



# A Proposed Results Framework for Large Scale Research Infrastructure

Presented by:

Gretchen B Jordan, 360 Innovation LLC

(co-author Steve Montague, Performance Management Network)

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# Need for and Objectives of the Study

Expressed Need

- Enhance the ability of Canadian agencies with an interest in funding Large Scale Research Infrastructure (LSRI), and the LSRI facilities themselves, to evaluate the nature and extent of impacts of LSRI on science, the economy and society.

Objectives of the Study

- Review existing practice and literature, identifying best practices and systems of measurement (evaluation) for LSRI impacts
- Recommend an approach including performance questions, indicators and methodologies with attention to what is unique to LSRI

# Review of Literature and Consultations

Over 100 documents and sources (including websites) gathered and reviewed

- Several recent reviews have noted the scientific and economic impacts of ‘big science’
- Few suggestions for improvement, and those propose theoretical frameworks for evaluation

Consultations with managers of 7 Canadian facilities and 4 international facilities

- Interested in improving assessment of impacts, considering their current approach inadequate
- LSRI report quantitative indicators of what can be counted
- Impact assessment is done with success stories and occasional economic cost benefit analysis of selected successes

# Gaps in Current LSRI Impact Assessment Practices

- Wide variance in the nature and context of LSRI conditions relating to performance – not consistently described
- Limited and inconsistent impact pathways
- Limited monitoring and evaluation approaches

If these gaps are addressed, the contribution of LSRI to societal benefits can be better understood and decision-makers will be better informed to make investment, policy, design and delivery improvements.

