1 data.
	Productivity	Increased ventilation can lead to productivity improvement resulting from increased occupant comfort and wellness. (See section 2.5)
EQc3.2 – Construction IAQ Management: Pre-Occupancy		
Approach	**Cost/Benefit**	**Notes**
Flushed building with fresh air for set duration until set volume of air has been reached. “Cleans” building of dust, construction residues, and to a lesser extent VOC’s from off-gassing products. Assumed to be achieved at Hypothetical Silver level.	Capital Costs	Building flush-out impacts and extends schedule of project but as it is usually scheduled at the end of the project (immediately prior to occupancy) the contractor can demobilize during flush-out without incurring additional costs.
	Electricity	Fan energy used for building flush-out is typically *negligible* for facilities of this size and has not been quantified.
	Productivity	Pre-Occupancy air quality management can lead to improved productivity due to reduced adverse reactions to VOCs, dust and other allergens. (See section 2.5).
EQc4.4 – Low Emitting Materials: Composite Wood & Laminates		
Approach	**Cost/Benefit**	**Notes**
Provided low-VOC products for all composite wood and laminates to reduce off-gassing and occupant discomfort. Assumed to be achieved at Hypothetical Silver level.	Capital Costs	Calculated as a 5% premium on materials (assumed 60/40 Labour: Material split).
	Non-Energy O&M	Water-based adhesives are less robust in nature than solvent based adhesives. Regular repairs of delaminating casework are often required. Calculated on a 5 year repair interval and amortized on a $/YR basis in model.
	Productivity	Low-VOC products can lead to improved occupant productivity due to fewer adverse reactions to VOCs and other irritants. (See section 2.5).

EQc5 – Indoor Pollutant Control		
Approach	**Cost/Benefit**	**Notes**
Installed built-in entrance floor grilles at all entrances to building to capture dirt and particulate entering the building. Assumed to be achieved at Hypothetical Silver level	Capital Costs	Calculated as $120/SF (supply & install)
	Non-Energy O&M	Manufacturer literature suggests entrance grilles can capture of 80% of dirt entering a building. This reduction in dirt suggests a maintenance savings in custodial costs, however, sufficient data is not currently available to quantify this benefit.
	Productivity	Reducing dirt (and dust) entering a building can improve occupant comfort by reducing exposure to irritants and allergens. (See section 2.5)

EQc6.1 – Controllability of Systems: Perimeter Spaces		
Approach	**Cost/Benefit**	**Notes**
Provided operable windows around perimeter of building and individual lighting controls in each space. Achieved at Gold level and assumed to not be pursued at hypothetical Silver level.	Capital Costs	Calculated as a premium cost for operable windows beyond fixed windows as LEED Silver scenario. (See Appendix C). No premium for additional lighting controls due to configuration of floor plan (controls would have been installed the same way in the alternate scenario).

EQc8 – Daylighting and Views		
Approach	**Cost/Benefit**	**Notes**
Provided daylighting to 75% of regular occupied spaces and views to 90% of occupied spaces by locating Fire truck garage in core of building and user facilities around perimeter. Floorplate was *oddly* (very intentionally) articulated to allow all offices/sleep rooms access to operable windows, daylighting and views.	Capital Costs	Calculated as premium cost for additional glazing and exterior wall assembly in areas where intentional floorplate articulation was done to achieve these credits. (See Appendix C)
	Non-Energy O&M	Premium for additional window cleaning calculated on an SF basis based on values from 3rd party literature.
	Electricity & Gas	Additional glazing and exterior wall surface would increase gas usage (heat loss) while decreasing electricity usage (lighting power density). It is assumed that both of these impacts are captured within the data provided via EAc1.
	Productivity	Increased access to natural light and views can have a positive impact on building occupant's health and wellness and lead to increased productivity. (See section 2.5)

IDc1.2 (WEc3) – Exceptional Performance: Water Use Reduction		
Approach	**Cost/Benefit**	**Notes**
Achieved via the cumulative effects of WEc2 and WEc3 (exceeded 50% water use reduction compared to LEED defined baseline).	Capital Costs	Captured under WEc2 & WEc3 estimates
	Non-Energy O&M	Captured under WEc2 & WEc3 estimates
	Water Savings	Total savings taken from LEED submittal data and incremental volume (L/YR) calculated as beyond savings generated via WEc2 & WEc3.

IDc2 – LEED AP		
Approach	**Cost/Benefit**	**Notes**
Engaged the services of a LEED accredited professional as a key member of the project team.	Consultant Fees	Provided directly by Client
	Cumulative Effects	The advice and expertise of the LEED AP as team member from early in the project in-part, leads to the results realized throughout all of

		the above credits.
	Integrated Design	The requirement for all disciplines to collaborate in the design process from the early stages of concept design can encourage greater innovation, and ultimately lead to better performing buildings. Insufficient data is available on this effect to quantify it directly, but it is assumed to in-part be captured within the outcomes of the above credits analyzed.

Table 2 – Fort Edmonton Park Administration Building

SSc5 – Alternative Transportation: Parking Capacity		
Approach	**Cost/Benefit**	**Notes**
Provided 'preferred' parking for carpooling staff and initiated a carpool program with sign-up sheet and staff notification/encouragement. Achieved at Silver level.	Reduced SOV Miles	Implementation of carpooling program induced behavior of two FTE's who now carpool together. Previous commute information provided directly by employee who now carpools instead of driving a single occupant vehicle.
SSc5 – Protect/Restore Open Space		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold level. Hypothetically, team would have provided additional planting density and area of new landscaping using native and adaptive plantings. Current site area meeting habitat requirements calculated, less total area needed to determine additional square footage. Tree density of planted area used to determine number of plantings in additional hypothetical habitat area.	Capital Costs	HDR Estimate (see Appendix C).
	Non-Energy O&M	$0.26/LF/Yr maintenance premium over standard turf. Values provided by 3rd party literature.
	Tree Benefits	HDR Calculations (values from 3rd party literature, see Appendix C).
SSc7.2 – Heat Island Effect: Roof		
Approach	Cost/Benefit	Notes
Provided metal roof with high solar reflectivity in lieu of bituminous roofing. Achieved at Silver level.	Capital Costs	HDR Estimate (see Appendix C)
	Non-Energy O&M	Calculated as avoided regular maintenance costs associated with conventional roofing. Values provided by 3rd party literature.
	Lifecycle Benefits	Calculated as the avoided replacement cost of standard roofing, based on the extended lifespan of the metal roof. Residual value added for lifecycle remaining beyond study period.
WEc2 – Innovative Waste Water		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold level. Difference assumed to be that project provided waterless urinals (in lieu of ultra-low flow), ultra-low flow toilets (in lieu of low-	Capital Costs	HDR Estimate (See Appendix C)
	Non-Energy O&M	Additional maintenance costs include cleaning/repair of waterless and ultra-low flow fixtures. Values provided by 3rd party literature and calculated on a per fixture basis.
	Water Savings	Savings taken from LEED submittal data, and

flow) and low-flow sinks (in lieu of standard sinks).		volume (L/YR) adjusted as beyond 30% savings over LEED defined baseline. 30% beyond LEED defined baseline was hypothesized to be the achieved value in the hypothetical Silver scenario. WEc2 achieved at Gold level is incremental only over what was already achieved at Silver.
WEc3.1 – Water Use Reduction: 30%		
Approach	**Cost/Benefit**	**Notes**
Provided ultra-low flow urinals and ultra-low flow lavatories. Achieved at Silver level.	Capital Costs	HDR Estimate (see appendix C). Values provided by 3rd party literature. It is often stated there a *negligible* cost premium for these fixtures because it is so small (<50$). It is still a quantifiable value however and HDR elected to include it in the capital costs.
	Non-Energy O&M	Additional maintenance costs relate to cleaning and repair of ultra-low flow fixtures. Values provided by 3rd party literature and calculated on a per fixture basis.
	Water Savings	Savings taken from LEED submittal data, and volume (L/YR) calculated as beyond 20% savings over LEED defined baseline. 20% beyond LEED defined baseline was considered "standard construction" due to the ubiquity of "low-flow" fixtures in the marketplace.
EAc1 – Optimize Energy Performance		
Approach	**Cost/Benefit**	**Notes**
Provided energy efficient design features including perimeter radiant heating, occupancy sensors for lighting and variable frequency drives for pumps and fans. 7 were achieved at Silver level however, it appears project design team used 'market value' for electricity costs instead of LEED defaults. To compare fairly to other projects, points achieved had to be adjusted based on energy *consumption.* Number of points at Silver level revised to 3. At hypothetical Gold level, it was assumed that energy recovery ventilation, additional thermal insulation and measurement and verification systems were added to project design. Points achieved at hypothetical Gold level increased to 6 based on NRCan meta-analysis of EUI at different LEED certification levels.	Capital Costs	HDR Estimate (see Appendix C). Individual technologies identified with assistance of project design team and estimated based on catalogue data and 3rd party literature.
	Non-Energy O&M	Facilities maintenance identified premature failure of VFD's in existing facilities. Probable cause in the opinion of maintenance staff is under-ventilation of mechanical rooms. List of work orders-by-facility relating to VFD repairs was provided and deconstructed into a $/SF proxy value to determine annual maintenance costs. HDR identified condensing boilers as a possible maintenance cost savings, and occupancy sensors as potentially requiring additional maintenance, however could not find sufficient data on maintenance cost to quantify these variables.
	Electricity & Gas Savings	Energy savings taken from LEED energy modelling data. kWh(e) converted to MJ/YR for use in SROI model. LEED Gold hypothetical scenario adjusted LEED Silver level energy savings by corresponding percentage relative to hypothetical number of points earned based on NRCan EUI meta-analysis. Gold level incremental performance is calculated as beyond that which was achieved at Silver level.

EAc3 – Best Practice Commissioning		
Approach	**Cost/Benefit**	**Notes**
Engaged the services of a 3rd Cx agent to provide enhanced commissioning services of major building systems, ensuring proper optimization and performance of installed components. Assumed to be already achieved at Hypothetical Silver level and not incremental at Gold.	Capital Costs	Costs to hire 3rd party commissioning agent for project provided directly by Client
	Non-Energy O&M	Calculated as $0.39/SF O&M savings based on values provided by 3rd party literature finding less maintenance/adjustments are required on properly commissioned systems.
	Electricity & Gas	Calculated as 0.14kWh/SF and 0.58MJ/SF based on 3rd party literature finding that proper commissioning supports better system optimization.
EAc5 – Measurement and Verification		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold level. Project hypothetically would have added DDC controls, Electricity sub-metering, and gas sub-metering for all major zones. Water sub-metering is already included in main facility water meter and is not considered incremental.	Capital Costs	HDR Estimate (see Appendix C)
	Non-Energy O&M	Calculated as a 10% reduction in non-utility buildings operations cost due to automated reporting and monitoring of systems. Less time spent by maintenance staff trouble-shooting problems to determine specific area of sub-optimization or failure. Value provided by 3rd party literature.
	Electricity & Gas Savings	10% energy savings added to values of EAc1 based on 3rd party literature findings of average performance outcomes (dynamic system optimization).
MRc5 – Regional Materials 20%		
Approach	Cost/Benefit	Notes
Provide 20% of project materials (by cost) that have been extracted and manufactured regionally (within 800km). Achieved at Silver level.	Capital Costs	No premium based on major building materials used in project.
	Reduced Truck Miles	Calculated as one time benefit based on potentially reduced trucking miles for building materials. LEED submittal data provides total truck miles for materials. A % savings is determined by comparing 4 building materials in different manufacturing classes (commodity, medium-value added x2 and high-value added) against the next largest competitor. The difference between the distance to plant location of what was used in the project and plant location of competing manufacturer becomes the basis of reduced miles. Due to the challenges of determining distance between point of extraction and manufacturing plant, distance from project site to point of extraction is not analyzed.
MRc7 – Certified Wood		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold. Project would have provided 50% of wood products from FSC certified sources.	Capital Cost	Previous studies by HDR have determined that the social value of FSC wood is equal to the additional capital cost, and as such no benefits or costs are realized in utilizing it.
	FSC Wood Social Value	

EQc1 – Carbone Dioxide (CO2) Monitoring		
Approach	Cost/Benefit	Notes
Not achieved at Silver level but hypothetically achieved at Gold level. Project would have incorporated CO2 sensors in intermittently occupied spaces and zones to allow demand controlled ventilation.	Capital Costs	Calculated based on 3rd party literature on a per sensor basis. Quantity determined based on logical locations in the opinion of HDR.
	Non-Energy O&M	Calculated as the annual cost of recalibration of sensors. High-end modern sensors are self-recalibrating, however still need semi-annual adjustments.
	Productivity	Increased and proper ventilation can increase occupant comfort and wellness and lead to increased productivity. (see section 2.5)
EQc2 – Ventilation Effectiveness		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold. Project would hypothetically Increase make-up air set points to provide 1.0 AC/H (30% beyond ASHRAE 62 recommendations).	Capital Costs	Additional technologies are not required to achieve this hypothetical approach.
	Non-Energy O&M	Approach does not generate maintenance costs or benefits
	Electricity & Gas	Additional electricity (fan energy) and additional gas (heat loss) usage result from increased ventilation rates, they are countered with the use of VFD's and Energy Recovery Ventilation. The net impacts are captured in the hypothetical EAc1 data.
	Productivity	Increased ventilation can lead to productivity improvement resulting from increased occupant comfort and wellness. (See section 2.5)
EQc3.2 – Construction IAQ Management: Pre-Occupancy		
Approach	**Cost/Benefit**	**Notes**
Flushed building with fresh air for set duration until set volume of air has been reached. "Cleans" building of dust, construction residues, and to a lesser extent VOC's from off-gassing products. Achieved at Silver level.	Capital Costs	Building flush-out impacts and extends schedule of project but as it is usually scheduled at the end of the project (immediately prior to occupancy) the contractor can demobilize during flush-out without incurring additional costs.
	Electricity	Fan energy used for building flush-out is typically *negligible* for facilities of this size and has not been quantified.
	Productivity	Pre-Occupancy air quality management can lead to improved productivity due to reduced adverse reactions to VOCs, dust and other allergens. (See section 2.5).
EQc4.4 – Low Emitting Materials: Composite Wood & Laminates		
Approach	**Cost/Benefit**	**Notes**
Provided low-VOC products for all composite wood and laminates to reduce off-gassing and occupant discomfort. Assumed to be achieved at Hypothetical Silver level.	Capital Costs	Calculated as a 5% premium on materials (assumed 60/40 Labour: Material split).
	Non-Energy O&M	Water-based adhesives are less robust in nature than solvent based adhesives. Regular repairs of delaminating casework are often required. Calculated on a 5 year repair interval and amortized on a $/YR basis in model.
	Productivity	Low-VOC products can lead to improved occupant productivity due to fewer adverse

		reactions to VOCs and other irritants. (See section 2.5).
EQc5 – Indoor Pollutant Control		
Approach	**Cost/Benefit**	**Notes**
Installed built-in entrance floor grilles at all entrances to building to capture dirt and particulate entering the building. Assumed to be achieved at Hypothetical Silver level	Capital Costs	Calculated as $120/SF (supply & install)
	Non-Energy O&M	Manufacturer literature suggests entrance grilles can capture of 80% of dirt entering a building. This reduction in dirt suggests a maintenance savings in custodial costs, however, sufficient data is not currently available to quantify this benefit.
	Productivity	Reducing dirt (and dust) entering a building can improve occupant comfort by reducing exposure to irritants and allergens. (See section 2.5)
EQc6.2 – Controllability of Systems: Non-Perimeter Spaces		
Approach	**Cost/Benefit**	**Notes**
Provided additional Thermostat controls and variable air volume boxes in non-perimeter spaces to allow individual occupant control of temperature and ventilation. Achieved at Silver level.	Capital Costs	Calculated using 3rd party literature values, on per control basis.
	Non-Energy O&M	Intuitively, additional thermostats and VAVs would increase the amount of maintenance required due to the fact there is simply more equipment to maintain. Insufficient data on these maintenance costs was available to quantify this impact.
	Productivity	A higher degree of occupant control can enhance occupant comfort and lead to greater productivity. (See section 2.5)
EQc8 – Daylighting and Views		
Approach	**Cost/Benefit**	**Notes**
Provided daylighting to 75% of regular occupied spaces and views to 90% of occupied spaces by use of a narrow floor plate and clerestory glazing. Building typology and concept design is conducive to achieving this credit. Roller shades were provided to meet glare control requirements. Achieved at Silver level	Capital Costs	Calculated as premium cost for additional roller shades to meet glare control requirements only. Building concept design achieved daylighting requirements.
	Non-Energy O&M	Not applicable based on DL strategy
	Electricity & Gas	No impact based on DL strategy
	Productivity	Increased access to natural light and views can have a positive impact on building occupant's health and wellness and lead to increased productivity. (See section 2.5)
IDc1.1 – Green Furniture		
Approach	**Cost/Benefit**	**Notes**
Provided "green furniture" for all systems furniture and seating. Green furniture requires low or zero VOC materials and finishes and often incorporates recycled content. Achieved at Silver level.	Capital Cost	Client confirmed no cost premium.
	Productivity	Low-VOC products can lead to improved occupant productivity due to fewer adverse reactions to VOCs and other irritants. (See section 2.5).
IDc1.2 (WEc3) – Exceptional Performance: Water Use Reduction		
Approach	**Cost/Benefit**	**Notes**
Not achieved at silver level but hypothetically achieved at gold.	Capital Costs	Captured under WEc2 & WEc3 estimates
	Non-Energy O&M	Captured under WEc2 & WEc3 estimates

Would be achieved via the cumulative effects of WEc2 and WEc3 (exceeded 50% water use reduction compared to LEED defined baseline).	Water Savings	Total savings taken from LEED submittal data and incremental volume (L/YR) calculated hypothetically as beyond savings generated via WEc2 & WEc3 up to 50% savings.
IDc2 – LEED AP		
Approach	**Cost/Benefit**	**Notes**
Engaged the services of a LEED accredited professional as a key member of the project team.	Consultant Fees	Provided directly by Client
	Cumulative Effects	The advice and expertise of the LEED AP as team member from early in the project in-part, leads to the results realized throughout all of the above credits.
	Integrated Design	The requirement for all disciplines to collaborate in the design process from the early stages of concept design can encourage greater innovation, and ultimately lead to better performing buildings. Insufficient data is available on this effect to quantify it directly, but it is assumed to in-part be captured within the outcomes of the above credits analyzed.

