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**GENOMICS RESEARCH
AND
DEVELOPMENT INITIATIVE (GRDI)
Horizontal Evaluation**

Final Report

Approved by

Executive Committee

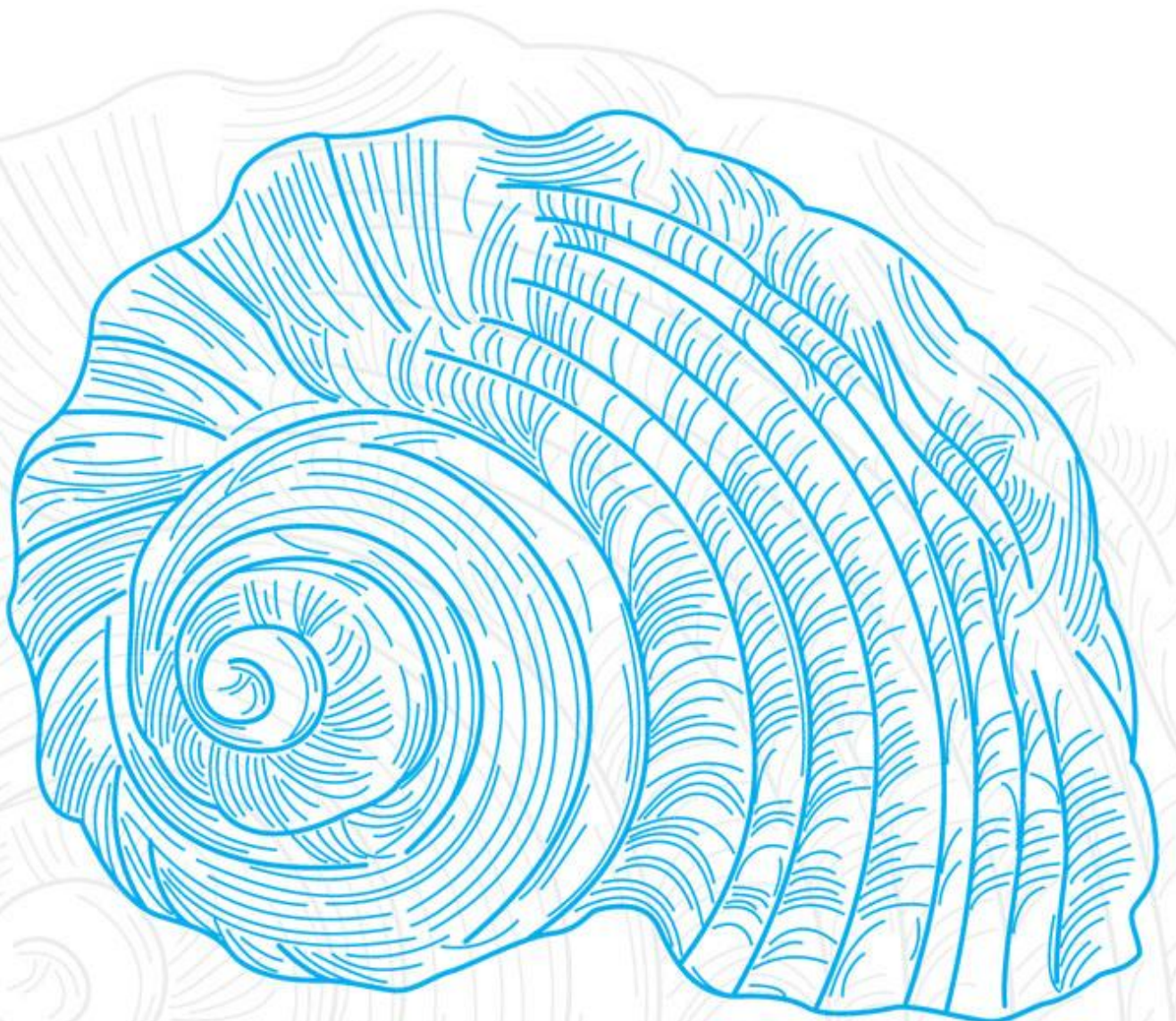
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Science-Metrix

**Evaluation of the Genomics
R&D Initiative (GRDI)
Final Evaluation Report**



Evaluation of the Genomics R&D Initiative (GRDI) Final Evaluation Report

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Executive Summary

Purpose

This document presents the key findings of the horizontal evaluation of the Genomics Research and Development Initiative (GRDI). Conclusions and recommendations stem from these key findings, which are based on the integrated analysis of multiple lines of evidence. In 2010, the GRDI Assistant Deputy Minister (ADM) Coordinating Committee mandated the Planning and Performance Management Directorate of the National Research Council Canada (NRC)'s Strategy and Development Branch to lead an evaluation of the GRDI. An Interdepartmental Evaluation Working Group (IEWG) was established, to support the evaluation process. An independent firm, Science-Metrix, was contracted to design and implement this evaluation and a mixed-team approach was used to conduct the fieldwork (evaluators from both Science-Metrix and NRC-SDB-PPM).