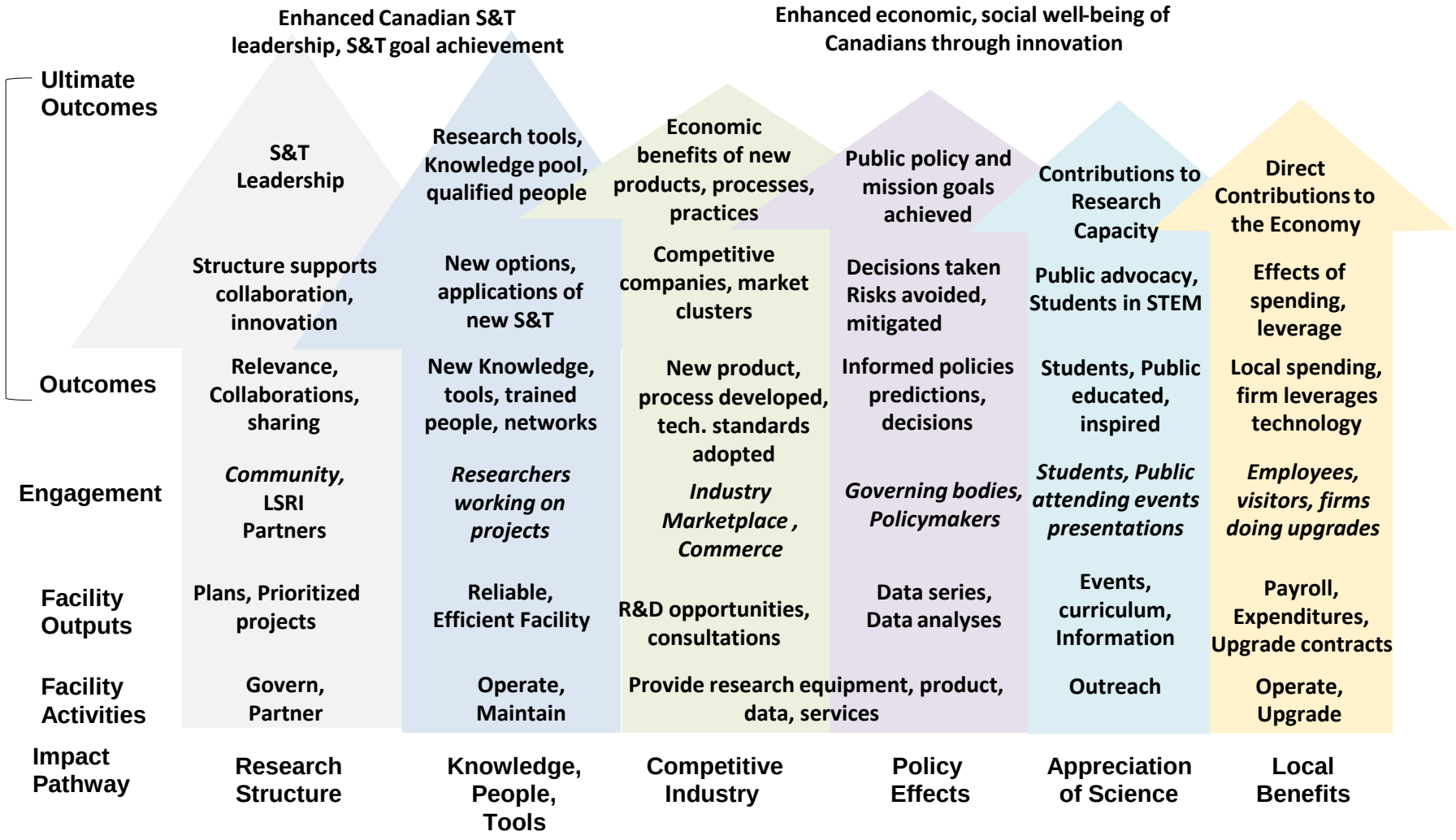
# Contextual Dimensions for LSRI

| Performance Level | External Influences (Examples) |
|---|---|
| Ultimate Outcomes / Impacts (Why?) | •Global S&T spending in field<br>•Serendipity<br>•General economic conditions<br>•Shifting societal challenges |
| Immediate and Intermediate Outcomes (What?) | •Speed of evolution in the S&T field<br>•Progress elsewhere<br>•Absorptive capacity in application areas, and communities targeted via outreach |