Table 3 – South-West Edmonton Police Services

SSc5 – Protect/Restore Open Space		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically could be achieved at Gold. Hypothetical scenario would include some radical site plan changes including the elimination of visitor parking (street parking only) and the creation of a green roof on the Southernmost, single storey block. Newly landscaped area would be provided with high-density landscaping, and native and adaptive plantings in lieu of non-porous surfaces or turf-grass. Current site area meeting habitat requirements calculated, less total area needed to determine additional square footage. Tree density of existing (at Silver level) planted areas used to determine number of plantings in additional hypothetical habitat area.	Capital Costs	HDR Estimate (see Appendix C)
	Non-Energy O&M	$0.26/LF/Yr maintenance premium over standard turf. Values provided by 3rd party literature.
	Tree Benefits	HDR Calculations (values from 3rd party literature, see Appendix C).
	Reduced Storm Flows & Total Suspended Solids	Stormwater management benefits are captured in SSc6 below but capital and O&M costs relating to landscaping are included in landscape calculations done for this credit
SSc6 – Storm Water Management		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold. In addition to the hypothetical site plan redesign noted under SSc5	Capital Costs	HDR Estimate (see Appendix C). Capital costs for swales and landcape based features captured under SSc5 above. Capital costs for pervious paving captured under this credit.

above, and the roof top rainwater harvesting system (WEc3) pervious paving would need to be incorporated throughout roughly 15% of remaining parking area.	Non-Energy O&M	Landscape maintenance costs captured in SSc5 O&M costs above.
	Reduced Storm Flows & Total Suspended Solids	HDR Calculations: Flow calculated based on 600L/m2/yr from environment Canada precipitation data. TSS calculated based on aggregate concentrations for various run-off surfaces (values from 3rd party literature). Avoided costs values used as proxy from City of Calgary study completed by HDR.
SSc7.2 – Heat Island Effect: Roof		
Approach	Cost/Benefit	Notes
Provided high reflectivity/high-albedo white roofing for portion of roof area in lieu of conventional bituminous roofing. Achieved at Silver level.	Capital Costs	HDR Estimate (see Appendix C)
	Non-Energy O&M	Calculated as avoided interval maintenance costs associated with conventional roofing. Values provided by 3rd party literature. LEED submittal documents noted an "albedo maintenance program" (white roof cleaning) which should have an associated maintenance cost, but insufficient data existed to quantify.
	Electricity & Gas	White roof membrane lowers cooling load during cooling season (electricity) but slightly increases heating load during heating season (gas). 3rd party literature study adjusted to reflect Edmonton Heating Degree days/year (6525 @ 18deg C) and Cooling Degree Days (84 @ 18deg C) found heating penalty considerably exceeds cooling benefit.
	Lifecycle Benefits	Calculated as the avoided replacement cost of standard roofing, based on the extended lifespan of the metal roof. Residual value added for lifecycle remaining beyond study period.
WEc2 – Innovative Waste Water		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold. In addition to rainwater harvester, water urinals would be installed (in-lieu of low-flow) and ultra-low flow WC's (in lieu of low-flow) for all staff fixtures.	Capital Costs	HDR Estimate (See Appendix C)
	Non-Energy O&M	Additional maintenance costs include cleaning/repair of waterless and ultra-low flow fixtures. Values provided by 3rd party literature and calculated on a per fixture basis
	Water Savings	LEED submittal data was incomplete however number of FTE was known and mechanical drawings indicated schedule of fixtures and sizing of rainwater system. HDR completed LEED letter template to establish baseline case and projected water savings. Volume (L/YR) adjusted as beyond 30% savings over LEED defined baseline. 30% beyond LEED defined baseline was achieved value at Silver level. WEc2 achieved at Gold level is incremental only over what was already achieved at Silver.
WEc3.1 – Water Use Reduction: 30%		
Approach	**Cost/Benefit**	**Notes**
Provided low-flow urinals, toilets and sensored lavatories for all staff	Capital Costs	Cost of rainwater system provided by Contractor/Client. No premium for fixtures.

fixtures. Transient (holding cell) fixtures not used in equation. Provided 50,000L roof top rainwater harvesting system to flush toilets and urinals as well as divert storm water (SSc6). Achieved at Silver level.	Non-Energy O&M	Additional maintenance may be required to change filters on rainwater harvesting system, however insufficient data exists to quantify those costs.
	Water Savings	LEED submittal data was incomplete however number of FTE was known and mechanical drawings indicated schedule of fixtures and sizing of rainwater system. HDR completed LEED letter template to establish baseline case and projected water savings. Volume (L/YR) adjusted volume (L/YR) adjusted as beyond 20% savings over LEED defined baseline. 20% beyond LEED defined baseline was considered "standard construction" due to the ubiquity of "low-flow" fixtures in the marketplace.
	Reduced Storm Flows and Total Suspended Solids	Roof area and flow calculated similarly to site based storm flows. TSS concentrations adjusted to reflect rooftop as run-off surface. TSS values added to total under SSc6 in SROI model.
EAc1 – Optimize Energy Performance		
Approach	**Cost/Benefit**	**Notes**
Provided energy efficient design features including increased thermal insulation, condensing boilers, occupancy sensors for lighting, variable frequency drives for pumps and fans and energy recovery ventilators. 6 Points achieved at Silver level. Hypothetical Gold scenario assumed to achieve 9 points based on NRCan meta-analysis of EUI at different LEED certification levels, and would additionally include super insulation, daylight automatic dimming controls, triple glazed windows and LED lighting.	Capital Costs	HDR Estimate (see Appendix C). Individual technologies identified with assistance of project design team and estimated based on catalogue data and 3rd party literature.
	Non-Energy O&M	Facilities maintenance identified premature failure of VFD's in existing facilities. Probable cause in the opinion of maintenance staff is under-ventilation of mechanical rooms. List of work orders-by-facility relating to VFD repairs was provided and deconstructed into a $/SF proxy value to determine annual maintenance costs. HDR identified condensing boilers as a possible maintenance cost savings, and occupancy sensors as potentially requiring additional maintenance, however could not find sufficient data on maintenance cost to quantify these variables.
	Electricity & Gas Savings	LEED submittal data incomplete. However, real utility data was known and total projected energy savings was provided by consultant (modelling in progress). HDR worked backwards to establish baseline usage versus design case savings. kWh(e) converted to MJ/YR for use in SROI model. LEED Gold hypothetical scenario adjusted LEED Silver level energy savings by corresponding percentage relative to hypothetical number of points earned based on NRCan EUI meta-analysis. Gold level incremental performance is calculated as beyond that which was achieved at Silver level
EAc3 – Best Practice Commissioning		
Approach	**Cost/Benefit**	**Notes**

Engaged the services of a 3rd Cx agent to provide enhanced commissioning services of major building systems, ensuring proper optimization and performance of installed components. Achieved at Silver level and not incremental at Gold.	Capital Costs	Costs to hire 3rd party commissioning agent for project provided directly by Client
	Non-Energy O&M	Calculated as $0.39/SF O&M savings based on values provided by 3rd party literature finding less maintenance/adjustments are required on properly commissioned systems.
	Electricity & Gas	Calculated as 0.14kWh/SF and 0.58MJ/SF based on 3rd party literature finding that proper commissioning supports better system optimization.
MRc5 – Regional Materials 20%		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at gold. Project would have provided 20% of project materials (by cost) that have been extracted and manufactured regionally (within 800km).	Capital Costs	No premium based on major materials used in project.
	Reduced Truck Miles	Calculated as one time benefit based on potentially reduced trucking miles for building materials. LEED submittal data provides total truck miles for materials. A % savings is determined by comparing 4 building materials in different manufacturing classes (commodity, medium-value added x2 and high-value added) against the next largest competitor. The difference between the distance to plant location of what was used in the project and plant location of competing manufacturer becomes the basis of reduced miles. Due to the challenges of determining distance between point of extraction and manufacturing plant, distance from project site to point of extraction is not analyzed.
EQc2 – Ventilation Effectiveness		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver level but hypothetically achieved at Gold. Project would Increase make-up air set points to provide 1.0 AC/H (30% beyond ASHRAE 62 recommendations).	Capital Costs	Additional technologies would not be required to achieve this credit.
	Non-Energy O&M	Approach does not generate maintenance costs or benefits
	Electricity & Gas	Additional electricity (fan energy) and additional gas (heat loss) usage result from increased ventilation rates, but they are countered with the use of VFD's and Energy Recovery Ventilation. The net impacts are captured in the hypothetical Gold level EAc1 data.
	Productivity	Increased ventilation can lead to productivity improvement resulting from increased occupant comfort and wellness. (See section 2.5)
EQc3.2 – Construction IAQ Management: Pre-Occupancy		
Approach	**Cost/Benefit**	**Notes**
Conducted IAQ testing prior to occupancy to ensure VOC levels were at an imperceptible threshold before occupants moved in. Achieved at Silver level.	Capital Costs	Calculated on an SF basis using values from 3rd party literature.
	Productivity	Pre-Occupancy air quality management can lead to improved productivity due to reduced adverse reactions to VOCs, dust and other allergens. (See section 2.5).

EQc4.4 – Low Emitting Materials: Composite Wood & Laminates		
Approach	**Cost/Benefit**	**Notes**
Provided low-VOC products for all composite wood and laminates to reduce off-gassing and occupant discomfort. Achieved at Silver level	Capital Costs	Calculated as a 5% premium on materials (assumed 60/40 Labour: Material split).
	Non-Energy O&M	Water-based adhesives are less robust in nature than solvent based adhesives. Regular repairs of delaminating casework are often required. Calculated on a 5 year repair interval and amortized on a $/YR basis in model.
	Productivity	Low-VOC products can lead to improved occupant productivity due to fewer adverse reactions to VOCs and other irritants. (See section 2.5).

EQc5 – Indoor Pollutant Control		
Approach	**Cost/Benefit**	**Notes**
Installed built-in entrance floor grilles at all entrances to building to capture dirt and particulate entering the building. Achieved at Silver level.	Capital Costs	Calculated as $120/SF (supply & install)
	Non-Energy O&M	Manufacturer literature suggests entrance grilles can capture of 80% of dirt entering a building. This reduction in dirt suggests a maintenance savings in custodial costs, however, sufficient data is not currently available to quantify this benefit.
	Productivity	Reducing dirt (and dust) entering a building can improve occupant comfort by reducing exposure to irritants and allergens. (See section 2.5)

EQc6.1 – Controllability of Systems: Perimeter Spaces		
Approach	**Cost/Benefit**	**Notes**
Not achieved at Silver, but hypothetically achieved at Gold. Project would provide operable windows around perimeter of building and individual lighting controls in each space.	Capital Costs	Calculated as a premium cost for operable windows beyond fixed windows as LEED Silver scenario. No premium for additional lighting controls.
	Productivity	Allowing users greater control of temperature, ventilation and lighting can increase occupant comfort and enhance productivity. (See section 2.5)

EQc8 – Daylighting and Views		
Approach	**Cost/Benefit**	**Notes**
Provided daylighting to 75% of regular occupied spaces and views to 90% of occupied spaces by locating non-regularly occupied spaces in core of building and introducing a glazing monitor as a spine along the centre of the building. Light shelves and exterior shading devices used to meet glare control requirements.	Capital Costs	Calculated as premium cost for additional glazing along monitor spine and premium cost for light shelves and exterior shading devices. (See Appendix C)
	Non-Energy O&M	Premium for additional window cleaning calculated on an SF basis based on values from 3rd party literature.
	Electricity & Gas	Additional glazing and exterior wall surface would increase gas usage (heat loss) while decreasing electricity usage (lighting power density). It is assumed that both of these impacts are captured within the data provided via EAc1.
	Productivity	Increased access to natural light and views can

		have a positive impact on building occupant's health and wellness and lead to increased productivity. (See section 2.5)
IDc1.1 – Green Furniture		
Approach	**Cost/Benefit**	**Notes**
Provided "green furniture" for all systems furniture and seating. Green furniture requires low or zero VOC materials and finishes and often incorporates recycled content. Achieved at Silver level.	Capital Costs	Client confirmed no cost premium.
	Productivity	Low-VOC products can lead to improved occupant productivity due to fewer adverse reactions to VOCs and other irritants. (See section 2.5).
IDc1.2 (WEc3) – Exceptional Performance: Water Use Reduction		
Approach	**Cost/Benefit**	**Notes**
Achieved via the cumulative effects of WEc2 and WEc3 (exceeded 50% water use reduction compared to LEED defined baseline).	Capital Costs	Captured under WEc2 & WEc3 estimates
	Non-Energy O&M	Captured under WEc2 & WEc3 estimates
	Water Savings	Total savings taken from LEED submittal data and incremental volume (L/YR) calculated as beyond savings generated via WEc2 & WEc3.
IDc2 – LEED AP		
Approach	**Cost/Benefit**	**Notes**
Engaged the services of a LEED accredited professional as a key member of the project team.	Consultant Fees	Provided directly by Client
	Cumulative Effects	The advice and expertise of the LEED AP as team member from early in the project in-part, leads to the results realized throughout all of the above credits.
	Integrated Design	The requirement for all disciplines to collaborate in the design process from the early stages of concept design can encourage greater innovation, and ultimately lead to better performing buildings. available on this effect to

APPENDIX C: COST BREAKDOWNS & CALCULATIONS

The following tables provide transparency into the more complex calculations made to arrive at inputs described within the credit evaluation matrix included in section 2.4 and Appendix B of this report. The proceeding calculations do not encompass all variables for which estimations and calculations were made. Single-step estimation and calculations (IE. 5% premium on composite wood product material costs for EQc4.4) relying on LEED submittal data, 3rd party literature, and standard construction estimation techniques have been omitted from the following in some instances due to their relative simplicity. It should also be considered that varying sources will offer different data on the pricing of construction materials and labour. While valid sources have been leveraged in generating cost estimates, the estimates are considered 'Class D' estimates in nature and may be subject to change in different markets and in different project contexts.