Evaluation Objective and Approach

The main objective of the present evaluation is to assess the performance and relevance of the GRDI with regard to its targeted outcomes. Five core issues related to performance and relevance are assessed in accordance with the Treasury Board Policy on Evaluation. A horizontal evaluation was performed in 2006 and addressed program design and delivery issues by examining the first two phases of the Initiative (1999-2005). The present evaluation focuses on the achievement of outcomes (impacts) of research and development (R&D) supported during Phase III of GRDI (2005-2008).

Although it draws on data collected from individual departments/agencies, the evaluation examines the Initiative as a whole, rather than the performance of each individually. The evaluation approach was comprised of the following three methods:

1. **A management, delivery and output review**, consisting of a review of program documents and external literature, and interviews with stakeholders, both internal and external to participating departments/agencies.
2. **An impact assessment through 15 project reviews**, including review of project documentation and interviews with federal project leaders, collaborators and users of R&D results.
3. **An impact web survey** of project collaborators and users of R&D results.

In total, 158 distinct individuals were consulted through this evaluation (44% were external to participating departments/agencies).

Profile of the GRDI

- **Objective:** The GRDI objectives focus on building and maintaining genomics human resource and infrastructure R&D capacity in Canadian federal science-based departments/agencies and developing comprehensive networks of research collaboration in the field.
- **Multidepartmental profile:** The GRDI is a multidepartmental funding initiative. Currently, the following seven departments and agencies participate: Agriculture and Agri-food Canada; Environment Canada; Fisheries and Oceans Canada; Health Canada; Public Health Agency of Canada; NRC; and Natural Resources Canada.
- **Funding phases:** Launched in 1999, the GRDI has undergone four phases of funding and activities, each of which has been allocated in three-year blocks. While Phase I (1999–2002) focused on capacity building and Phases II and III (2002–2008) on the development and application of genomics research testing procedures and tools, the current Phase IV (2008-2011) aims to sustain and expand the genomics activities undertaken in the first three phases.

- **Funding profile:** Since its inception, the Initiative has been supported with approximately \$19.9 million in annual federal funding, for an average of \$60 million per 3-year phase and a total of \$234 million over the 12-year period. Funding allocations vary between the seven participating departments and agencies and have remained unchanged since the inception of the Initiative in 1999. The GRDI funding allocations are expected to be supplemented with resources from both internal and external sources.
- **Management and governance:** Each department and agency is also responsible for identifying targeted strategic R&D areas and establishing a competitive peer-review process for project selection and funding, as well as managing and reporting on progress and performance. Initiative-wide governance is provided by the ADM Coordinating Committee, which oversees collective management and the Interdepartmental Working Group (WG), which supports the work of the Committee. The GRDI does not have a formal secretariat; however, NRC facilitates the governance and management structure of the Initiative.

Key Findings – Performance: Achievement of Expected Outcomes

- **The GRDI has enabled federal researchers to participate in and contribute to genomics research in a way that has kept pace with developments in the field, with the level of impact expected to increase in coming years.** Investments in capacity building made during the first two phases have positioned researchers to now begin applying resources to the development and application of new or improved methods, products, processes or technologies in projects that are more translational and commercially oriented.
- **GRDI-funded researchers have made significant contributions to the development and advancement of fundamental genomics research.** These advances have led to new and improved applications of this research towards more translational and commercially-oriented projects. Initial impacts are beginning to be seen on the regulatory and policy side, but remain fairly limited.
- **There have been a few instances of longer term impacts as a result of GRDI-supported research, although in many cases direct application of GRDI research results is limited by the lengthy timelines required for implementation and uptake.** This includes developments in science-based regulations, policies and decision making, as well as impacts in the strategic outcome areas of improved health care, reduced environmental impacts and improved competitiveness of Canadian companies.
- **The GRDI has successfully addressed and satisfied stakeholder needs, despite the fact that most users of the R&D were not systematically identified or integrated into the research process.** Where they occurred, close working relationships and effective communication between scientists, their departments, collaborators and users of R&D results were essential in designing mandate-driven, application-oriented research built on common objectives.
- **Collaborators and users of R&D results were satisfied with the manner and extent to which research results were transferred to interested parties.** The most common means for transferring GRDI-related scientific knowledge and technologies were conventional research dissemination mechanisms. R&D results with potential for subsequent commercial applications were generally transferred through patent applications and material transfer agreements.
- **The Initiative has allowed participating federal departments/agencies and Canada as a whole to establish and consolidate their position as credible contributors to genomics research and applications at the national and international level.** However, the profile and visibility of the Initiative itself and funded researchers could be further enhanced within Canada.