| Engagement (Who?) | •Global trends in this area<br>•Political influences on collaboration;<br>•Sector capacity and readiness to engage |
| Inputs and Activities (How?) | •Existing national strengths, strategy<br>•Speed of evolution in the S&T field<br>•Authorities, governance and overall management norms |

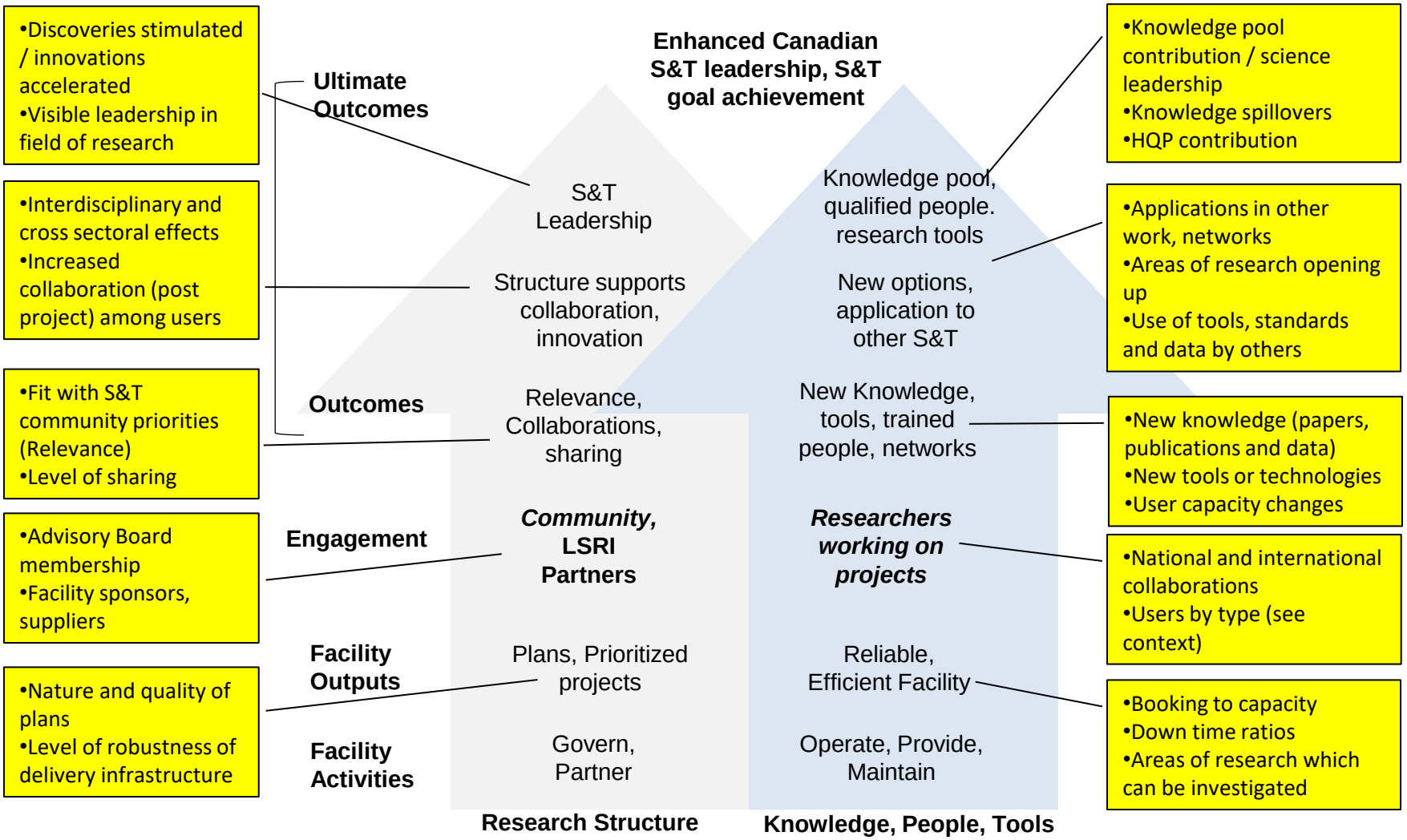
# Proposed LSRI Logic Model – Six Impact Pathways