1.1 – Ellerslie Fire Station No. 27

Tree Benefits Calculations			
Quantity	**Value Range**		**Benefit Value/YR**
76 Trees	High	$25/tree/yr	$1,900
	Mid	$22/tree/yr	$1,672
	Low	$19/tree/yr	$1,444

Landscaping Capital Costs				
Element Type	**Capital Costs**	**Area**	**Increment Value**	**Incremental Cost**
Bioswale	$80,000	215LF	+600% (premium)	$66,666
Delete Storm Pipes	($28,752)	n/a	n/a	($28,752)
O&M Costs	n/a	215LF	$0.26/LF	$55.90/Yr
Total Capital Increment		$28,752		
Annual O&M		$55.90/Yr		

Storm Retention Pipes Capital Cost		
System Capacity	**Increment Value**	**Incremental Capital Cost**
4,768ga	$.200/ga	$9,536

Storm Flow and Total Suspended Solids (TSS)		
Volume/Year	TSS Concentration (average)	TSS Removed/Year (80% efficacy)
960,000L/yr	133.5mg/L	10,252kg/yr

Waste Water Fixtures					
Fixture Type	**Capital Cost**	**O&M Cost**	**Quantity**	**Incremental Capital**	**Incremental O&M**
Waterless Urinal	$0.00	$20/yr	2	$0.00	$40/yr
Dual Flush WC	$140.00	Nil	1	$280	Nil
Sensored Lav	$35.00	$10/yr	2	$35	$20/yr
Total Capital Increment	$315.00				
Total O&M Cost per Year	$60.00				
Water Savings/Year			**Savings beyond 30%**		
47,937L			20,937L		

Optimize Energy Performance - Capital Costs				
Design Element	**Increment Value**	**Quantity**	**O&M Cost**	**Capital Increment**

In-Slab Radiant	$8/SF	5,145	Nil	$41,160
Perimeter Radiation	$1/SF	17,778	Nil	$17,778
Thermal Insulation (+2”)	$2.20/SF	10,200	Nil	$22,440
VFDs	$700/HP	12	$393.80/yr	$150
Occupancy Sensors	$25/Sensor	6	Unknown	$8,400
ERVs	$1/CFM	1,610	Nil	$1,610
Total Incremental Capital	$91,538			
Total O&M Cost per Year	$393.80			

Optimize Energy Performance – Energy Consumption			
Scenario	**Total Energy (MJ)**	**Electricity (kWh[e])**	**Gas (MJ)**
Reference Building	3,146,752	1,170,086	1,978,336
Designed Building	1,654,126	578,225	1,0693,49
Difference	**1,492,626**	**591,861**	**908,987**
Note: Assume silver scenario would have achieved 4 points (38% vs. 51% savings): NRCan study on EUI correlations to certification levels & energy points: certified = <2, Silver = 2-4, Gold= 5-7, Platinum = 8-10.			

Daylighting and Views					
Design Element	**Capital Increment**	**Quantity**	**O&M Increment**	**O&M cost**	**Capital Cost**
Punched Windows	$600/EA	20	$2.50/pane	$200	$12,000
Curtain Wall	$27/SF	66	$4.00/pane	$240	$1,782
Exterior Wall	$30/SF	1160	Nil	Nil	$34,800
Total Incremental Capital	$48,582				
Total O&M Cost per Year	$440				

1.2 **– Fort Edmonton Park Administration Building**

Heat Island: Roof - Capital Costs			
Design Element	**Increment Value**	**Quantity**	**Capital Cost**
Metal Roofing	$26.00/SF	9,000	$239,400
Mod-Bit Roofing	$17.00/SF	9,000	$153,000
Incremental Capital	$86,400		

Heat Island: Roof – Lifecycle				
Design Element	**Lifecycle**	**Study Period**	**Residual Value**	**Replacement Capital**
Metal Roofing	50 Years	30 years	$119,700	Nil
Mod-Bit Roofing	25 Years	30 Years	$59,184	$73,980

Heat Island: Roof – O&M					
Design Element	**Annual $/SF**	**Interval $/SF**	**Annual O&M**	**Interval O&M**	**Total Increment**
Metal Roofing	Nil	Nil	Nil	Nil	Nil
Mod-Bit Roofing	$0.05	$0.25	$450	$2,250	$15,750
O&M Cost per Year (Total/study period)	$525				

Water Use Reduction					
Design Element	**Capital Cost**	**O&M Cost**	**Quantity**	**Incremental Capital**	**Incremental O&M**
Ultra-Low Flow Urinal	$50	Nil	1	$50	Nil
Sensored Lav	$150	$10/yr	4	$400	$40/yr

Total Incremental Capital	$450
Total O&M Cost per Year	$40

Optimize Energy Performance (Silver) – Capital Costs

Design Element	Increment Value	Quantity	O&M Cost	Capital Cost Increment
Radiant Heating	$1/SF	7,000	Nil	$7,000
VFDs	$700/HP	12.7	$154/yr	$8,890
Occupancy Sensors	$25/sensor	12	Unknown	$300

Total Incremental Capital	$16,190
Incremental O&M per Year	$154

Optimize Energy Performance (Silver) – Energy Usage

Scenario	Total Energy (MJ)	Electricity (kWh[e])	Gas (MJ)
Reference Building	1,198,482	79,542	903,882
Designed Building	779,519	49,373	596,655
Difference:	**418,963**	**30,169**	**307,227**

Optimize Energy Performance (Hypothetical Gold) – Capital Costs

Added Design Elements	Increment Value	Quantity	Capital Cost Increment
ERVs	$1/CFM	6,000	$6,000
Thermal Insulation (+2")	$2.20/SF	6,450	$14,190
M&V Automation	(see M&V breakdown)	Nil	(see M&V breakdown)

Total Hypothetical Increment	$20,190

Optimize Energy Performance (Hypothetical Gold) – Energy Usage

Performance Level	Increment Value	M&V Effect	Electricity(kWh[e])	Gas (MJ)
Silver	0%	0%	30,169 (savings)	307,227 (savings)
Gold	12%	10%	36,686 (savings)	385,895 (savings)
Difference	12%	10%	**6,517**	**78,758**

Note1: EAc1 uses energy cost as metrics. Project team used "market value" for electricity instead of LEED defaults and achieved 7 points. Energy consumption used as metric instead for fair comparison and number of points adjusted to suit correlative score using default LEED values.
Note 2: Assume Gold scenario would have achieved 6 points (adjusted point value) = 35% vs. 47% saving: NRCan study on EUI correlations to certification levels & energy points: certified = <2, Silver = 2-4, Gold= 5-7, Platinum = 8-10.

Restore Open Space (Hypothetical Gold)

Site Area(s)	Design Element	Hypothetical Cost	O&M Increment
50% of site less B.A: 33,950SF	Hydro-seed	$1,395	Nil
	Habitat Plantings	$50,246	$0.0043/SF

Total Capital Increment	$48,850
Total O&M per Year	$147

Tree Benefits

Quantity	Value Range		Benefits/Year
95 Trees	High	$25/tree/yr	$2,375
	Mid	$22/tree/yr	$2,090
	Low	$19/tree/yr	$1,805

Waste Water Fixtures (Hypothetical Gold)

Fixture Type	Capital Cost	O&M Cost	Quantity	Incremental Capital	Incremental O&M
Waterless Urinals	Nil	$20/yr	1	Nil	$20/yr
Dual Flush WC	$35	Nil	3	$105	Nil
Low-Flow Sink	$100	$10/yr	2	$200	$20/yr
Total Capital Increment	$305				
Total O&M per Year	$40				
Water Savings/year			**Savings Beyond 30%**		
71,981L/yr			30,403L/yr		

Measurement & Verification (Hypothetical Gold)			
Design Element	**Increment Value**	**Quantity**	**Cost Increment**
DDC Controls	400% Controls Cost	13,500	$40,500
Water-Sub Metering	Incl. in main meter	n/a	n/a
Electric Sub-Metering	$705/each	12	$9,000
Gas Sub-Metering	$500/inch diameter/each	4	$2,000
Total Capital Increment	$51,500		
Note 1: Measurement & Verification added 10% bonus to Energy Calculations Note 2: Measurement & Verification added 10% savings to O&M benefit			

1.3 **– South-West Edmonton Police Services**

Heat Island: Roof - Capital Costs			
Design Element	**Increment Value**	**Quantity**	**Capital Cost**
Reflective Roofing	$20.36/SF	16,436	$334,611
Mod-Bit Roofing	$17.00/SF	16,436	$279,412
Incremental Capital	$55,199		

Heat Island: Roof – Lifecycle				
Design Element	**Lifecycle**	**Study Period**	**Residual Value**	**Replacement Capital**
Reflective Roofing	30 Years	30 years	$0	Nil
Mod-Bit Roofing	25 Years	30 Years	$112,136	$135,103

Heat Island: Roof – O&M					
Design Element	**Annual $/SF**	**Interval $/SF**	**Annual O&M**	**Interval O&M**	**Total Increment**
Reflective Roof	$0.04	Nil	$685	Nil	$137
Mod-Bit Roofing	$0.05	$0.25	$822	$4,109	$11,642
O&M Cost per Year (Total/study period)	$388				

Heat Island: Roof – Energy				
	Reference Study		**Edmonton DHD & DCD**	
Roof Type	**Summer (kWh)**	**Winter (kWh[e])**	**Adjusted Summer**	**Adjusted Winter**
Black (1000m2)	1,488	21,223	225	32,896

White (1000m2)	657	21,802	110	33,793
Difference	831	(579)	116	(897)

Adjusted Savings/(Penalty)x1.6 for 1600m2 roof	(1,436)

Waste Water Fixtures (Hypothetical Gold) & Water Use Reduction

Fixture type	Capital Cost	O&M Cost	Quantity	Capital Increment	O&M Increment
Waterless urinal	Nil	$20/yr	11	Nil	$220/yr
Ultra Low Flow WC	$35	Nil	23	$805	Nil
Rainwater harvesting	$59,000	Unknown	1	$59,000	Unknown

Total incremental Capital	$59,805
Total incremental O&M Costs/yr	$220

Water Savings/yr (total)	Rain Water Harvesting	Beyond 20% (WEc3)	Beyond 30% (WEc2)
4,471,614L	1,264,725L	804,891L	498,225L

Optimize Energy (Silver) – Capital Costs

Design Element	Increment Value	Quantity	O&M Cost	Capital Cost Increment
Condensing Boilers	$2500/MMBtu	4.4	Unknown	$11,000
VFDs	$700/HP	61.5	$1,320/yr	$43,050
Occupancy Sensors	$25/Sensor	67	Unknown	$1,675
Heat Recovery Wheel	$1.25/CFM	8,900	Nil	$11,125
Thermal Insulation (+2”)	$2.20/SF	21,850	Nil	$48,070

Total Incremental Capital	$114,920
Total Incremental O&M/yr	$1,320

Optimize Energy (Silver) – Energy Usage

Scenario	Total Energy (MJ)	Electricity (kWh[e])	Gas (MJ)
Reference Building	11,775,882	1,668,995	5,767,500
Designed Building	7,656,619	1,085,172	3,750,000
Difference:	4,119,263	**583,823**	**2,017,500**

Optimize Energy (Hypothetical Gold) – Capital Costs

Added Design Elements	Increment Value	Quantity	Capital Cost Increment
LED Lighting	$25/Fixture	573	$14,325
Triple Glazed Windows	120% of window cost	$1,100,000	$220,000
Daylight Dimming	$200/Sensor	67	$13,400
Super Insulation (+3” total of +5” beyond status quo)	$3.50/SF	21,850	$48,070

Total Hypothetical Increment	$295,795

Optimize Energy (Hypothetical Gold) – Energy Usage

Performance Level	Increment value	Electricity (kWh[e])	Gas (MJ)
Silver	0%	583,823 (savings)	2,017,500 (savings)
Gold	13%	800,792 (savings)	2,767,275 (savings)
Difference:	13%	**216,969**	**749,775**

Note 1: Assume Gold scenario would have achieved 9 points = 50% vs. 63% saving: NRCan study on EUI correlations to certification levels & energy points: certified = <2, Silver = 2-4, Gold= 5-7, Platinum = 8-10.

Daylighting and Views

Design Element	Capital Cost	O&M Cost	Quantity	Incremental Capital	Incremental O&M
Monitor Spine	$27/SF	$4/pane	890	$24,030	$368

Sunshades/Shelves	$40/SF	Nil	2950	$118,000	Nil

Total Capital Increment	$142,030
Total O&M Cost per Year	$368

Restore Open Space (Hypothetical Gold) – Area Analysis

Area Type	**Area Size (SF)**
50% of Site less Building Area (required)	109,600
Parking Lot	130,680
Turf Grass	9,475
Habitat	79,145
Additional Habitat Needed	**30,455**

Restore Open Space (Hypothetical Gold) – Reimagined Site Plan

Intervention	**Area (SF)**	**Capital Cost**
Eliminate Visitor Parking (transit or street parking access only)	12,905	($256,000)
Replace Turf w/ Plantings	9,475	$2,337
Replace West patio w/ Plantings	1,580	($1,144)
Green Roof at Southern 1 storey block of building	12,378	$309,450

Total additional habitat provided (SF)	36,338
Total Incremental Capital	$54,642

Tree Benefits

Quantity	**Value Range**		**Benefits/Year**
195	Low	$19	$3,705
	Mid	$22	$4,290
	High	$25	$4875

Storm Water Management (Hypothetical Gold) – Capital Costs

Scenario	**Capital Cost**	**Quantity**	**Incremental Capital**
Pervious concrete	$2.71/SF	27,320	$74,175
Note1: Costs associated w/ landscape based SWM captured under Restore Open Space calculations above.			

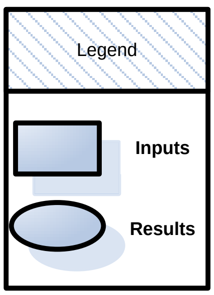
Storm Water Management (Hypothetical Gold) – Storm Flow and TSS

Site Feature	Volume/Year	TSS Concentration	TSS Removed/Year
Existing Infiltration	930,000L	133.5mg/L	19,224kg/yr
New Swales	382,200L		
Pervious Paving	507,600L		
Rainwater harvesting	1,264,725L	66.75mg/L	6,753kg/yr

APPENDIX D: STRUCTURE & LOGIC DIAGRAMS

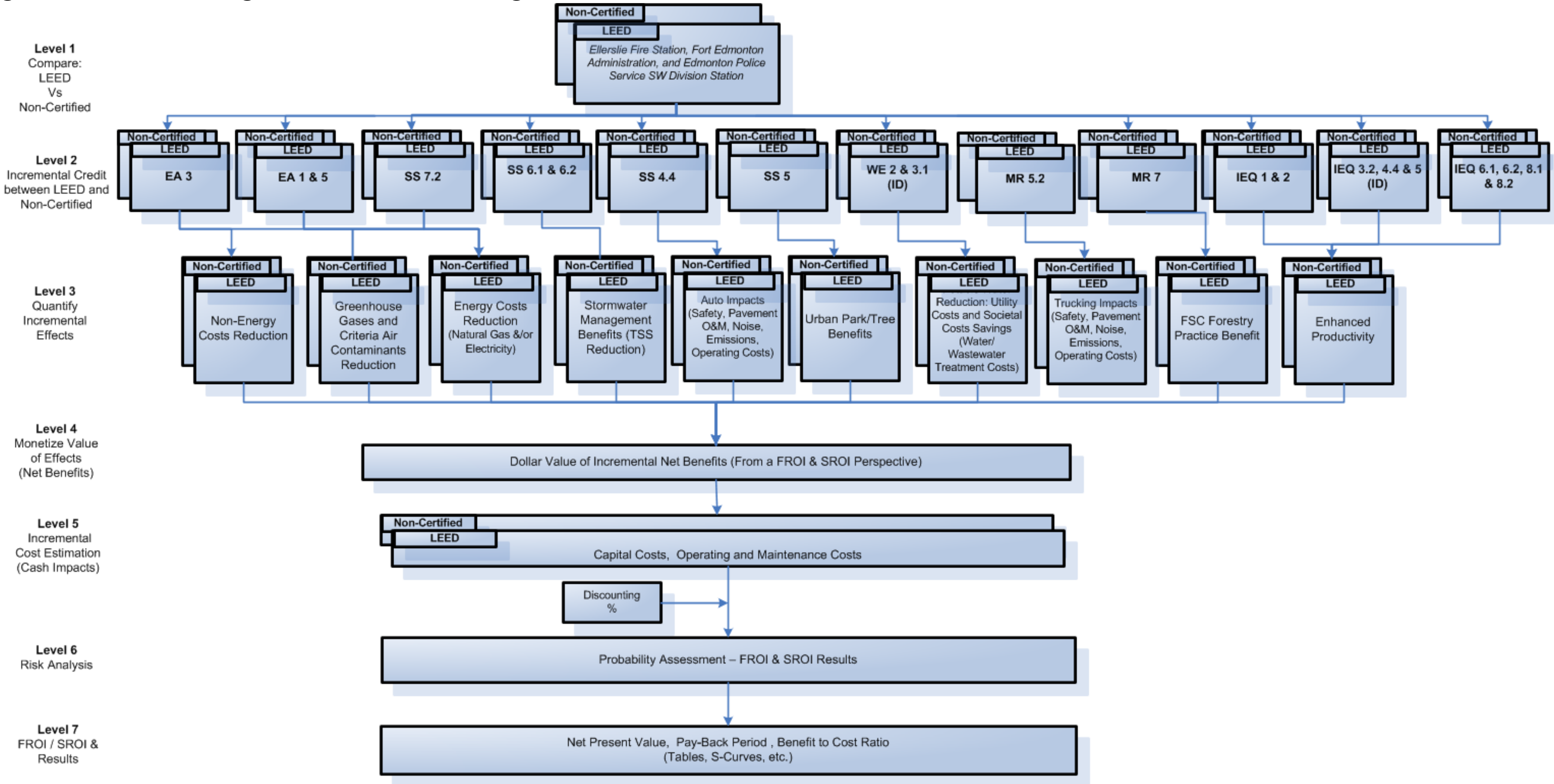
The methodology for the various benefits and costs is presented graphically in the form of a flow chart called a “structure and logic model” (S&L). Such models provide a graphical illustration of how the various inputs combine to determine the benefit or cost evaluated. They are intended to provide a transparent record of how each benefit and cost is calculated.