Key Findings – Performance: Demonstration of Efficiency and Economy

- **GRDI-funded departments and agencies have implemented specific processes aimed at maximizing efficiency, increasing transparency and reducing the redundancy of R&D project delivery and management processes.** These processes have included priority setting, the selection of projects to align with these priorities and increased coordination activities between departments. Further opportunities for continued improvement in these areas are being considered and included in plans for future GRDI horizontal management activities.
- **Internal and external stakeholders ranked most management practices tied to the GRDI highly and believe that efforts to increase program efficiency have been successful.** Some issues were raised at the departmental level, such as the inability to use GRDI funds for salary support, a lack of communication between GRDI management and departmental staff, and long-term planning challenges due to uncertainty surrounding project funding and program continuity.
- **According to Annual Performance Reports, GRDI investments have been complemented with additional resources from departments or other sources at a ratio of 1.5 times the GRDI investments.** The financial review of Phase III projects revealed that a significant proportion of the leveraged funds came from the internal (A-base) funds of the respective departments/agencies and only a small proportion was leveraged from external sources. However, multiple lines of evidence cast doubts on the validity of data collected on leveraging and further efforts would be required to conclude on this issue.
- **The cost-effectiveness of R&D projects is perceived to be high by a large proportion of collaborators and users of R&D results involved in Phase III projects.** However, cost data were not readily available across all departments for the evaluation; therefore, it was not possible to perform a cost-effectiveness analysis of GRDI funding overall.
- **The allocation of funding to support multiple departmental mandates constitutes the main added value of the horizontal nature of the Initiative.** It enabled the federal government to establish genomics R&D capacity and to demonstrate its potential to address issues in several niche areas.
- **Preliminary evidence suggests that the fixed departmental funding distribution established at the inception of the Initiative impedes the overall cost-effectiveness of the Initiative.** One of the most valuable features of the overall Initiative lies in the application of funding in support of multiple departmental mandates. However, these departmental funding allocations have remained unchanged since 1999, and preliminary evidence indicates that this fixed distribution may not represent the scientific advances in genomics and the current capacity of mandate-driven research within participating departments/agencies. Individually, Phase III projects are seen as being highly cost-effective and their ultimate merit and value in relation to the GRDI investment are seen to have been significant.
- **Given the fairly low level of multi- or inter-departmental collaboration in projects supported by the GRDI, perceptions of the cost-effectiveness and utility of the horizontal nature of the Initiative were mixed.** Although some expressed concerns that this low level of collaboration may have diminished resource use efficiency and research returns, others believed that the interdepartmental delivery of projects is not necessarily appropriate for all types of research investigations and that moving towards a more horizontal delivery approach will further limit the GRDI resources available for some departments.
- **Evidence suggests that there are opportunities to further support specific inter-departmental genomics R&D projects in high profile priority areas where existing R&D capacity and progress of individual departments/agencies are complementary.** Such

integration would maximize both the efficiency and cost-effectiveness of targeted R&D projects by leveraging the existing research capacity, shared priorities and advancement of applications.

- **Overall, little duplication or overlap appears to exist between GRDI-funded research and other genomics research in Canada.** Duplication of effort was largely avoided through the competitive processes used to select GRDI-funded R&D projects, which feature a combination of senior management decisions and peer-review of projects. Efforts are being made to increase collaboration between the GRDI and Genome Canada, but the current funding eligibility criteria preclude the formation of a more formal partnership.

Key Findings – Relevance: Alignment with Government Priorities

- **GRDI-supported R&D is directly aligned with government S&T priorities and the mandates and strategic objectives of the individual departments.** A defining characteristic of the Initiative is its strong alignment between the objectives and results of GRDI research with government priorities and individual departmental mandates. GRDI-funded projects must demonstrate a clear correlation between project goals and these broader objectives in order to be recommended and approved, both by peers and senior management. The GRDI's governing bodies work to ensure that this high degree of alignment is reached.

Key Findings – Relevance: Alignment with Federal Roles and Responsibilities

- **The role played by the federal government in this area is appropriate and necessary and the Initiative has supported mandate-driven genomics R&D that generated results that have not been achieved elsewhere.** Research funded by the GRDI has answered to a specific need that is not being fulfilled by the other genomics R&D being conducted in Canada—it represents the single most important mechanism in Canada through which mandate-driven R&D results in genomics can be generated. The Initiative's strategic alignment with federal government and departmental objectives and priorities is well suited to research that is exploratory, conducted in support of regulation or addresses specific issues of importance to Canada.

Key Findings – Relevance: Continued Need for Program

- **There is a continued need for an initiative that supports genomics R&D within select federal departments/agencies, as well as a need for the Initiative to be managed horizontally.** Although the last decade has seen many significant changes to the context in which the GRDI operates, none have diminished the relevance of the Initiative or its value to Canadians. The existing horizontal structure is credited with facilitating interdepartmental collaborations and the integrated sharing of resources, which have helped to build a core capacity in many areas of applied genomics. However, more effective mechanisms for communication between GRDI senior management and program-level staff are needed to support interdepartmental coordination and program transparency.