- Research Structure
- Knowledge, People, and Tools
- Competitive Industry
- Policy Effects
- Appreciation of Science
- Local Benefits

# A Generic Logic Model with Six Impact Pathways

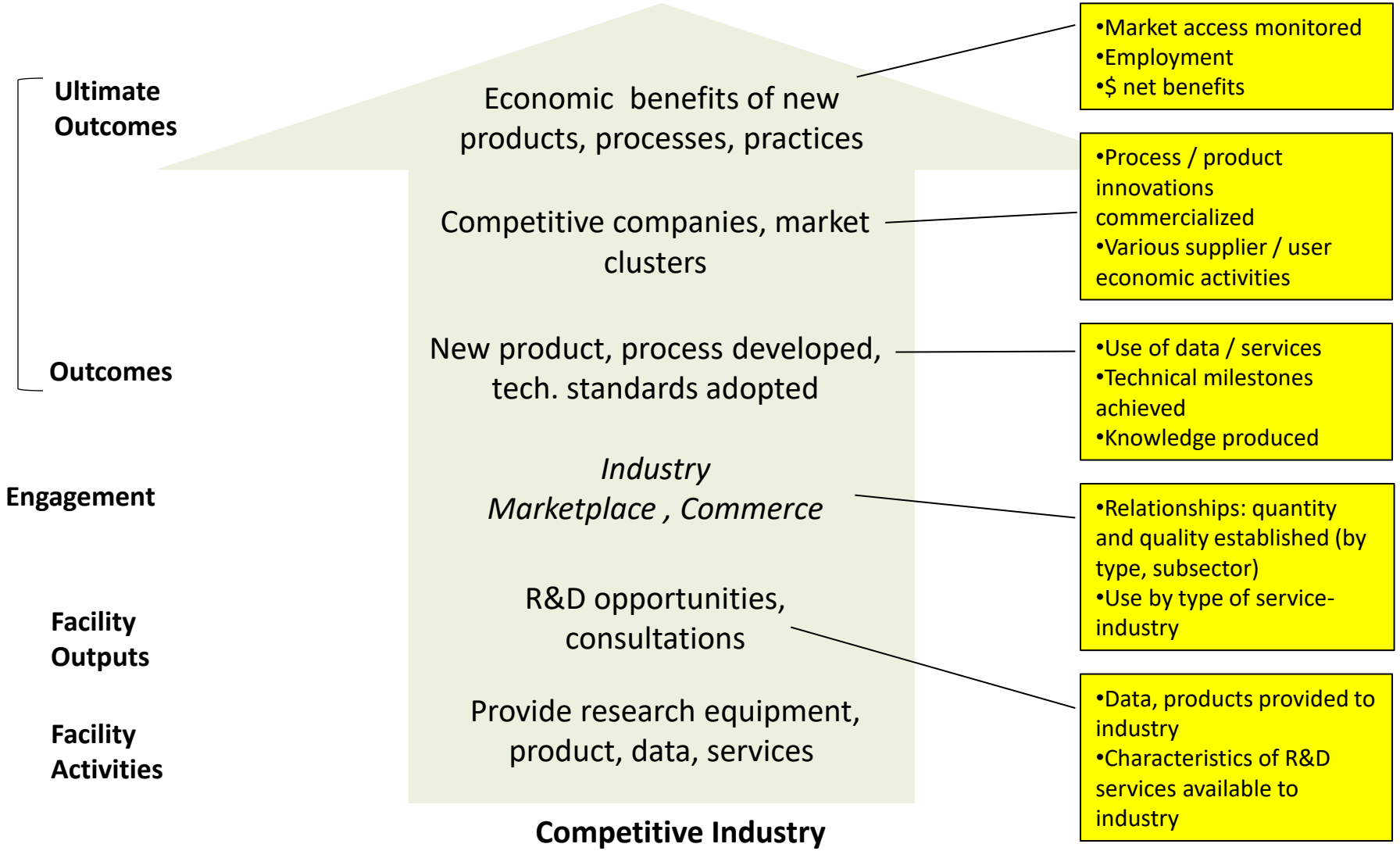


# Create a Research Structure That Supports Discovery and Innovation and Build Knowledge and Research Capacity – Some Select Metrics




These pathways follow a science support and impact logic – enabling better science, HQP networks and knowledge pool improvements. Qualitative contextualized approaches (e.g. case studies) will be important to complement quantitative indicators.

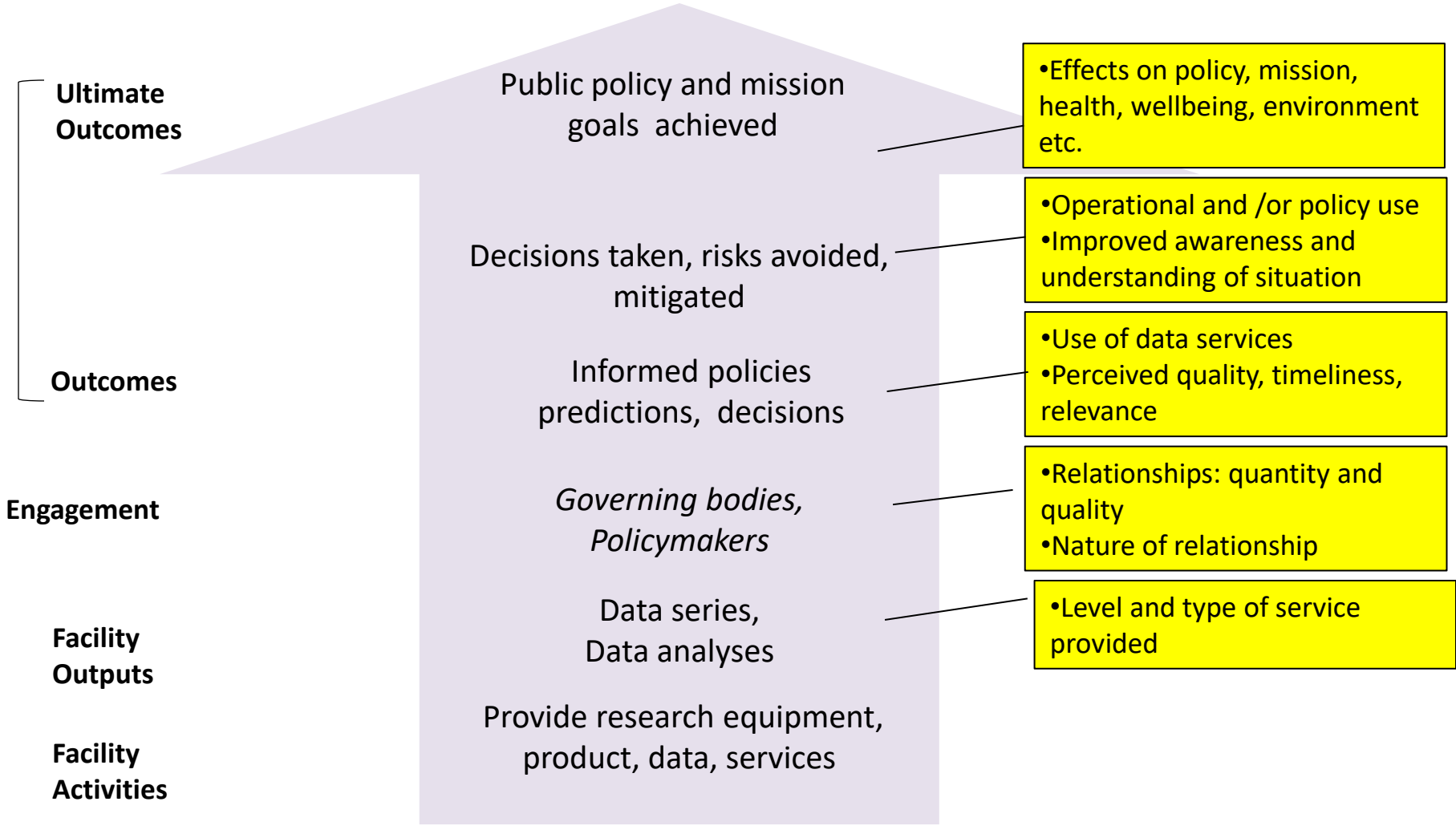
# Contribute to New Technologies, Competitive Companies, Markets Clusters – Some Select Metrics