The diagram on the following page identifies the methodological format of the analysis. The analysis starts at Level 1 with a detailed description of the design alternative. Level 2 identifies the incremental credits between LEED™ certification versus following the same approach only without registering and certifying. The third level involves an explicit calculation of the impacts associated with each credit, while the fourth level monetizes (converts to monetary terms) those incremental impacts. This analysis requires a series of exercises generated by an array of inputs that often carry a high degree of uncertainty. Each of these inputs is assessed by the model at Level 6 to get the overall probability distribution of the net benefit of the alternative. Once the incremental costs for each alternative have been determined they are weighed against the monetized incremental benefit to obtain the NPV of the cost-benefit analysis at Level 7.



The methodology for the S&L diagrams follows as the inputs to the calculations shown are reflected as squares/rectangles, while outputs of calculations are reflected as ovals.

Figure 1: FROI & SROI High Level Structure and Logic Model



NOTE: The credits analyzed vary by building type.

Structure and Logic models at the incremental credit levels are presented below. While the first credit listed below, EA1, includes some dialog on how to interpret the diagram, the remaining credits do not have an accompanying write-up for sake of preventing any repetition.

Figure 2. FROI Credit Level – Optimize Energy Performance (EA1)

From a purely financial perspective, this credit generates two benefits relating to the reduced cost of natural gas and electricity, and costs which are related to the additional up-front capital costs for the equipment, as well as any additional operating & maintenance (O&M) costs. To further illustrate, the benefit of 'Reduced Natural Gas Costs', shown in the circle on the lower left of the diagram, is a function of the reduction in natural gas consumption multiplied by the natural gas utility rate.

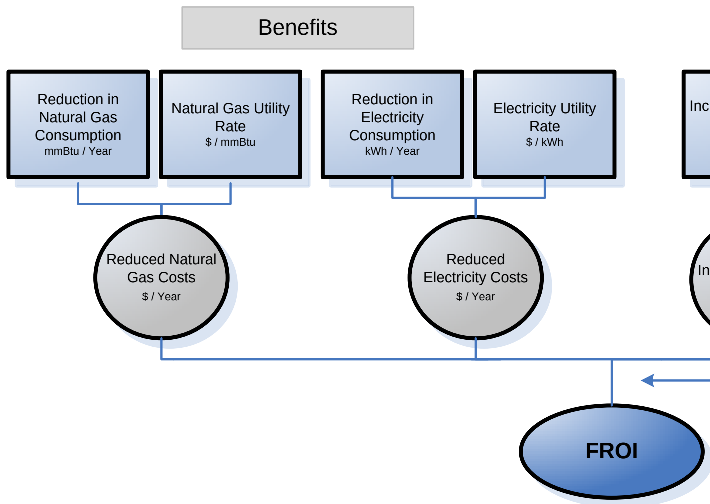


Figure 3. SROI Credit Level – Optimize Energy Performance (EA1)

Adding the monetized social and environmental impacts to the financial impacts listed above provides the SROI perspective. In this credit, as there are natural gas and electricity savings, the emissions reductions (both greenhouse gases (GHG) and criteria air contaminants (CAC)) must be incorporated and valued as shown below. For example, electricity savings are valued as a reduction in emissions from the Alberta grid as a function of the amount of electricity saved, multiplied by the value of those emissions.

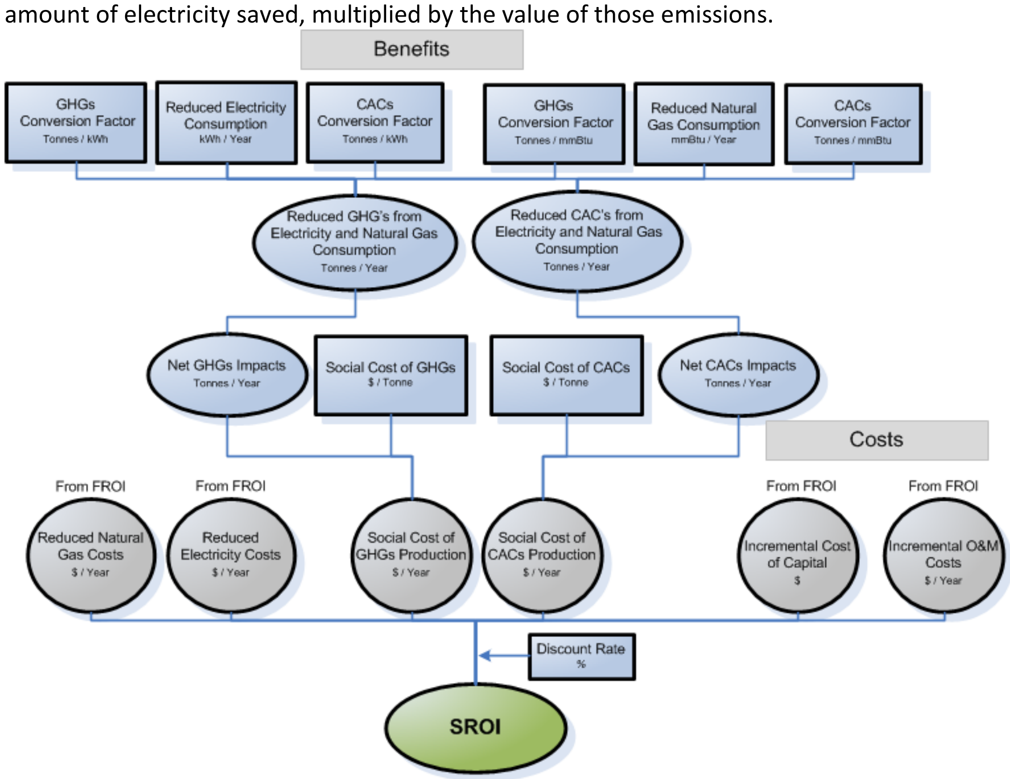


Figure 4. FROI Credit Level – Best Practice Commissioning (EA 3)

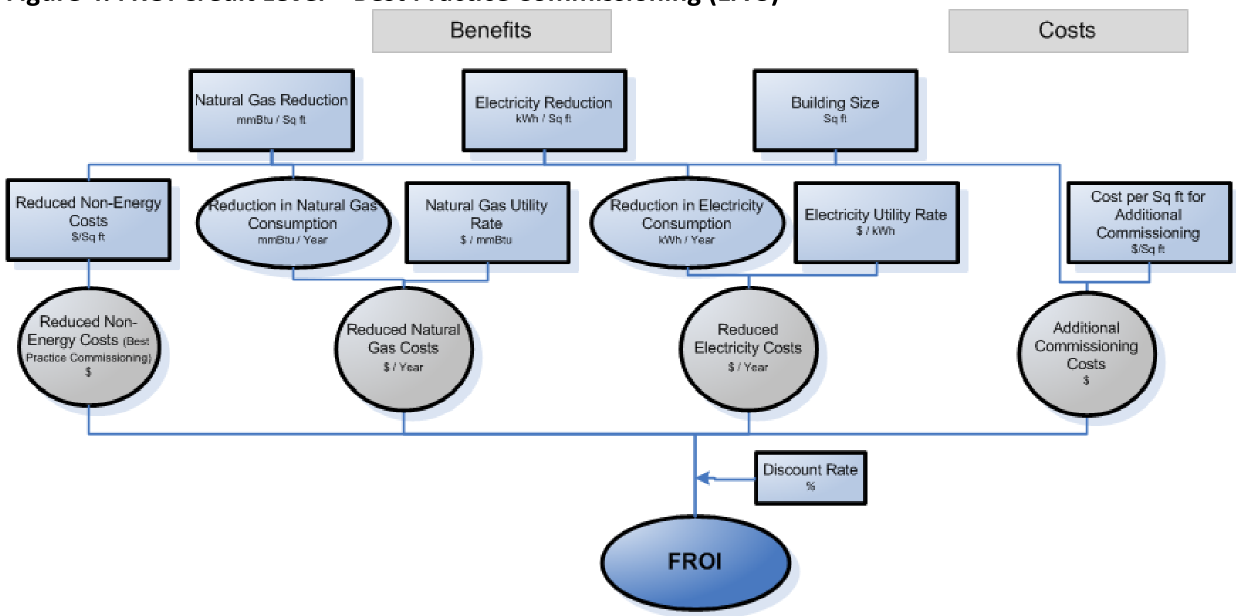


Figure 5. SROI Credit Level – Best Practice Commissioning (EA 3)

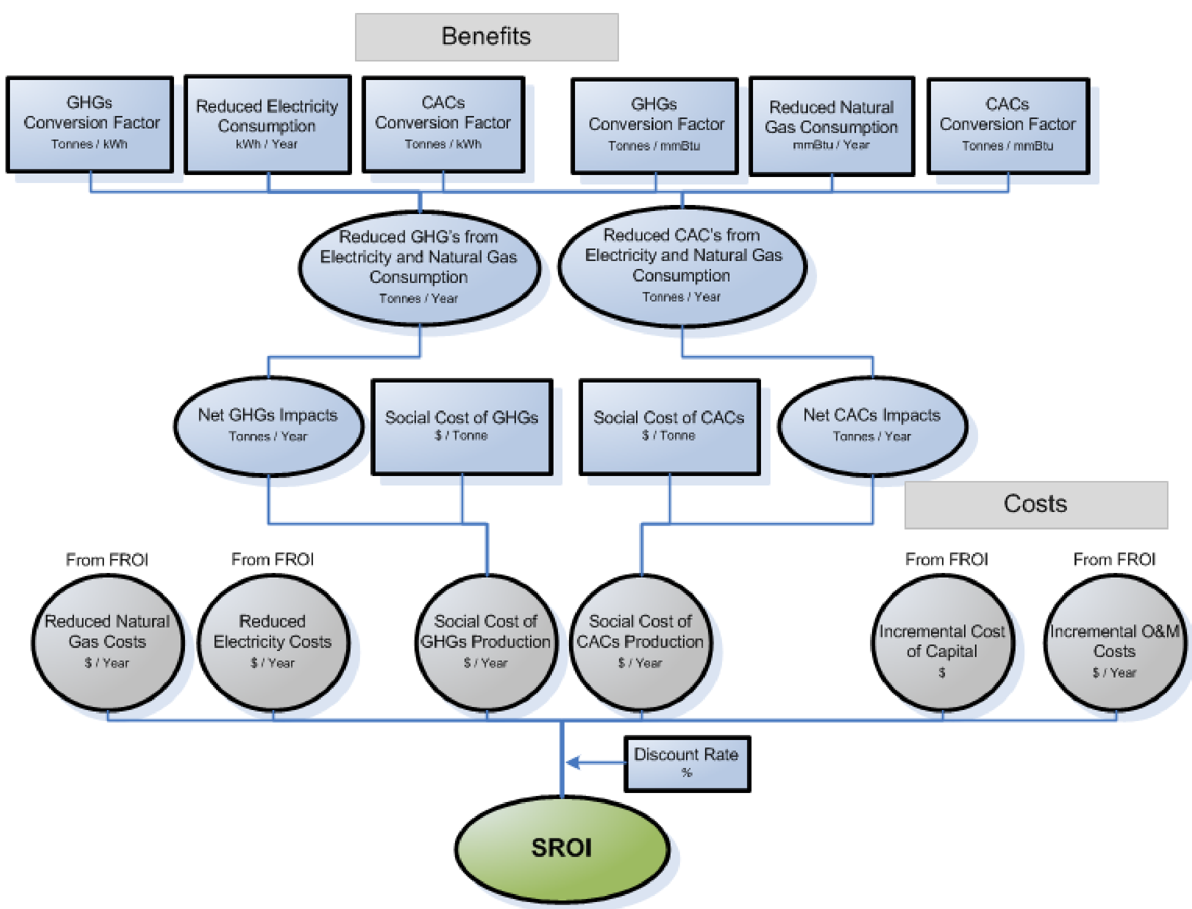


Figure 6. FROI Credit Level – Measurement & Verification (EA 5)

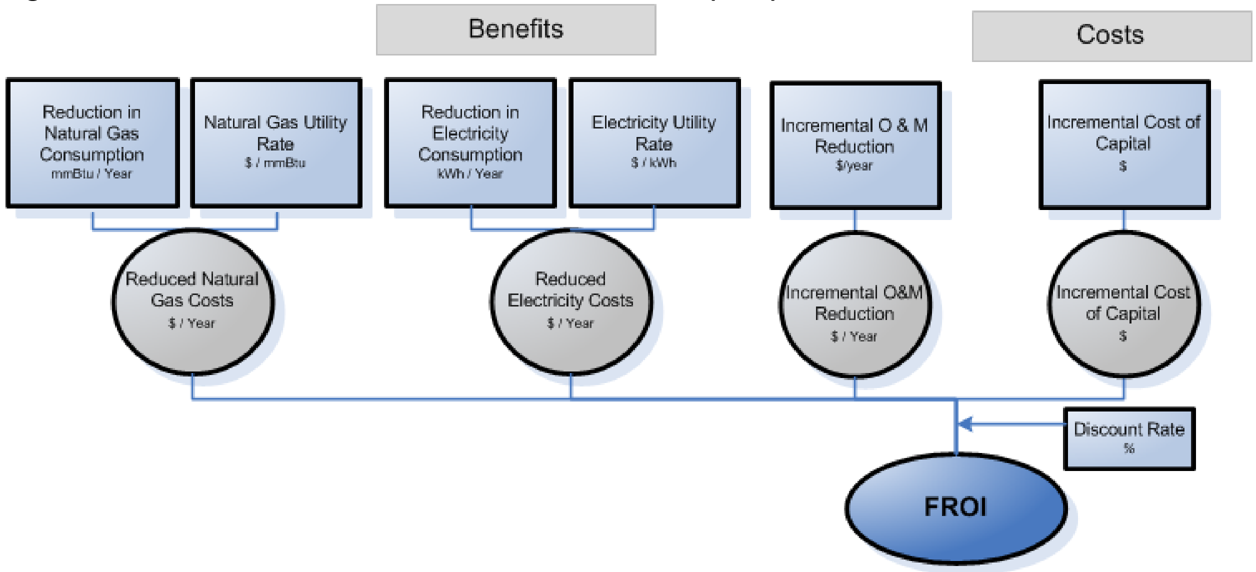


Figure 7. SROI Credit Level – Measurement & Verification (EA 5)