Conclusion and Recommendations

The evaluation found that the GRDI as a whole is relevant and effective. To support ongoing program improvement, the evaluation process has identified design and delivery considerations to heighten the program's likelihood of success. Recommendations are presented below.

Recommendation 1: Develop opportunities to support specifically interdepartmental genomics R&D projects with shared resources in high profile priority areas. Given the economic context and fixed resources available for research at this time, the support of such integrated projects should be small in scale in order to minimize the reduction of funds for ongoing departmental mandate-driven genomics R&D and to leverage the existing research programs and capacity and advancements of applications. In addition, the selection of high-profile areas of priority for Canada should build on existing complementary strengths, shared departmental priorities and strategic outcomes, and progress made by departments.

Recommendation 2: Should the Initiative be renewed, a significant proportion of the funding to individual departments should continue in order to build on the research capacity and expertise generated in their respective niche areas. This continued support will allow the federal government to take full advantage of the demonstrated potential of genomics R&D in supporting departmental mandates and strategic objectives. Research funded through the GRDI is now well positioned to produce more operational impacts as it moves from the proof-of-principle stage into one more translationally oriented.

Recommendation 3: Should the Initiative be renewed, review the distribution of funding among participating departments/agencies. According to results-based management principles, allocations should consider the current and potential level of activity, capacity and performance of mandate-driven genomics R&D conducted in participating departments (including the scientific excellence, progress and potential impact within their respective areas). This will support strategic results-based management and accountability as well as transparency in the allocation of funds.

Recommendation 4: Develop and implement a communication strategy to increase the visibility and profile of the Initiative (including the profile of funded genomics R&D, departmental capacity, progress and performance reporting/evaluations), both within and outside of federal departments/agencies. This will increase awareness and facilitate opportunities for collaboration among stakeholders and other genomics initiatives at the federal, national and international levels. Importantly, this strategy should include specific means to increase levels of communication and exchange between GRDI stakeholders in participating departments (including current and potential GRDI-funded researchers, collaborators and users of R&D results).

Recommendation 5: Develop mechanisms that further integrate users of R&D results in all stages of genomics R&D projects' life cycles in order to ensure proper alignment of scientific progress with targeted potential uses and expected impacts (as outlined in the Logic Model). Efforts should specifically be made to ensure effective interactions at the transfer and adoption phases in order to obtain feedback for continuous improvement and future development. The Initiative should consider the integration of dissemination and transfer plans in project proposals that identify the nature of user(s) involvement and expectations, as well as a knowledge transfer/translation strategy. This will allow the Initiative to increase its focus on the ultimate translation of R&D results.

Recommendation 6: Continue to improve the tracking and reporting of performance, specifically to ensure that reliable information on total departmental investments and expenditures related to GRDI is available and understood. This would include data for all types of contributions that complement GRDI funding, which are collected and made available for ongoing performance management, reporting and evaluation processes. Participating departments/agencies should put in place processes to collect detailed financial profiles of GRDI-supported project/activities, including expenditures. In addition, the GRDI WG should work with participating departments/agencies to conduct a scan of the funding landscape for overall departmental/agency genomics R&D activities in order to determine the materiality of the GRDI and the relative importance of genomics in departmental R&D activities. This will inform the review of the distribution of funding among participating departments/agencies (Recommendation 3) and could be done prior to each renewal of the Initiative.

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1.0 Introduction

This report presents the key findings of the evaluation of the Genomics Research and Development Initiative (GRDI). The evaluation is based on the integrated analysis of multiple lines of evidence and includes conclusions and recommendations that stem from the key findings. Given the horizontal nature of the Initiative, this evaluation focused primarily on the Initiative as a whole, yet drew on information collected from individual departments/agencies.¹

The report's introductory section presents: an overview of the GRDI (Section 1.1), including its design and delivery, governance, key beneficiaries and the GRDI outputs and expected outcomes according to its logic model; the context, objectives and scope of the evaluation (Section 1.2); and the evaluation issues and questions (Section 1.3). The evaluation approach and methods are summarized in Section 1.4 (a more detailed description of the methods is presented in Appendix C), whereas limitations of the evaluation methods are discussed in Section 1.5.

The findings of the study are presented by evaluation question in Sections 2.0 to 6.0. A summary of key findings is presented for each question, followed by detailed findings established from multiple lines of evidence. Key findings are numbered and cross-referenced in the report to support evaluation findings in different sections, as necessary. Section 7.0 concludes the report with discussions on the findings and on their implications for the design and delivery of the Initiative. Recommendations are presented and discussed in the last section, along with other suggestions for the inter-departmental evaluation working group (IEWG) members' consideration. The Management Response Action Plan is also included in this section.