**Competitive Industry**

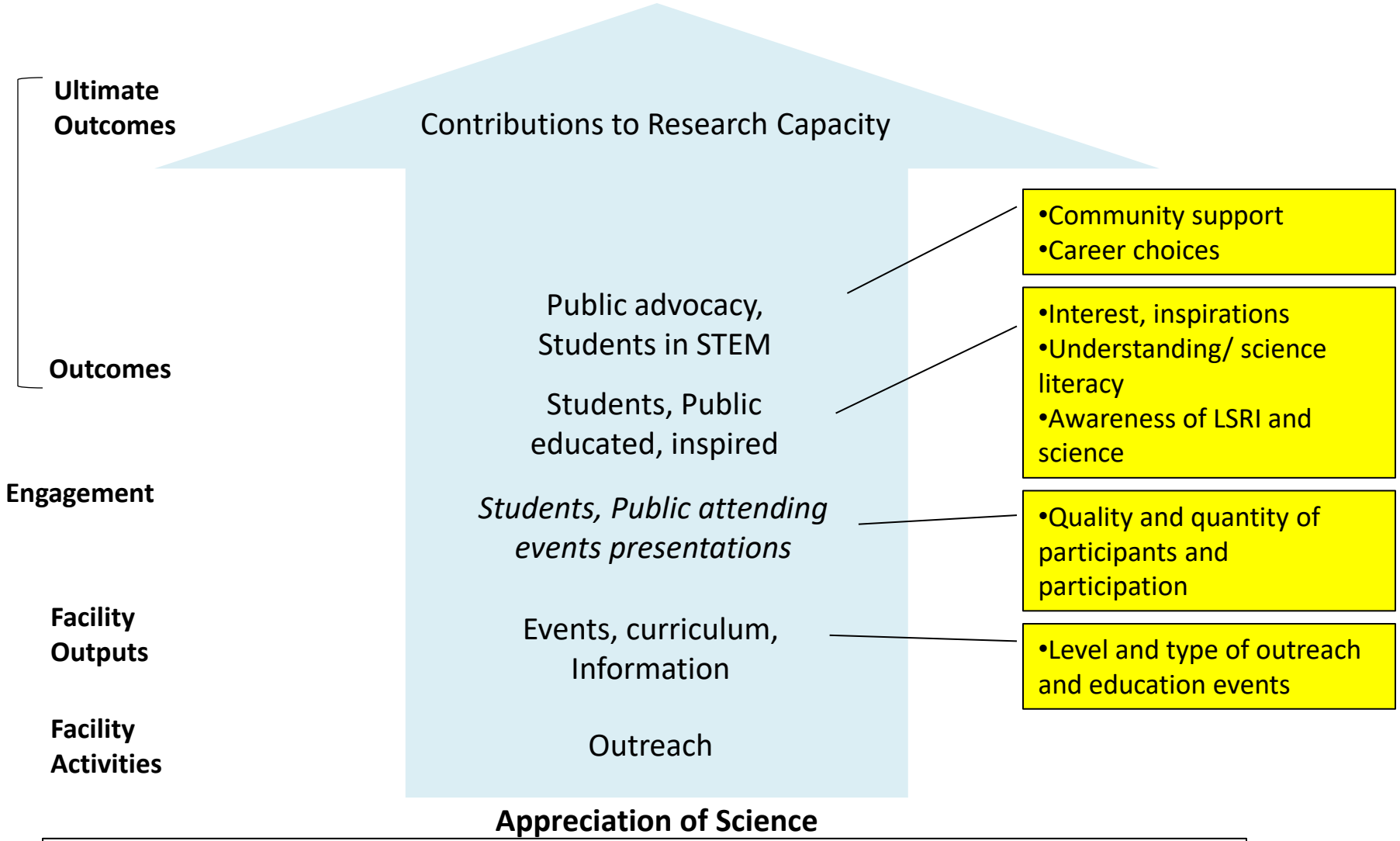
This pathway follows a product-process commercialization (marketplace innovation) logic. Key impacts relate to the benefits of commercialization and innovation such as employment and net financial benefits to industry. The potential for this pathway varies extensively by LSRI.