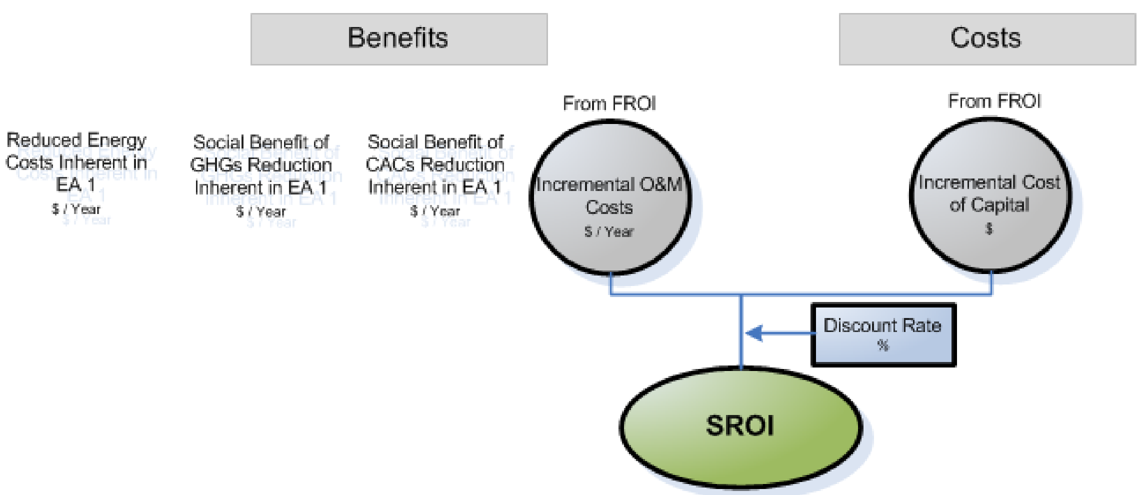


Figure 8. FROI Credit Level – Alternative Transport: Parking Capacity (SS 4.4)

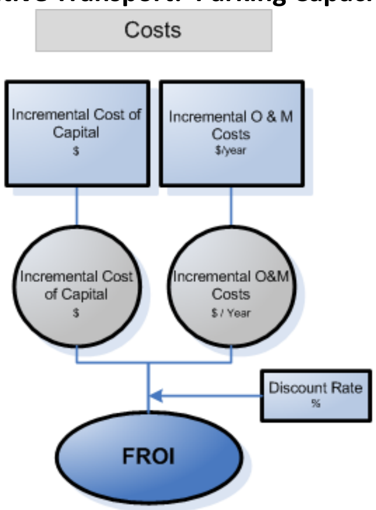


Figure 9. SROI Credit Level – Alternative Transport: Parking Capacity (SS 4.4)

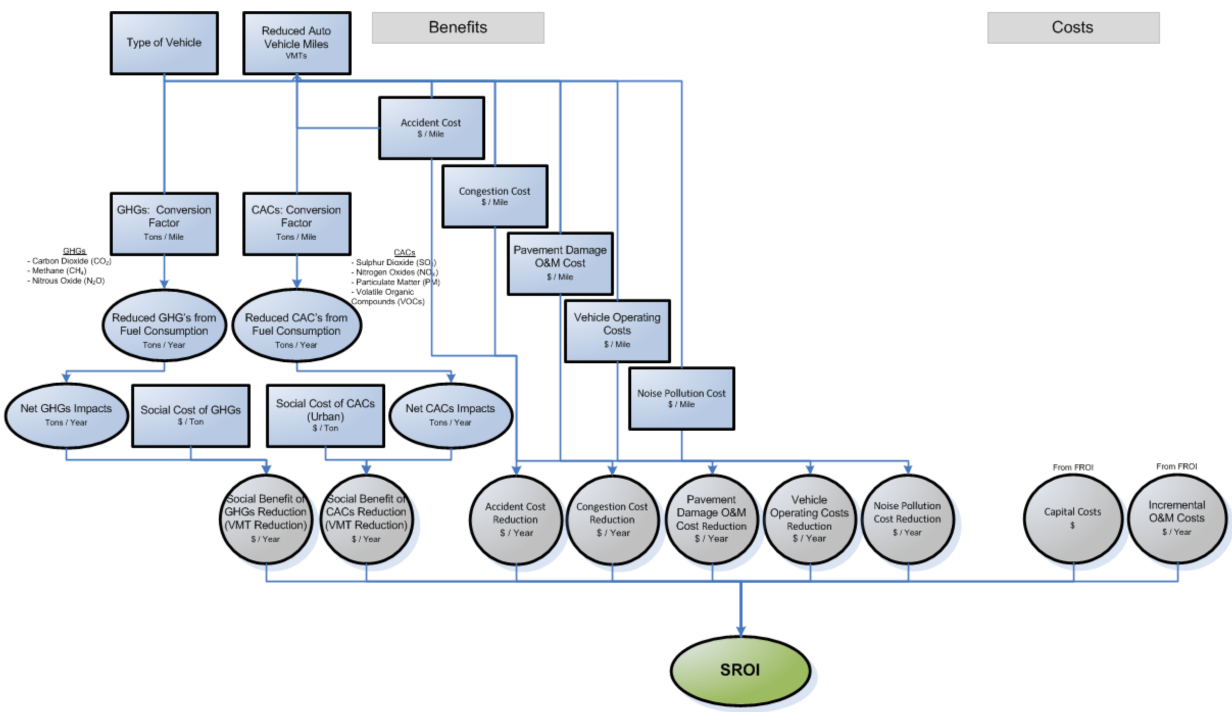


Figure 10. FROI Credit Level – Protect/Restore Open Spaces (SS 5)

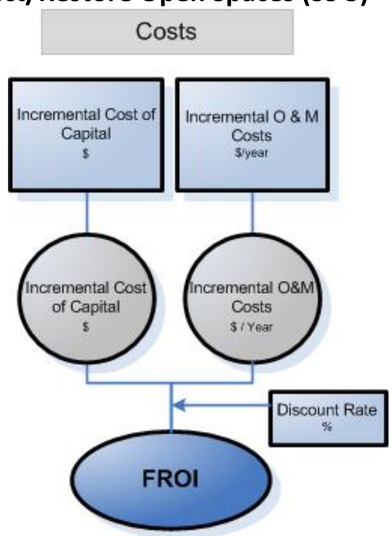


Figure 11. SROI Credit Level – Protect/Restore Open Spaces (SS 5)

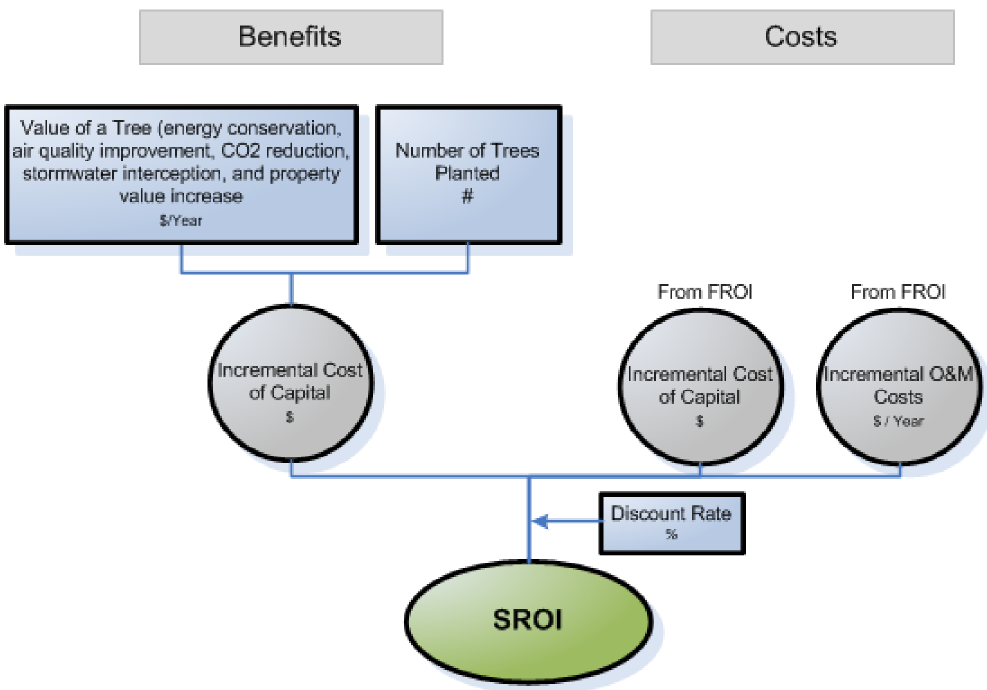


Figure 12. FROI Credit Level – Stormwater Management: Rate & Treatment (SS 6.1 & SS 6.2 Combined)

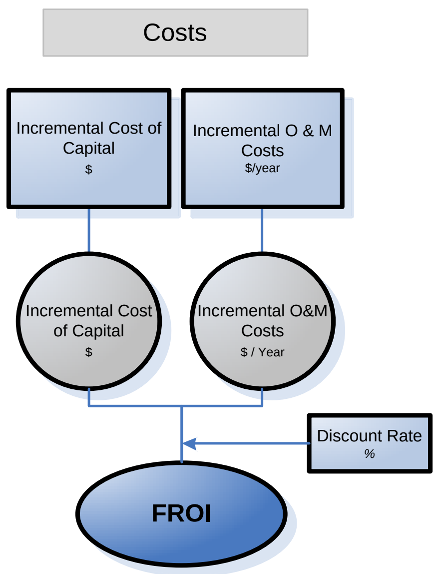


Figure 13. SROI Credit Level – Stormwater Management: Rate & Treatment (SS 6.1 & SS 6.2 Combined)

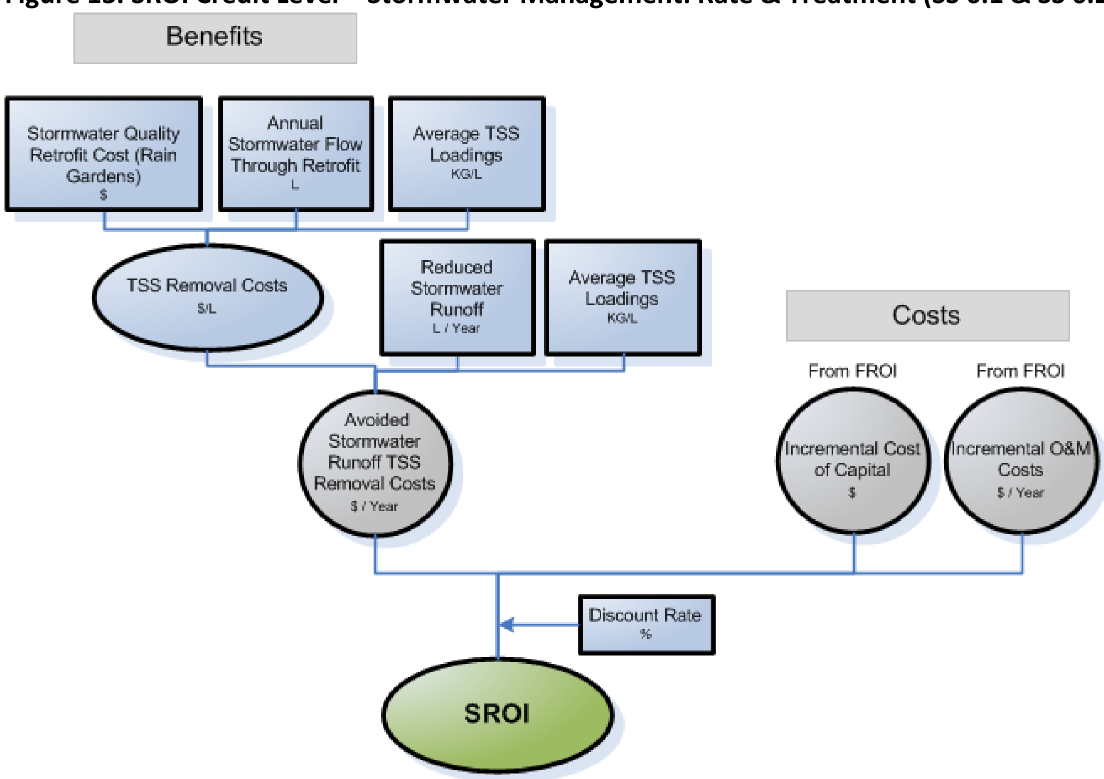


Figure 14. FROI Credit Level – Heat Island Effect, Roof (SS 7.2)

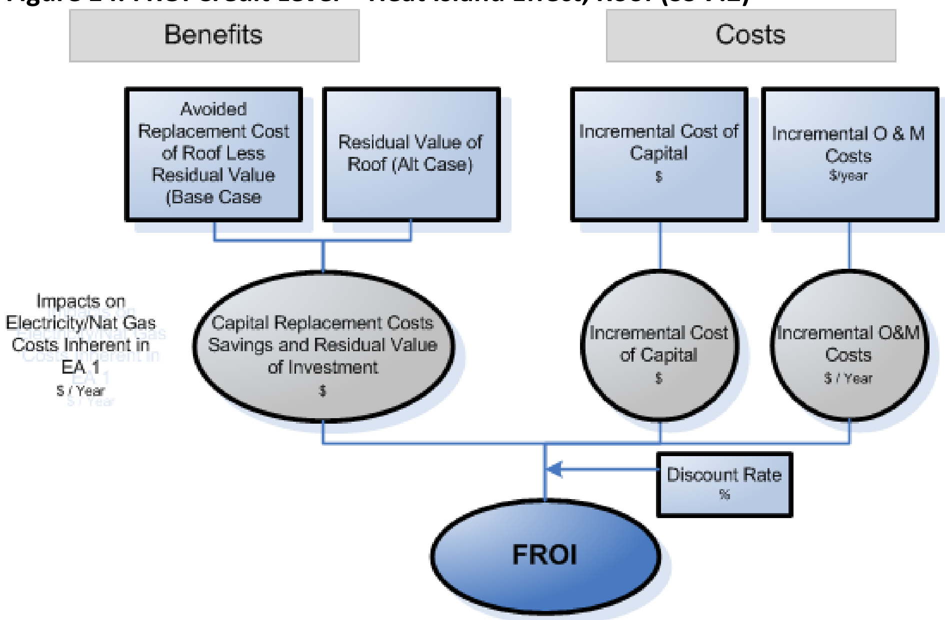


Figure 15. SROI Credit Level – Heat Island Effect, Roof (SS 7.2)

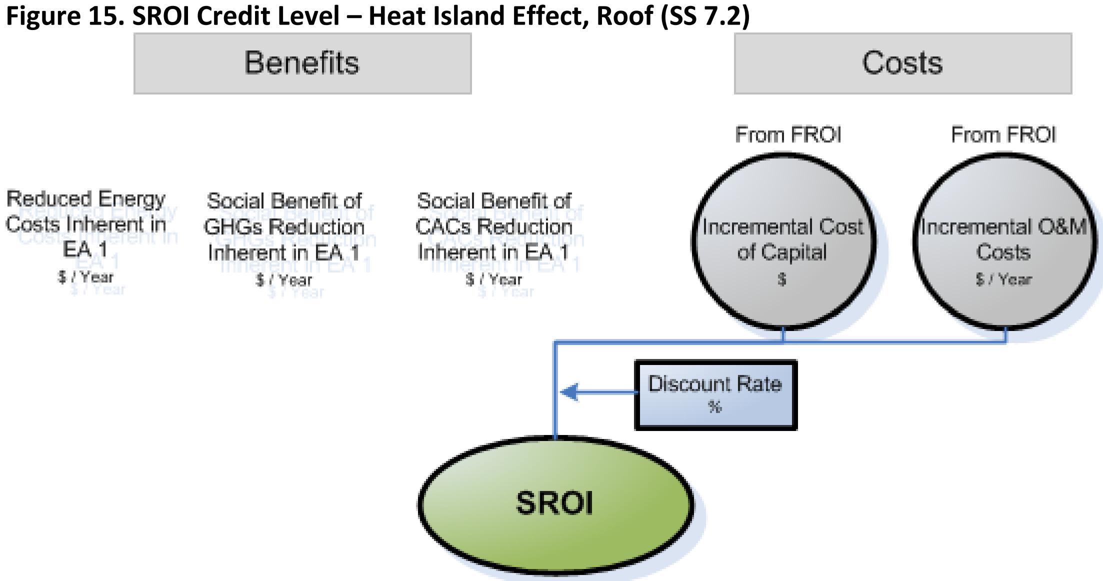


Figure 16. FROI Credit Level – Water Use Reduction (WE 2 & 3.1)