1.1 GRDI Program Profile

1.1.1 Program Context and Rationale

Launched in 1999, the GRDI is a multidepartmental funding initiative that was established to build and maintain genomics research capacity in government departments. As an enabling technology, genomics provides tools and information to support operational mandates upon which policy and regulatory decisions can be based. The GRDI is one of a number of federal mechanisms that demonstrate the Government of Canada's commitment to genomics research. Under the GRDI, federal science-based departments interact with partners, stakeholders and clients and link these enabling tools and technologies with value-added applications in order to assist Canada in responding to national priorities, delivering on government mandates and supporting the development of wealth for Canadians.² More specifically, the multidepartment Initiative seeks to build the human resource and infrastructure capacity of federal government laboratories and develop comprehensive networks of research collaboration in the field. Key results are related to four important program areas: management, capacity-building, research and development (R&D) and outreach.³

The economic, scientific and policy contexts in which the GRDI operates are changing. For example, in only the last several years, rapid technological advances in the field have presented fresh economic opportunities and new health and environmental threats have emerged that require novel solutions. Additionally, a federal Science & Technology (S&T) Strategy has been issued that seeks to position

¹ Throughout the evaluation report, the term departments will be used to refer to the federal departments and agencies participating in the GRDI.

² Working Group for the Genomics R&D Initiative. (2008). *Genomics R&D Initiative Annual Performance Report 2007-08*.

³ Performance Management Network Inc. (2007, January). *Horizontal Results-based Management and Accountability Framework (RMAF) for the Genomics R&D Initiative: Final draft*.

Canada at the leading edge of global science research.^{4,5} However, the Initiative itself has *not* changed significantly, but rather continues to work within the original framework established in 1999 and with a similar budget. The departments involved in the Initiative have proposed to renew the GRDI with the goal of realigning the Initiative to better address the evolving face of genomics research and build on past investments.

This realignment process is now underway. Following a series of interdepartmental workshops, a Draft Policy Framework was put forward in 2009-2010 and the preparation of material to support the renewal process is set for 2010-2011. Taken together, these efforts aim to bring the Initiative to a new level that will ensure that the greatest value is wrought from the GRDI. More specifically, the new iteration of the GRDI will seek to strengthen delivery mechanisms around broad government priorities that cross departmental mandates and improve inter-departmental integration to best fulfill the role of federal government research towards national objectives.⁶ Before the next steps can be taken, however, the findings and recommendations from an updated evaluation of the GRDI must be considered.

1.1.2 Program Delivery

The strategic focus of GRDI research is the contribution of solutions to issues of key importance to Canadians: protecting and improving human health (including the development of new treatments for chronic and infectious diseases), protecting the environment and managing agricultural and natural resources in a sustainable manner.⁷ Focusing on the specific role of federal government research, the program is intended to support evidence-based decision making, policy development and the formulation of standards and regulations, as well as facilitate the development of Canadian commercial enterprises.

At this time, the Initiative has undergone four phases of funding and activities, each of which has been allocated in three-year blocks. The level of maturity of projects funded under GRDI has evolved over the four phases, from Phase I, which centred on the building of research capacity (people and equipment) within federal departments in the area of genomics research, to Phase IV, which is expected to lead to the use of research results for the achievement of outlined objectives. The GRDI is a multidepartmental initiative currently involving the following seven departments and agencies:

- Agriculture and Agri-food Canada (AAFC);
- Environment Canada (EC);
- Fisheries and Oceans Canada (DFO);
- Health Canada (HC);
- Public Health Agency of Canada (PHAC);
- National Research Council Canada (NRC); and
- Natural Resources Canada (NRCan).

Throughout the report, the term departments is used to refer to all seven of these federal departments and agencies.

⁴ Organisation for Economic Co-operation and Development (OECD). (2009). *The Bioeconomy to 2030: Designing a Policy Agenda*.

⁵ Burrill & Company. (2010). *Biotech 2010 Life Sciences: Adapting for Success (24th Annual Report on the Industry)*.

⁶ GRDI ADM Coordinating Committee. (2009, December). *Proposal for an integrative approach to address Canada's biological challenges in food, environment, energy and health: Strategic leadership through collaboration: Draft report*.

⁷ Working Group for the Genomics R&D Initiative. (2009). *Genomics R&D Initiative Annual Performance Report 2008-09*.

Departments are expected to dedicate intramural resources to internal genomics R&D programs and projects and to seek, as much as possible, external resources. GRDI funding allocations have supplemented the intramural resources dedicated to genomics.