# Inform Government Policies and Decisions – Some Select Metrics



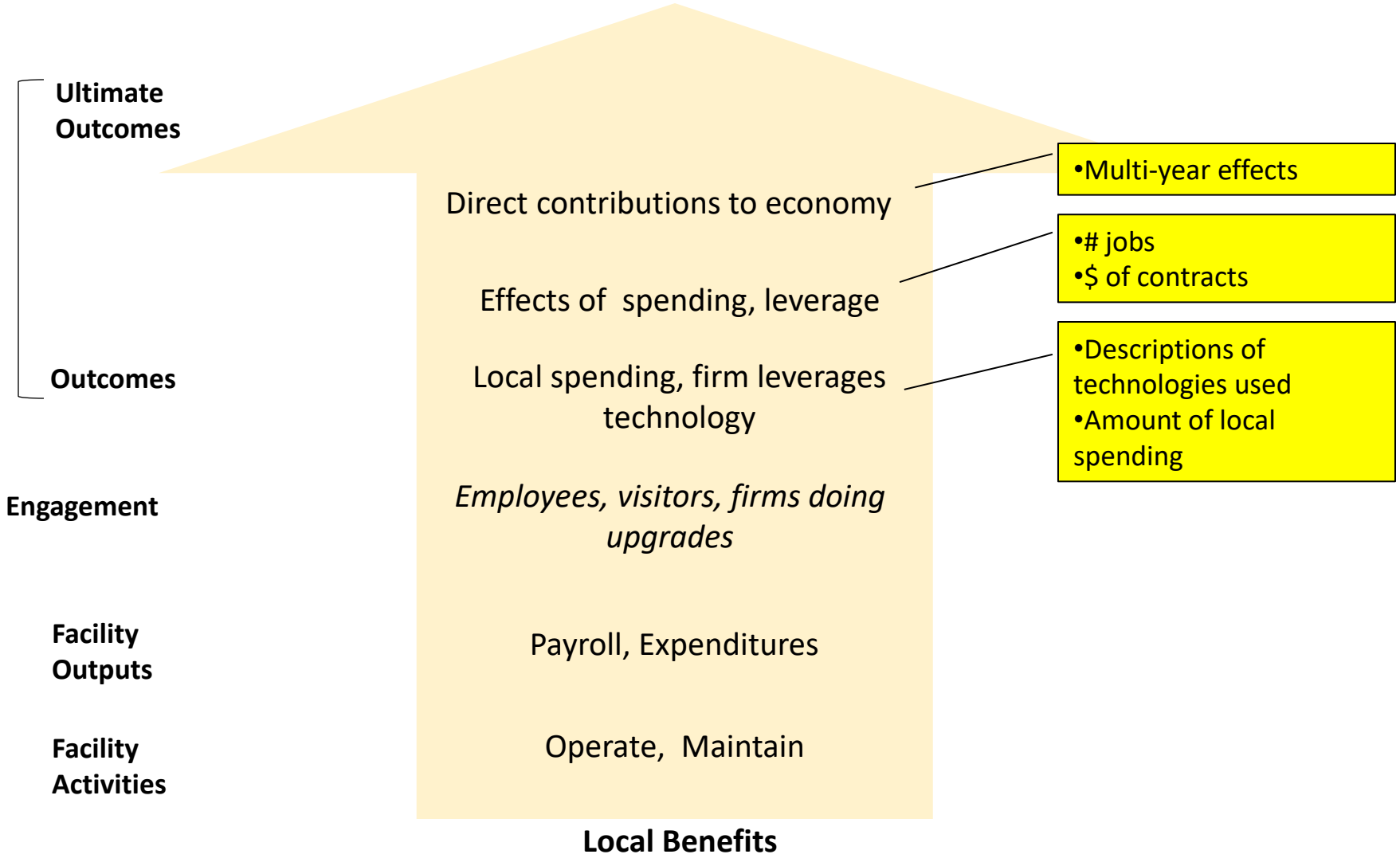

This pathway follows a logic relating to science influencing public mission and policy (and some operations). The key metric for this pathway is contribution to mission achievement. The nature of this pathway and its potential varied extensively by LSRI and policy area.