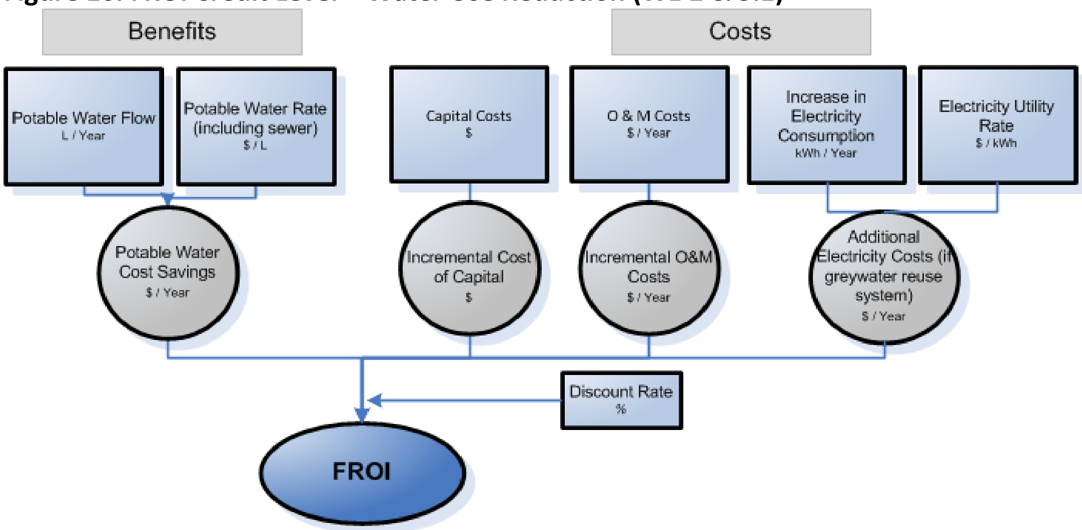


Figure 17. SROI Credit Level – Water Use Reduction (WE 2 & 3.1)

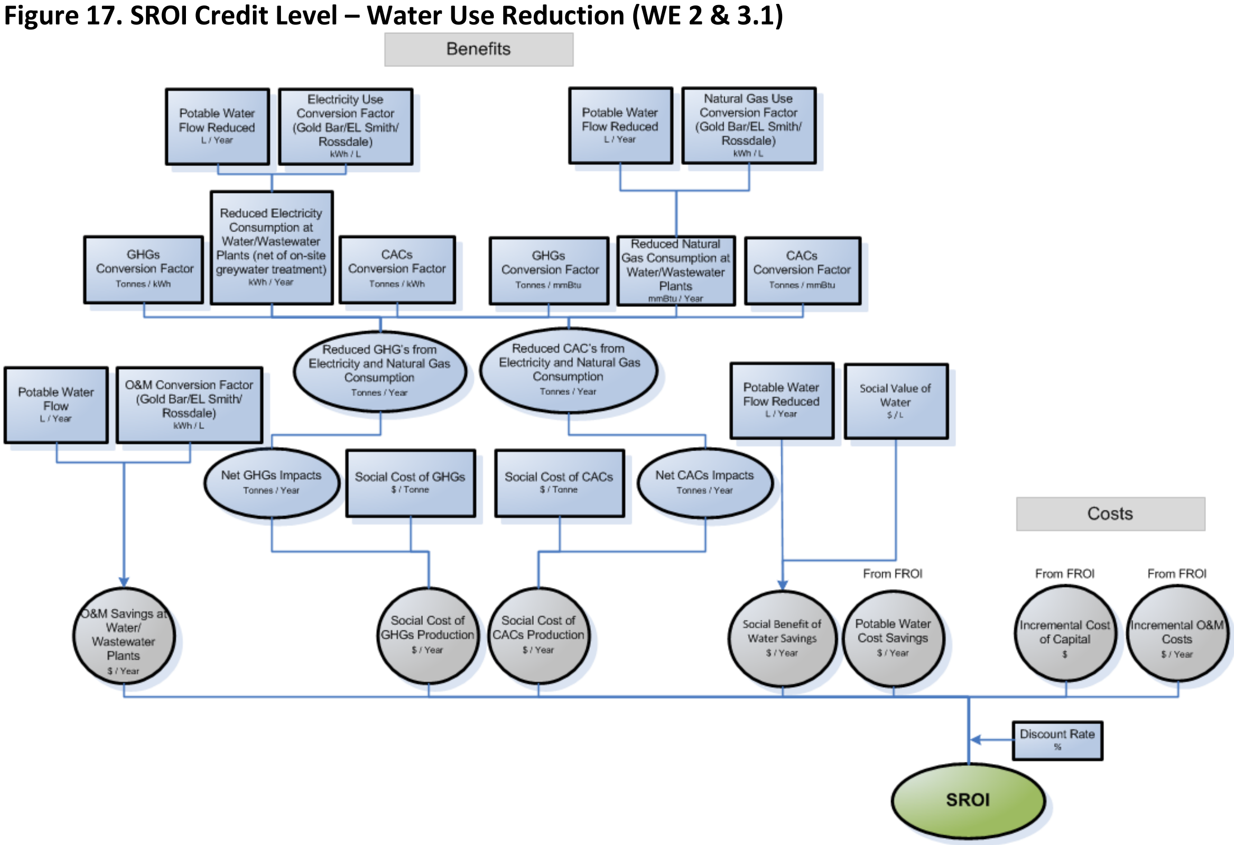


Figure 18. FROI Credit Level – Regional Materials (MR 5)

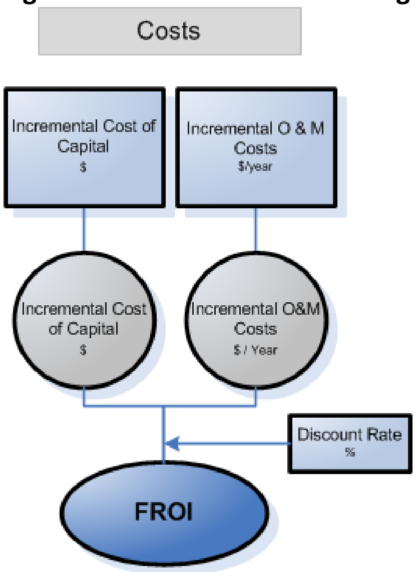


Figure 19. SROI Credit Level – Regional Materials (MR 5)

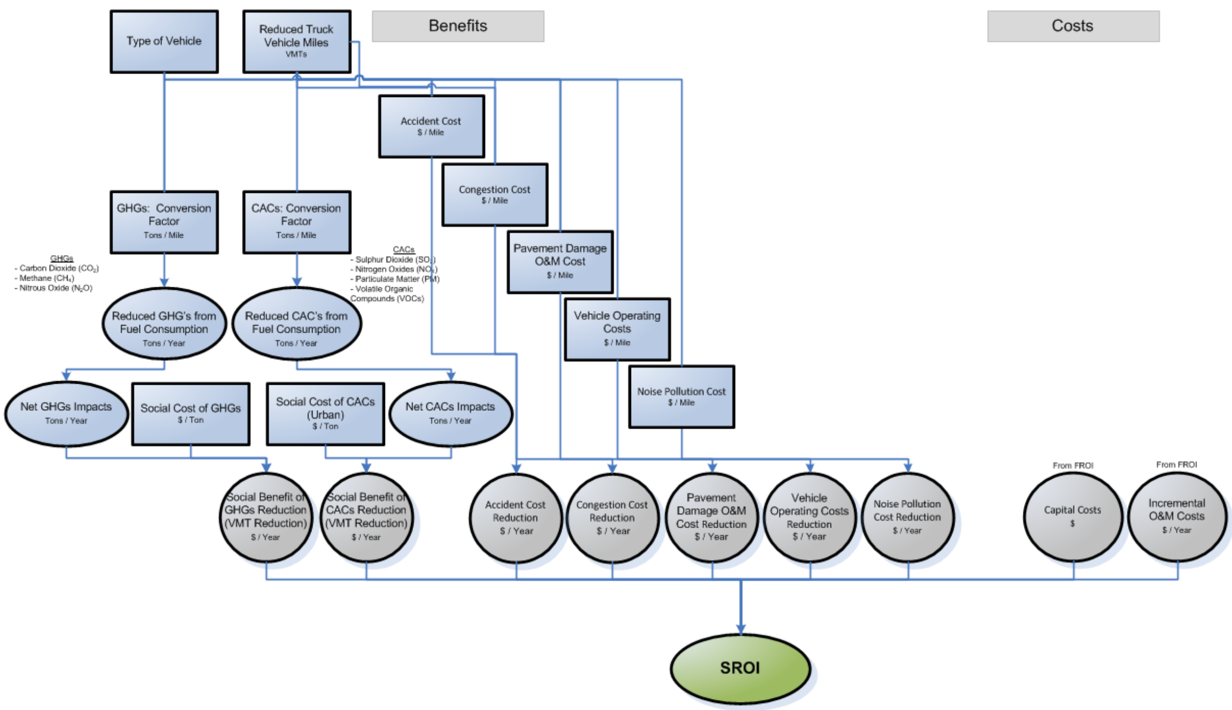


Figure 20. FROI Credit Level – Certified Wood (MR 7)

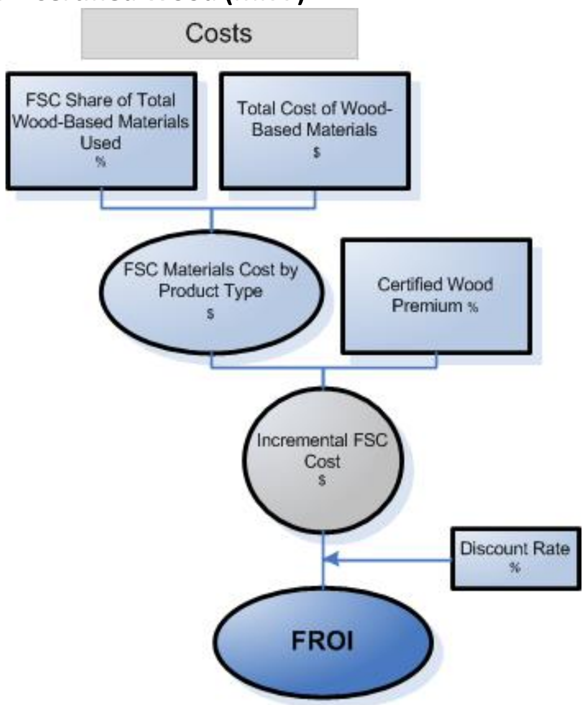


Figure 21. SROI Credit Level – Certified Wood (MR 7)

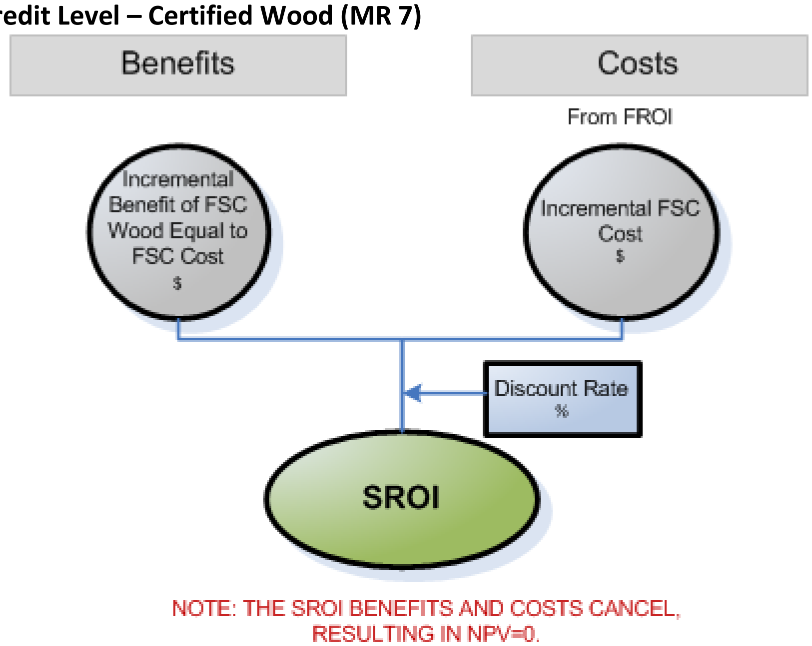


Figure 22. FROI Credit Level – Reduced Toxins/Irritants (IEQ 3.2, 4.4, & 5)

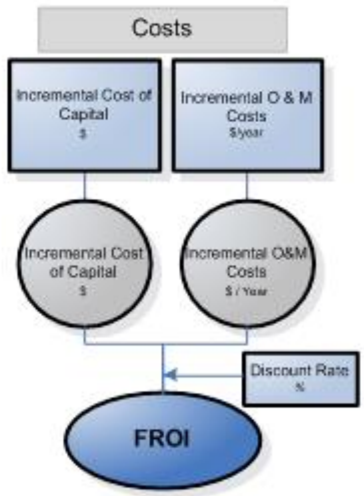


Figure 23. SROI Credit Level – Reduced Toxins/Irritants (IEQ 3.2, 4.4, & 5)

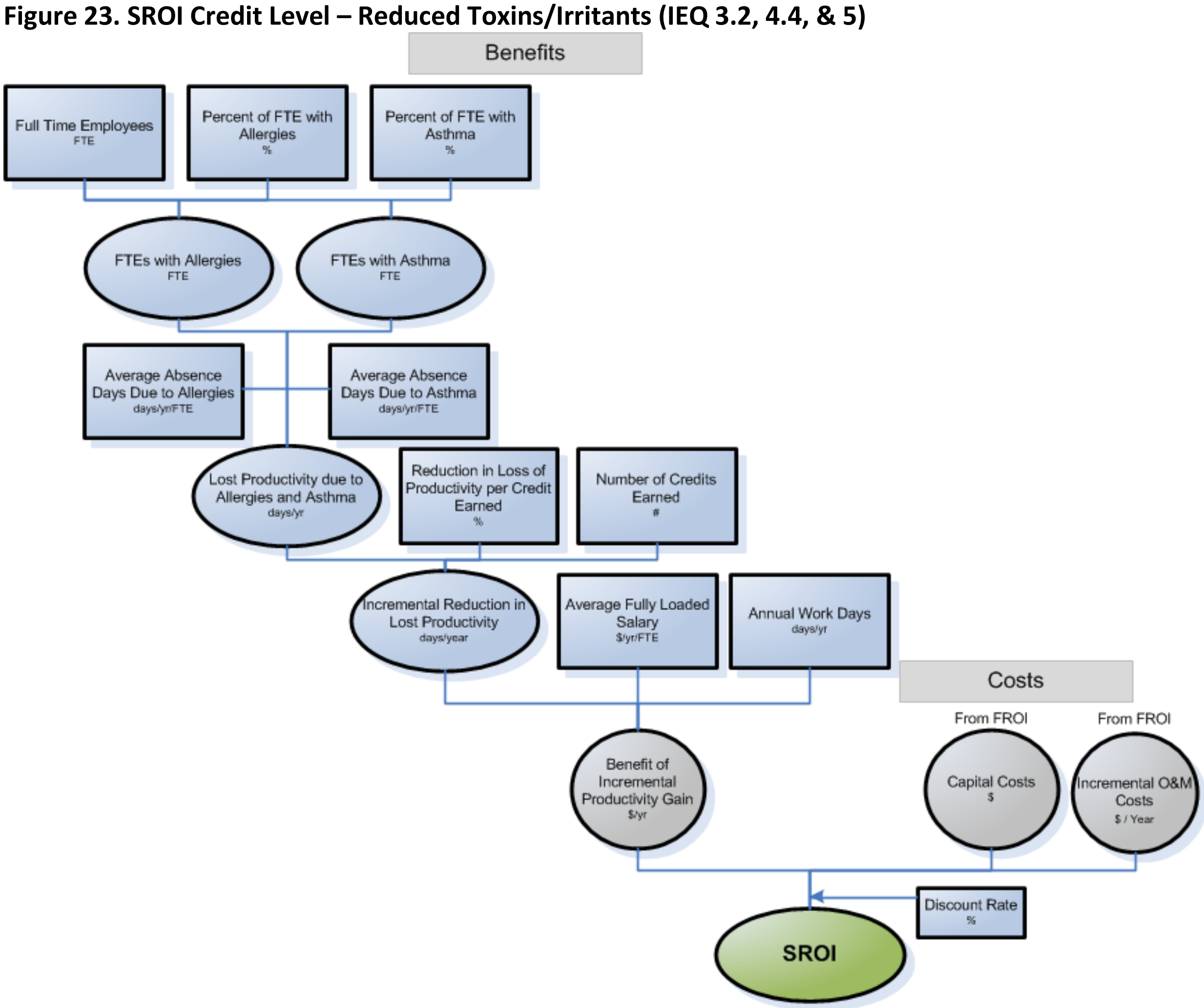


Figure 24. FROI Credit Level – Enhanced Comfort Control (IEQ 6.1, 6.2, 8.1, & 8.2)