Overview of the GRDI phases

- **Phase I (1999–2000 to 2001–02):** The purpose of Phase I was to build capacity (people and equipment) within federal laboratories in the areas of genomics research.
- **Phase II (2002–03 to 2004–05):** This phase, built on the previous phase, focused on the development and application of testing procedures and tools needed for genomics research.
- **Phase III (2005–06 to 2007–08):** This phase aimed to apply the tools developed in Phase II, leading to new discoveries.
- **Phase IV (2008–09 to 2010–11):** The purpose of this phase is to sustain and expand the genomics activities undertaken in the first three phases.

Select federal departments participating in the GRDI were eligible to apply to Genome Canada for funding during phases I and II. Federal funding regulations have since changed and now no longer allow federal scientists to apply. Genome Canada is a not-for-profit organization that was established in April 2000 to develop and implement a national strategy for supporting large-scale genomics and proteomics research projects. It is also the largest source of genomics research funding in Canada—since its inception, the federal government has allocated a total of \$915 million to the organization.^{8,9} Collaboration with academic researchers funded through Genome Canada can provide GRDI participants with a significant leveraging opportunity. In addition, GRDI scientists can be directly supported by co-funding leveraged through provincial genomics agencies (e.g. Genome Alberta).

1.1.3 Program Governance and Structure

The GRDI's governance framework consists of an interdepartmental Genomics R&D Assistant Deputy Minister (ADM) Coordinating Committee, established at the end of Phase II, which oversees the collective management and coordination of the Initiative. The Committee was convened to ensure that effective priority-setting mechanisms are established within departments and that investments are focused and strategic. It also ensures that common management principles are implemented and horizontal collaborations between organizations are pursued wherever relevant and possible. The Committee includes members from each of the organizations receiving funding, a representative from the Canadian Food Inspection Agency (CFIA) (as an observer) and a representative from Industry Canada.¹⁰

An Interdepartmental Working Group (WG) supports the work of the Committee. The mandate of the WG is to provide recommendations and advice to the ADM Coordinating Committee regarding strategic priority setting and overall management of the Genomics R&D Initiative. The WG also supports evaluation and reporting requirements related to the Initiative.

More recently, an Interdepartmental Evaluation Working Group (IEWG) was created.¹¹ This Group acts as the main decision-making body on issues related to the evaluation of the GRDI on behalf of the participating departments. The IEWG is composed of two representatives from each of the seven participating departments (AAFC, DFO, EC, HC, NRC, NRCan and PHAC), one from each of the relevant program areas and the departmental evaluation unit.

⁸ KPMG LLG. (2009, May). *Evaluation of Genome Canada—Final Report*.

⁹ Genome Canada. (2010). *About Genome Canada* [web page]. Retrieved from <http://www.genomecanada.ca/en/about/>

¹⁰ Performance Management Network Inc. (2007, January). *Horizontal Results-based Management and Accountability Framework (RMAF) for the Genomics R&D Initiative: Final draft*.

¹¹ Interdepartmental Evaluation Working Group. (nd). *Evaluation of the Genomics R&D Initiative Interdepartmental Evaluation Working Group Terms of Reference*.

The GRDI does not have a formal secretariat. However, NRC facilitates the governance and management structure of the Initiative. NRC, as the lead organization for the GRDI, chairs the ADM Coordinating Committee and coordinates both Working Groups. NRC also manages interactions with the Treasury Board of Canada Secretariat (TBS) on behalf of participating departments for the renewal processes every three years.¹² However, the GRDI funds flow directly to the departments, which are responsible for the allocation of funds to genomics R&D projects and activities.

The identification and selection of the targeted strategic R&D areas is the responsibility of each participating department. Since the end of Phase II, participating departments have been required to establish a competitive peer-review process for the selection and attribution of funding to R&D projects. Considered in the selection process are factors such as the level of alignment with departmental Program Activity Architectures (PAAs), scientific excellence, contribution of projects to expected outcomes and potential impacts and partnerships (or the potential for leveraging). Departments are also responsible for the management of genomics R&D projects and for the reporting of progress and performance.

In terms of performance reporting, since 2006-07, the progress, outputs and achievements of genomics R&D projects within individual participating departments have been integrated into GRDI Annual Performance Reports.¹³

1.1.4 Funding Allocations

Since it was established in 1999, the GRDI has put forward approximately \$19.9 million per year, for an average of \$60 million per 3-year phase and a grand total of \$234 million over the 12-year period (Table 1). The funding allocations vary between the seven participating departments.¹⁴ The allocation formula was established at the beginning of the Initiative in 1999 and has remained consistent throughout all four phases. AAFC and NRC received the highest proportions of the funding (30% each), corresponding to approximately \$18 million per phase.