# Student and General Public Appreciation of Science – Some Select Metrics




This pathway follows an education and social marketing logic. The key metrics involve tracking engagement, reactions and then knowledge and attitudinal changes. Difficulties attributing longer term results means that only limited effort should be taken to track this path in most cases.

# Direct Economic Impacts of Facility Spending and Upgrades – Some Select Metrics




This pathway follows a logic relating to the conventional economic impacts occurring from a major investment into a regional economy.

# Good Practice: Components of Proposed Framework for LSRI Impact Assessment

1. At the beginning of the assessment period, define the logic of the LSRI, including the conditions underpinning this. This will vary considerably across LSRI.
2. Next, describe a sequence of results expected for all the impact pathways that apply, and determine indicators to see if these occur.
3. To assess impact along the pathways, develop and implement a multi-year assessment plan that has three levels of analysis integrated over a period of time: monitoring, mid term review, and periodic in depth assessment.

# Conclusions

- Logic models and underlying conditions are critical for framing performance
- Distinct impact pathways and common indicators can be described and used
- Multi-year assessment plans and mixed approaches (both qualitative and quantitative) with consideration of context make sense in most cases

# Contact Information

Gretchen Jordan
360 Innovation LLC
Gretchen.jordan@comcast.net

Steve Montague
Performance Management Network Inc.
steve.montague@pmn.net

# Templates, Differences in LSRI Impact Pathways

# Template 1: Questions to help define logic and existing conditions

The following are questions that LSRI staff can answer to develop a description of the program logic or impact pathways.

**The "Why" (Ultimate Outcomes)**

1. In what area(s) will this LSRI enhance Canadian S&T leadership (fields, enabling services)? What broad strategic needs are served? How does it fit into national S&T policy? Why is it significant?
2. What role does this LSRI play in the international arena? How does it benefit S&T in this era of globalization?
3. Can it bring together and focus S&T communities?
4. What are likely and/or possible socio-economic impacts from use of the outputs of the LSRI and its users in further S&T or new commercial products or processes or policies or practices?

**The "What" (Early Outcomes and Outputs) Consider all of the impact pathways that might apply.**

5. What user needs are satisfied by this facility?
6. What specific results can be expected in five years in the arenas the LSRI operates in? For example, these may be big science questions (define these) or options for solutions to an identified problem, or development of a new technology?
7. What are the possible application areas for those results, scientific and otherwise?
8. What, if any, results are expected from education and outreach activities?

**The "Who" (Engagement of Partners and Users)**

9. What S&T communities support and/or use this LSRI, national and international?
10. How multi or interdisciplinary or trans-sectoral is the work supported?
11. How much development and innovation is currently occurring in equipment, techniques, data, technical standards, and/or services of the facility? Might this spill over to firms or other applications? Where?
12. To what extent and how are industry and government policy makers directly involved, if at all?

**The "How" (Activities and Inputs)**

13. What are the unique capabilities of the LSRI that enable research? What kinds of research?
14. Does LSRI staff perform research and development as well as host these activities?
15. What activities does the LSRI perform in addition to research and research support? These could include providing products, data sets, analyses, protocols, public outreach.
16. What else, if anything, distinguishes this LSRI: Capital intensity, economics of scale or scope?

**External Influences (Driving and Restraining Forces for Success)**

17. What big picture changes might influence your success, such as global S&T spending, serendipitous discovery, or economic or societal conditions?
18. What circumstances - anticipated or not - might slow or hasten your progress toward outcomes, such as pace of evolution in S&T, S&T progress made elsewhere, technology readiness of those who would apply S&T to problem areas?
19. What external events could influence collaborators or user groups, such as global trends, capacity, or political influences in collaboration or expenditures on S&T?
20. What external influences, that you have not already accounted for in LSRI design, might affect how the LSRI operates (e.g. national strengths or strategy, scientific or technical change, or governing authorities and management norms)?