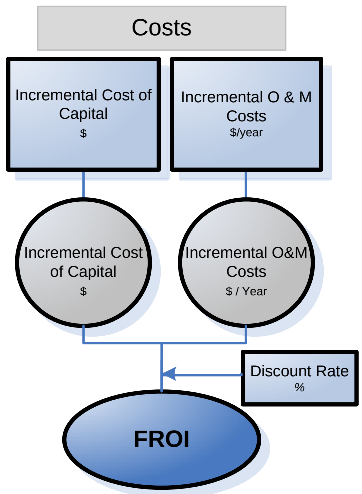


Figure 25. SROI Credit Level – Enhanced Comfort Control (IEQ 6.1, 6.2, 8.1, & 8.2)

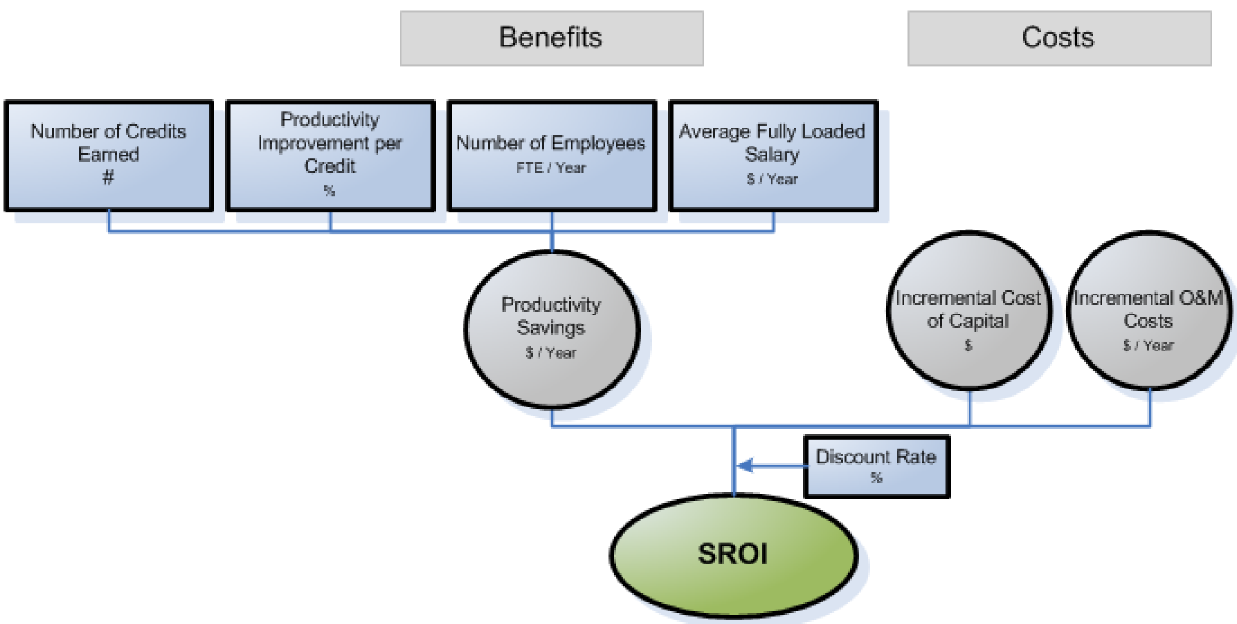


Figure 26. FROI Credit Level – Reductions in Communicable Diseases (IEQ 1 & 2)

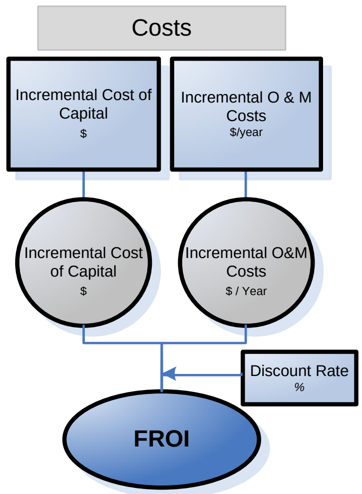
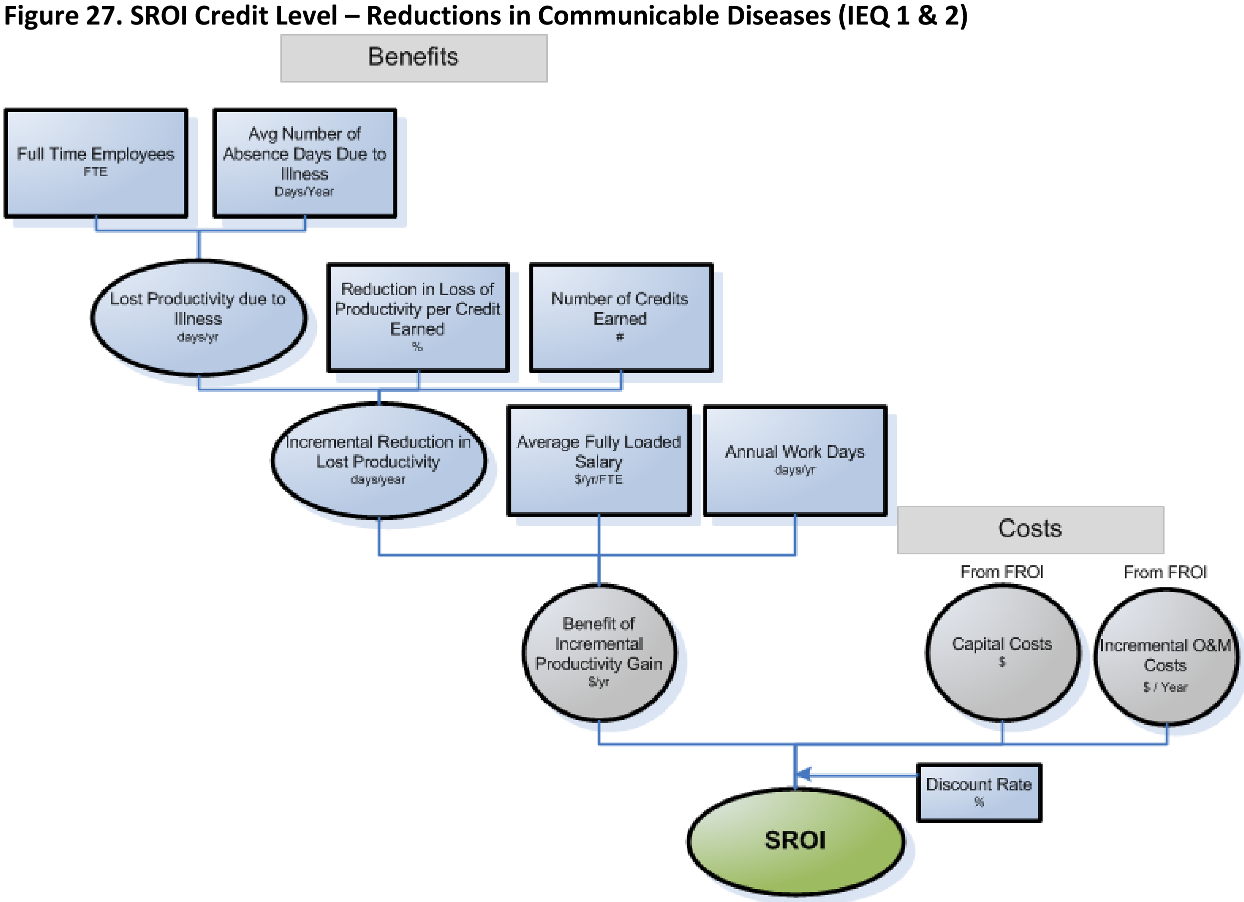


Figure 27. SROI Credit Level – Reductions in Communicable Diseases (IEQ 1 & 2)



APPENDIX E: OVERVIEW OF SUSTAINABLE RETURN ON INVESTMENT (SROI)

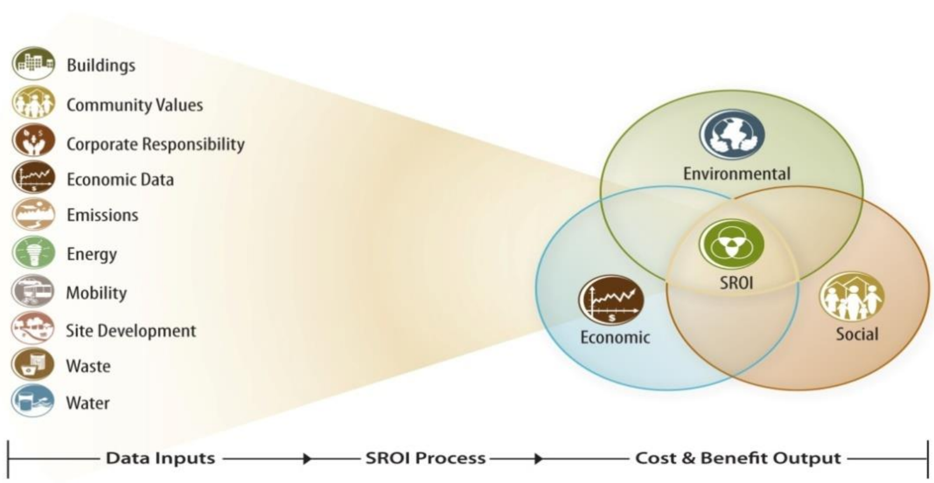
Issues related to sustainability, sustainable communities, and sustainable development is at the forefront of social debate today. Sustainable development is typically defined as the pattern of development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, Brundtland Commission, 1987). Sustainable development combines the financial considerations of development with broader socio-economic concerns including environmental stewardship, human health and equity issues, social well-being, and the social implications of decisions.

While the importance of these issues is widely recognized, organizations are challenged when they try to integrate sustainability considerations into their investment and operating decisions. Traditional financial evaluation tools used to assess an investment project, such as Business Case Analysis or Life-Cycle Cost Analysis (LCCA), rely exclusively on financial impacts. These traditional tools have two primary drawbacks:

1. An inability to accurately quantify the non-cash benefits and costs accruing to both the organization in question and to society as a whole resulting from a specific investment (sustainable benefits and costs).
2. A failure to adequately incorporate the element of risk and uncertainty.

HDR's Sustainable Return on Investment (SROI) process is a broad-based analysis that helps overcome these drawbacks by accounting for a project's triple-bottom line – its full range of financial, economic, as well as social and environmental impacts.

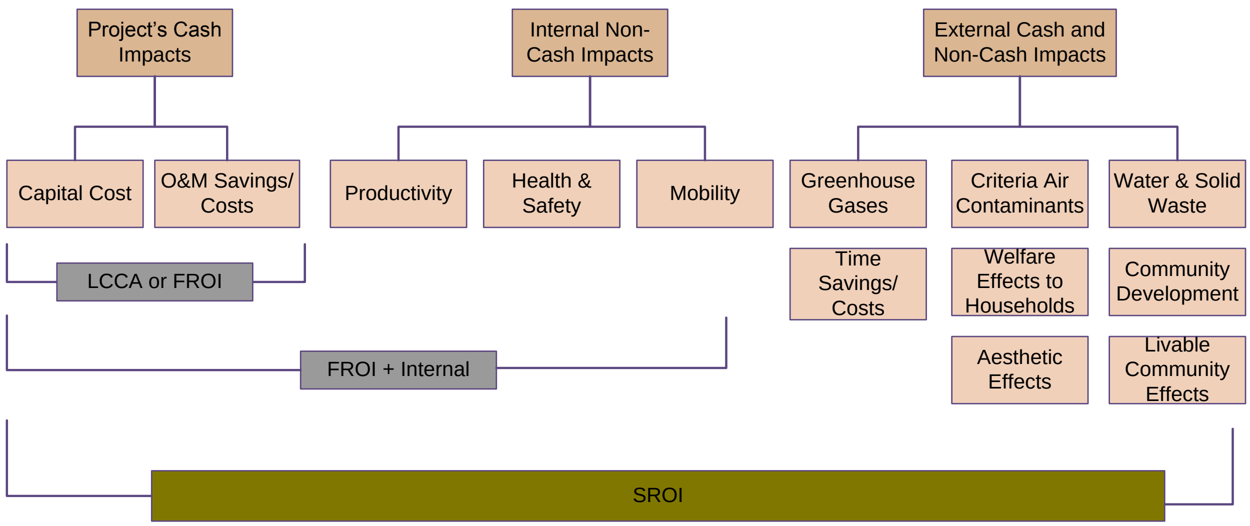
Figure A-1: SROI Methodology Guides Your Decision Making Process



The SROI process builds on best practices in Cost-Benefit Analysis and Financial Analysis methodologies, complemented by Risk Analysis and Stakeholder Elicitation techniques. The SROI process identifies the significant impacts of a given investment, and makes every attempt to credibly value them in monetary terms. Any relevant impacts that cannot be monetized are also identified, and ideally quantified in some way. Results are presented in innovative ways that help clients and their stakeholders prioritize projects, better understand trade-offs, and evaluate risk.

A key feature of SROI is that it converts to dollar terms (monetizes) the relevant social and environmental impacts of a project yet still provides the equivalent of traditional financial metrics (referred to as "Financial Return on Investment (FROI)"). FROI accounts for internal (i.e., accruing to the organization) cash costs and benefits only, while SROI accounts for all internal and external costs and benefit. The diagram below illustrates how traditional financial models differ from SROI.

Figure A-2: Comparison of SROI to Traditional Life-Cycle Costing



The SROI process includes the traditional financial impacts, such as savings on utility bills or reduced/ higher O&M costs, internal productivity effects and a range of social and environmental impacts that would result directly from the evaluated project. Examples include:

- Value of enhanced productivity from employees working in a green building (e.g., fewer sick days or performing a task more efficiently);
- Quantified and monetized value of reduction in environmental emissions;
- Quantified and monetized value of reduction in generation of waste ;
- Value of time savings and costs resulting from the evaluated project; and,
- Value of quality of life improvements, including improvements to households and broader community.

The SROI process involves four steps:

1. Development of the structure and logic of costs and benefits over the project life cycle. This involves determining the costs and benefits that result from the proposed investment and a graphical depiction to quantify these values. In particular, this step focuses on quantification of all broad (financial and sustainable) costs and benefits.

2. Quantification of input assumptions and assignment of risk/uncertainty, or initial risk analysis. This step involves building the preliminary outline of the SROI model, populating the model with

initial data assumptions and performing initial calculations for identified costs and benefits (financial, social and environmental).

3. Facilitation of a Risk Analysis Process (RAP) session. This is a meeting, similar to a one-day charrette, which brings together key stakeholders to reach consensus on input data values and calculations to be used in the model.[13]

4. Simulation of outcomes and probabilistic analysis. The final step in the process is the generation of SROI metrics, including Net Present Value (NPV), Discounted Payback Period, Benefit-Cost Ratio and the Internal Rate of Return, in addition to the traditional financial metrics. Financial metrics are included as a point of comparison and to transparently and comprehensively illustrate the relative merits of all potential investment scenarios being analyzed.

Each of the above steps is discussed in detail below.

Step 1: Structure and Logic of the Cost and Benefits

A "structure and logic model" depicts the variables and cause and effect relationships that underpin the forecasting problem at-hand. The structure and logic model is written mathematically to facilitate analysis and also depicted diagrammatically to permit stakeholder scrutiny and modification during Step 3.

Step 2: Central Estimates and Probability Analysis

Traditional financial analysis takes the form of a single "expected outcome" supplemented with alternative scenarios. The limitation of a forecast with a single expected outcome is clear – while it may provide the single best statistical estimate, it offers no information about the range of other possible outcomes and their associated probabilities. The problem becomes acute when uncertainties surrounding the underlying assumptions of a forecast are material.