Table 1 GRDI funding allocations (\$'000) by phase, 1999-2002 to 2008-2011

Department/Agency	Phase I	Phase II	Phase III	Phase IV	Total	
	1999-2002	2002-2005	2005-2008	2008-2011	(\$'000)	(%)
Agriculture and Agri-food Canada	17,000	18,000	18,000	18,000	71,000	30.3%
Environment Canada	3,000	3,000	3,000	3,000	12,000	5.1%
Fisheries and Oceans Canada	2,500	2,700	2,700	2,700	10,600	4.5%
Health Canada Public Health Agency of Canada	10,000	12,000	12,000	12,000	46,000	19.6%
National Research Council Canada	17,000	18,000	18,000	18,000	71,000	30.3%
Natural Resources Canada	5,000	6,000	6,000	6,000	23,000	9.8%
Medical Research Council ¹	500	-	-	-	500	0.2%
Total	55,000	59,700	59,700	59,700	234,100	100%

¹ As the precursor to the Canadian Institutes of Health Research (CIHR), the Medical Research Council received a one-time allocation in 1999-2000 to assist in the establishment and support of a Genome Canada Secretariat.

Source: Compiled by Science-Metrix from the GRDI Annual Performance Report (2008-2009)

¹² GHI Coordination Office (2006). *NRC Genomics and Health Initiative Integrated Performance Report, 2006-2007*.

¹³ Working Group for the Genomics R&D Initiative. (2006-07—2008-09). *Genomics R&D Initiative Annual Performance Reports*.

¹⁴ PHAC was established in September 2004 and was confirmed as a legal entity in December 2006 by the Public Health Agency of Canada Act. Researchers at Health Canada were reallocated between HC and PHAC. During Phase IV, PHAC joined the Initiative as a legal entity.

1.1.5 Program Beneficiaries and Stakeholders

Canadian federal departments and federal scientists are the direct beneficiaries of the GRDI. Collaborators and users of R&D results comprise the second main stakeholder group through their collaboration and various levels of involvement in the R&D projects supported by the Initiative. This group includes organizations from the public and private sectors, including Canadian and international universities and research organizations, governments, non-profit organizations and industries. The third group of stakeholders includes organizations that are not project collaborators or direct users of R&D results but are organizations that benefit (or would benefit) indirectly from research funded by the GRDI. Ultimately, all Canadian citizens are expected to benefit from the research results; new or improved methods, products, processes or technologies; and improved science-based regulations and policies that improve their quality of life.

1.1.6 Program Logic Model

The logic model of the GRDI was created in 2006-07 for the development of the GRDI RMAF (Figure 5, Appendix B). The logic model uses a top-down diagrammatic structure to represent the program's composition and process flow. The organizational processes of the GRDI—management, capacity-building, R&D and outreach—are presented in the logic model according to three main categories: activities, outputs and targeted outcomes.

1.2 Objectives and Scope of the Evaluation

1.2.1 Background and Objectives of the Evaluation

The main objective of this evaluation is to assess the performance and relevance of the Initiative according to the Treasury Board Policy on Evaluation with regard to the Initiative's targeted outcomes. Originally planned for 2011-12, the evaluation process has been accelerated to 2010-11 to make evaluation results available prior to the proposed renewal of the Initiative by March 2011.

The evaluation process was led by the Planning and Performance Management (PPM) Directorate within NRC's Strategy and Development Branch (SDB) in consultation with the IEWG, which acted as the evaluation steering committee and provided feedback during the planning and implementation phases of the evaluation project.

Science-Metrix has been mandated by NRC-SDB-PPM to perform this evaluation. Between February and March 2010, Science-Metrix participated in the planning and development of the evaluation framework. This framework was developed collaboratively with NRC's evaluation function and in consultation with the members of the IEWG. The evaluation planning is based primarily on views gathered through interviews with members of the IEWG and on the review of available documents and data/information. The planning work also used a pilot risk-based planning approach, developed by NRC, in order to determine the approach and the associated level of effort for the GRDI evaluation.¹⁵ This pilot approach and its effect on the evaluation's scope, approach, questions and methods are presented and discussed in related sections. The risk-based planning tool has also been pilot-tested in the context of other NRC evaluation projects. The pilot approach has also been presented and discussed with the evaluation community for continuous improvement.^{16,17}

¹⁵ National Research Council (2010). *Risk-based approach for determining the evaluation approach and level of effort to be applied to individual evaluations*. Discussion paper.

¹⁶ Amo, C. (2009). *Risk-based approach for determining evaluation approach and level of effort*. Presented at the second meeting of the TBS Low Risk Evaluation Working Group, Ottawa, ON.

¹⁷ Amo, C. (2010). *Evaluation at NRC: Striving for quality*. Presented at the 2010 Annual Meeting of the Canadian Evaluation Society (CES), Victoria, BC.

In July 2010, Science-Metrix was selected through an open competitive process to refine and implement the evaluation framework and to produce this Evaluation Report. A mixed team approach has been used to conduct the evaluation: two evaluation officers from NRC-SDB-PPM were integrated within the Science-Metrix team of evaluators to support the evaluation by facilitating and contributing to the data collection and reporting processes.