# Template 2: Description of Impact Pathways

| TEMPLATE 2 | | | | | | |
|---|---|---|---|---|---|---|
| Area | Description of Impact Pathways (not all will apply) | | | | | |
| | Research Structure | Knowledge, People, Tools | Competitive Companies | Policy Effects | Appreciation of Science | Local Benefits |
| Activities/ Outputs | | | | | | |
| | | | | | | |
| Who is Engaged | | | | | | |
| Other major influences | | | | | | |
| Early Outcomes (1-2 years) | | | | | | |
| Intermediate Outcomes (3-5 years) | | | | | | |
| Longer term Outcomes (6-10 years) | | | | | | |
| Ultimate Outcomes (10+ years) | | | | | | |

# Template 3: Assessment questions, indicators, approach, data sources

| Level 1 Data Collection and Analysis – Routine Monitoring | | | |
|---|---|---|---|
| **Topic** | **Questions** | **Indicators** | **Assessment *Approach*<br>Data Sources** |
| ***Outputs, Engagement, Short term Outcomes, Influences for Activity Area (Impact Pathway) 1*** | | | |
| **Outputs** | | | |
| **Engagement** | | | |
| **Short –term Outcomes** | | | |
| **External Influences** | | | |
| ***Outputs, Engagement, Short term Outcomes, Influences for Activity Area (Impact Pathway) 2*** | | | |
| **Outputs** | | | |
| **Engagement** | | | |
| **Short –term Outcomes** | | | |
| **External Influences** | | | |

| Level 2 Data Collection and Analysis – Periodic Assessment of Outcomes | | | |
|---|---|---|---|
| **Topic** | **Questions** | **Indicators** | **Assessment *Approach*<br>Data Sources** |
| ***Impact Pathway Area 1*** | | | |
| **Relevant Monitoring Data** | | | |
| **Short –term Outcomes** | | | |
| **Intermediate-term Outcomes** | | | |
| ***Impact Pathway Area 2*** | | | |
| **Relevant Monitoring Data** | | | |
| **Short –term Outcomes** | | | |
| **Intermediate-term Outcomes** | | | |

| Level 3 Data Collection and Analysis – Periodic In Depth Study of Impacts | | | |
|---|---|---|---|
| **Topic** | **Questions** | **Indicators** | **Assessment Approach<br>Data Sources** |
| **Contribution to - *For each impact pathway that applies using data from Levels 1 and 2*** | | | |
| **S&T Leadership and National Goals** | | | |
| **Research Capacity (Knowledge, tools, people)** | | | |
| **Socio-economic impacts through Industry** | | | |
| **Socio-economic impacts through Policy, Government** | | | |
| **Impacts through Outreach to Students and Public** | | | |
| **Estimated Direct and/or Indirect Benefits (Facility Expenditures, upgrades; Take up by Industry, Government)** | | | |

# Examples of Differences in LSRI Impact Pathways

| Facility | Contextual Dimensions (Selected) |
|---|---|
| Canadian Light Source | Support **fundamental science in multiple fields** including applied (health, environmental materials). **Industry** is fee for service, has own advisory group. Do **innovations in detector technology**. Have application to **policy**, such as measurement standards for mine tailings. Active education program. |
| TRIUMF | **Fundamental science, multiple discipline**; Beam line also used by **industry**. Do technical **consulting** services. **Produce medical isotopes** for treatment of cancer. Plan to combine research and development of new isotopes. Major engagement with **public and students.** Look for patents and companies spun off. |
| SNOLab | Located in an **active mine**. Lab is at a unique depth. **Host multi-disciplinary experiments**, providing all necessary conditions and services for users. Global competition for available space. Seen as **innovator in business model** for Centers of Excellence. |
| CFHT | **Fundamental science**; Careful validation of quality of data recorded. **Users access archived data**. Multi-country collaboration; Small global astronomy community. Last UV panoramic imaging in northern hemisphere. No interaction with industry except for **involvement of key industry suppliers on proposed new telescope.** |
| Oceans Network | **Pioneering, community-based research using their labs**. Working on **public policy** with Transport Canada, providing data products, e.g., sea state index, with long term continuous data. Work related to international trade agreements, defense, indigenous populations. |
| Compute Canada | A set of data centers, **meeting increasing use of big data analysis and simulation in research**. Do centralized software development. Achieve **economies of scale and scope**, saving the country money. Do lots of community consultation. Doing process innovation. |
| CCGS Amundson | Provide scientific equipment for experiments in Arctic with **1-1 staff to user ratio** to trouble shoot. **Multi-disciplinary and trans-sectoral research**. Users change, e.g. oil industry was active but no longer. Data will be used by **industry**, e.g., seismic surveys, fish protocol. Political experts view related to **territorial disputes**. |