Another common approach to provide added perspective on reality is "sensitivity analysis." Key forecast assumptions are varied one at a time, in order, to assess their relative impact on the expected outcome. A concern with this approach is that assumptions are often varied by arbitrary amounts. A more serious concern with this approach is that, in the real world, assumptions do not veer from actual outcomes one at a time but rather the impact of simultaneous differences between assumptions and actual outcomes is needed to provide a realistic perspective on the riskiness of a forecast.

Risk analysis provides a way around the problems outlined above. It helps avoid the lack of perspective in "high" and "low" cases by measuring the probability or "odds" that an outcome will actually materialize. A risk-based approach allows all inputs to be varied simultaneously within their distributions, avoiding the problems inherent in conventional sensitivity analysis. Risk analysis also recognizes interrelationships between variables and their associated probability distributions.

Risk analysis and probabilistic simulation techniques can be used to account for uncertainty in both the input values and model parameters. All projections and input values are expressed as probability distributions (a range of possible outcomes and the probability of each outcome), with a wider range of values provided for inputs exhibiting a greater degree of uncertainty. Of note, each element is converted into monetary values to estimate overall impacts in comparable financial terms and discounted to translate all values into present-value terms. Specifying uncertainty ranges for key parameters entering the decision calculus allows the SROI framework to evaluate the full array of social costs and benefits of a project while illustrating the range of possible outcomes to inform decision-makers.

Each variable is assigned a central estimate and a range to represent the degree of uncertainty. Estimates are recorded on Excel-based data sheets. The first column gives an initial median. The second and third columns define an uncertainty range representing a 90 percent confidence interval—the range within which there exists a 90 percent probability of finding the actual outcome. The greater the uncertainty associated with a forecast variable the wider the range.

Figure A- 3: Example of Data Input Sheet *(Illustrative Example)*

Data Input	Median	Low	High	Realized
Percent reduction in electricity use	30.0%	22.5%	37.5%	**30.0%**
Building sqft	252,752	252,752	252,752	**$ 252,752**
Cost of electricity per kWh	$ 0.100	$ 0.050	$ 0.250	**$ 0.117**
Electricity use in kWh per sqft/year	49.33	39.46	59.19	**49.33**

Probability ranges are established using both statistical analysis and subjective probability assessment. Probability ranges do not have to be normal or symmetrical. In other words, there is no need to assume a bell-shaped normal probability curve. The bell curve assumes an equal likelihood of being too low and too high in forecasting a particular value. For example, if projected unit construction costs deviate from expectations, it is more likely that the costs will be higher than the median expected outcome than lower.

The Excel-based risk analysis add-on tool @Risk transforms the ranges depicted in the table above into formal probability distributions (or “probability density functions”), helping stakeholders understand and participate in the process even without formal training in statistical analysis.

The central estimates and probability ranges for each assumption in the forecasting structure and logic framework come from one of three key sources, as described below:

- The best available third party information from a variety of sources, including the Environmental Protection Agency, the Department of Energy, the Federal Highway Administration, the Bureau of Labor Statistics, other government agencies, financial markets, universities, think tanks, etc.
- Historical analysis of statistical uncertainty in relevant time series data and an error analysis of forecasting “coefficients,” which are numbers that represent the measured impact of one variable (say, fuel prices) on another (such as the price of steel). While these coefficients can only be known with uncertainty, statistical methods help uncover the level of uncertainty (using diagnostic statistics such as standard deviation, confidence intervals, and so on). This is also referred to as “frequentist” probability.
- Subjective probability assessment (also called “Bayesian” statistics, for the mathematician who developed it) in which a frequentist probability represents the measured frequency with which different outcomes occur (i.e., the number of heads and tails after thousands of tosses). The Bayesian probability of an event occurring is the degree of belief held by an informed person or group that it

will occur. Obtaining subjective probabilities is the subject of Step 3.

Step 3: Expert Evaluation: The RAP© Session

The third step in the SROI process involves the formation of an expert panel to hold a charette-like one or two day meeting that we call the Risk Analysis Process (RAP) session. We use facilitation techniques to elicit risk and probability beliefs from participants about:

I. The structure of the forecasting framework
II. Uncertainty attached to each input variable and forecasting coefficient in the framework

In (i), experts are invited to add variables and hypothesized causal relationships that may be material, yet missing from the model. In (ii), the initial central estimates and ranges that were provided to panelists prior to the session are modified based on subjective expert beliefs and discussion.

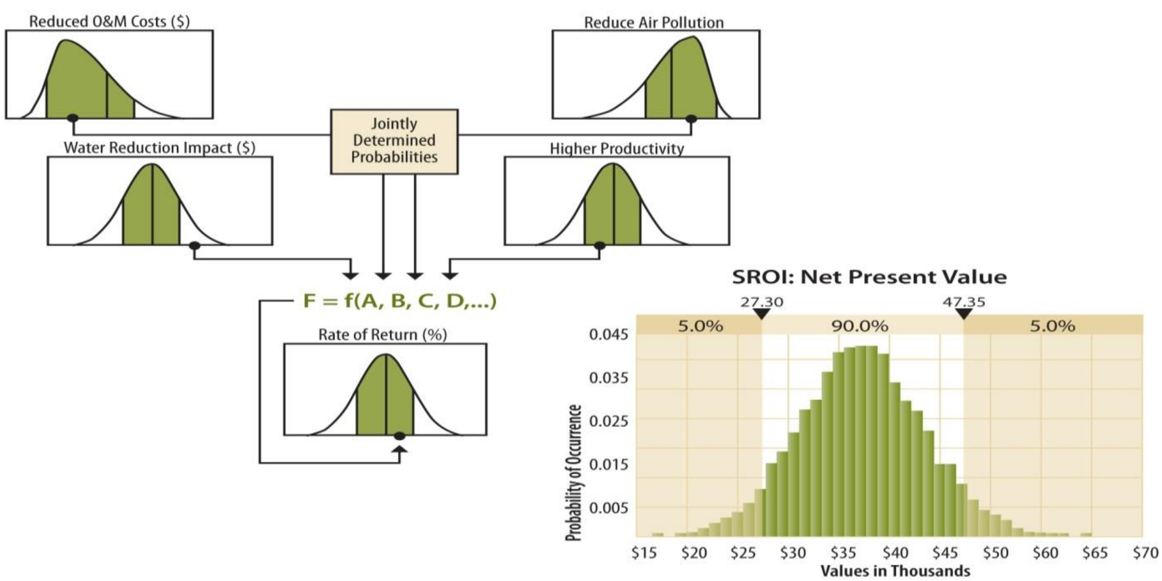
Examples of typical RAP session participants include:

- **Client**
  - Project tam
  - Technical specialists
  - Financial experts
- **HDR**
  - Facilitator
  - Economists
  - Technical Specialists
- **Outside Experts**
  - Public Agencies and Officials
  - Business Groups

Step 4: Simulation of Outcomes and Probabilistic Analysis

In step four, final probability distributions are formulated by the risk analyst (Economist) and represent a combination of probability information drawn from Steps 2 and 3. These are combined using simulation techniques (called Monte Carlo analysis) that allow each variable and forecasting coefficient to vary simultaneously according to its associated probability distribution (see Fig A-4 for a graphical representation of this process).

Figure A- 4: Combining Probability Distributions *(Illustrative Example)*



The

result of the analysis is a forecast that includes estimates of the probability of achieving alternative outcomes given the uncertainty in underlying variables and coefficients.

For example, probability distribution of NPV of a project is demonstrated in Figures A-5 and A-6. As the figure and the table show, the average expected outcome of the hypothetical project is an NPV of $392.41 over the period of analysis considered. There is a 10% chance that the NPV will exceed $580.11, and a 1% chance that the NPV will exceed $751.29. However, the proposed project also has a downside and a non-zero probability of performing at a much lower magnitude of NPV than the average outcome. Specifically, as the table shows there is a 99% probability that the NPV will exceed the negative $36.29. This implies that there is a risk (about 1% to 2% in this case) that the NPV of the project considered would fall below zero, or generate no net benefits. Examining the table further, one can also determine that there is a risk of underperformance of the project, or the situations when the project generates net benefits that are much lower than the mean expected outcome.

Figure A- 5: Risk Analysis of Net Incremental Benefits of a Project

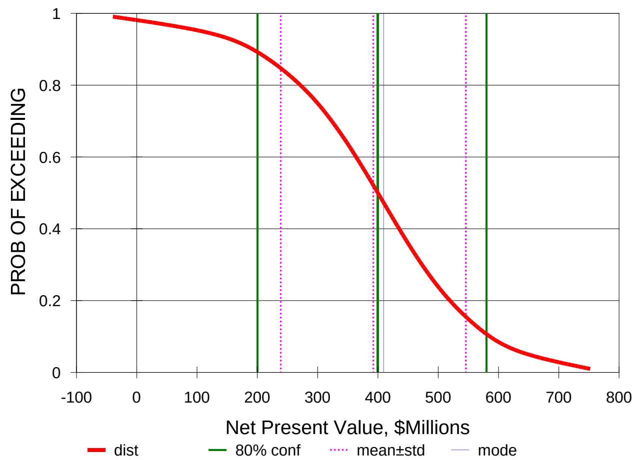


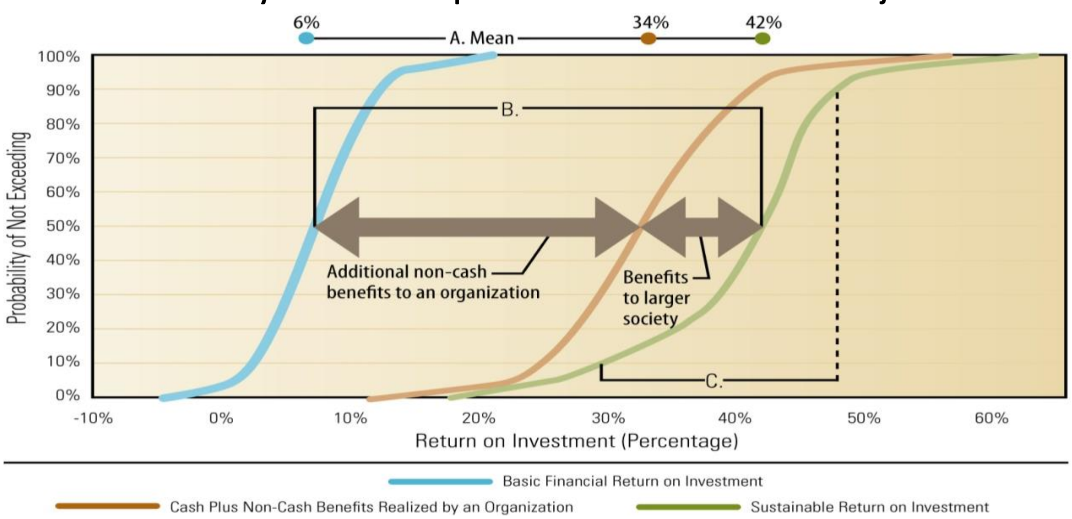
Figure A- 6: Risk Analysis of Net Present Value of a Project (*Illustrative Example)*

Project Net present Value ($ M)	Probability of Exceeding Value Shown at Left
-$36.29	0.99
$128.11	0.95
$**200.01**	**0.90**
$275.91	0.80
$325.05	0.70
$364.50	0.60
$**400.05**	**0.50**
$434.81	0.40
$471.95	0.30
$516.08	0.20
$**580.11**	**0.10**
$636.22	0.05
$751.29	0.01
$**392.41**	**Mean Expected Outcome**

Using the SROI process, the net present value of a project (as in the example above) and other evaluation metrics can be estimated taking into account the three types if impacts discussed earlier: (1) only project cash impacts, (2) project cash impacts and non-cash impacts internal to the organization, and (3) all comprehensive societal or sustainable impacts. This allows decision-makers the ability to prioritize worthy—but competing—projects for funding based on the maximum financial and societal returns. In the following example, a project's outcome metrics are synthesized into an intuitive risk analysis model based on estimated return on investment.

A. Compare the financial return on investment and sustainable return on investment. In this example, the mean sustainable return on investment is more than double the traditional return on investment.
B. Evaluate non-cash benefits, such as improvements in employee health and productivity, and the benefits to larger community.
C. Assess the statistical likelihood that return will fall within an 80% confidence interval. In this example, sustainable return on investment ranges from 15% to 34%.

Figure A- 7: The Sustainability "S" Curve to Optimize the Total Value of Your Projects



APPENDIX F: GLOSSARY OF TERMS

Discounted Value: The discounted value is the present value of a future cash amount. The present value is determined by reducing its future value by the appropriate discount rate (interest rate used in determining the present value of future cash flows) for each unit of time between the times when the cash flow is to be valued to the time of the cash flow. To calculate the present value of a single cash flow, it is divided by one plus the interest rate (discount rate) for each period of time that will pass. This is expressed mathematically as raising the divisor to the power of the number of units of time.

Net Present Value (NPV): The net value that an investment or project adds to the value of the organization, calculated as the sum of the present value of future cash flows less the present value of the project's costs.

Discounted Payback Period (DPP): The period of time required for the return on an investment to recover the sum of the original investment on a discounted cash flow basis.

Benefit To Cost Ratio (BCR): The overall "value for money" of a project, expressed as the ratio of the benefits of a project relative to its costs, with both expressed in present-value monetary terms.

Sustainable Return on Investment (SROI): SROI is an enhanced form of Cost-Benefit Analysis (CBA) - it provides a triple-bottom line view of a project's economic results and goes even further by incorporating state-of-the-art risk analysis. SROI monetizes (converts to monetary terms) all relevant social and environmental impacts related to a given project, and provides the equivalent of traditional financial metrics.

Greenhouse Gases: A greenhouse gas (abbreviated GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone. SROI monetizes carbon dioxide, methane, and nitrous oxide.

Criteria Air Contaminants: Criteria air contaminants (abbreviated CAC) are a set of air pollutants that cause smog, acid rain and other health hazards. CACs are typically emitted from many sources in industry, mining, transportation, electricity generation and agriculture. In most cases they are the products of the combustion of fossil fuels or industrial processes. The basis for monetizing the social impacts of criteria air contaminants was to primarily use the results from three reputable studies by the U.S. Department of Transportation, the European Commission, and Yale University. The main criteria air contaminants analyzed were Nitrogen Oxide (NOx), Volatile Organic Compounds (VOCs), Particulate Matter (PM), and Sulfur Dioxide (SO2). The latter two were further split and categorized into Rural, Urban, and Dense Urban.

Carbon Dioxide (C02): Carbon dioxide is a heavy colorless gas that does not support combustion and is absorbed from the air by plans in photosynthesis. Industrial carbon dioxide is produced mainly from six processes: Directly from natural carbon dioxide springs, where it is produced by the action of acidified water on limestone or dolomite; As a by-product of hydrogen production plants, where methane is converted to CO2; From combustion of fossil fuels and wood; As a by-product of fermentation of sugar in the brewing of beer, whisky and other alcoholic beverages; From thermal decomposition of limestone, $CaCO3$, in the manufacture of lime, CaO.

Nitrogen Oxides (NOx): Nitrogen oxides include a number of gases that are composed of oxygen and nitrogen. In the presence of sunlight these substances can transform into acidic air pollutants such as nitrate particles. The nitrogen oxides family of gases can be transported long distances in our atmosphere. Nitrogen oxides play a key role in the formation of smog (ground-level ozone). At elevated levels, NOx can impair lung function, irritate the respiratory system and, at very high levels, make breathing difficult, especially for people who already suffer form asthma or bronchitis.

Particulate Matter (PM): Particulate matter refers to tiny particles of solid or liquid suspended in a gas. Sources of particulate matter can be man made or natural. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols.

Volatile Organic Compound (VOC): Volatile organic compounds (VOCs) are a large and diverse family of chemicals that contain carbon and hydrogen. They can be emitted into indoor air from a variety of sources including cigarette smoke, household products like air fresheners, furnishings, vehicle exhaust and building materials such as paint, varnish and glues. Examples of VOCs are aldehydes, ketones, and hydrocarbons.

HDR

www.hdrinc.com

MISSION

To be a superior professional firm known for vision, value, and service to our clients, our communities and our employees.