1.2.2 Scope of the Evaluation

The evaluation of the GRDI covers the period from fiscal year 2005-2006 to the present and focuses on performance issues by examining the last two phases of the Initiative. The rationale for this scope is based on the following considerations:

- To date, one horizontal evaluation of the GRDI Initiative has been performed (in 2006).¹⁸ The evaluation largely addressed program design and delivery issues by examining the first two phases of the Initiative, which took place between 1999 and 2005.
- Given the scope of the last evaluation and the duration of the funding period (nearly 12 years), the GRDI IEWG and the ADM Coordinating Committee indicated that the present evaluation would need to focus on capturing the Initiative's performance in terms of its immediate and intermediate outcomes (primarily impacts).
- While relevance issues are examined in this evaluation, the results of the risk-based approach used to determine the evaluation approach and stakeholder consultations held during the planning process indicated that this evaluation should place more emphasis on issues pertaining to the GRDI's performance. More specifically, it was suggested that emphasis be placed on the achievements and impacts of research programs and projects supported during Phase III of the GRDI (2005-06 to 2007-08), as it would be premature to concentrate on ongoing activities (Phase IV) and because impacts in the field tend to occur in the long term.
- The evaluation also captured and integrated, when possible, outcomes of the GRDI by including the review of activities that have been built on the research capacity and results generated in Phases I and II.
- Furthermore, activities and outputs based on the full lifespan of the program were considered using available secondary sources of performance data in order to update the findings of the previous evaluation.

1.3 Evaluation Issues and Questions

This evaluation addresses the five "core issues" defined by TBS in the Directive on the Evaluation Function, effective April 2009.¹⁹

- **Performance (effectiveness, efficiency and economy)** of the GRDI's genomics research programs, projects and activities:
 - Achievement of expected outcomes
 - Demonstration of efficiency and economy
- **Relevance** of the GRDI's genomics research programs, projects and activities:
 - Alignment with government priorities
 - Alignment with federal roles and responsibilities
 - Continued need for program

¹⁸ Performance Management Network Inc. (2006, December). *Horizontal Evaluation of the Genomics R&D Initiative: Final Report*.

¹⁹ Treasury Board of Canada. (2009). *Directive on the evaluation function*. Retrieved on October 4, 2010.

Evaluation questions that pertain to these five core evaluation issues were identified and validated during the evaluation planning process through a consultative process with the IEWG members. During these planning consultations, respondents were asked to identify the most important issues for the forthcoming evaluation, as well as prioritize questions that should be addressed.

The risk-based method used to determine the evaluation approach and level of effort revealed that relevance issues were almost equally important to performance issues (i.e., medium-low level of risk). However, this result was heavily influenced by the high rating given to the risk associated with the sustainability of financial resource levels for participating departments.

The 2006 evaluation found that there existed a continued need for federal genomics R&D.²⁰ The views of the internal and external stakeholders that were consulted also support the continued need for the GRDI, and emerging challenges and opportunities have in fact made the GRDI even more relevant over the last five years. Accordingly, the specific questions proposed in the Results-Based Management and Accountability Framework (RMAF)²¹ for the GRDI were adjusted to ensure a focus on performance issues. The GRDI's performance is thus being addressed using 11 specific questions, whereas 4 questions were developed to address the relevance of the GRDI (Table 2).

Table 2 Evaluation questions for the GRDI evaluation by issue

Performance: Achievement of expected outcomes	
1)	To what extent has genomics R&D supported by the Initiative: a) produced applications that generated new or improved methods, products, processes or technologies? b) contributed to the improvement of science-based regulations, policies and/or decision making?
2)	How have the scientific knowledge and technologies resulting from the research been transferred (made accessible) to targeted end-users, partners, collaborators and stakeholders?
3)	What operational changes and benefits that occurred from the adoption and application of genomics R&D have been generated and transferred through the Initiative at the level of: a) Departments and the federal government? b) Organizations outside of the federal government (universities, companies, and others)?
4)	To what extent has the Initiative successfully addressed (and satisfied) the needs of the main stakeholders, including the participating departments, the federal government, and partners and collaborators?
5)	How have the direct outcomes stemming from the Initiative contributed to: a) Improved health care (public health and wellness)? b) Reduced environmental impacts (environmental sustainability)? c) Improved competitiveness of Canadian companies?
6)	To what extent has the Initiative allowed participating federal departments and Canada as a whole to establish and consolidate their position as credible contributors to genomics research and applications at the national and international level?
Performance: Demonstration of efficiency and economy	
7)	Have the recommendations stemming from the evaluation of the GRDI completed in 2006 been implemented, and, if so, to what extent have these had an impact on the delivery and performance of the Initiative?
8)	How was duplication of effort managed (or avoided) in order to ensure effective use of resources within this Initiative and within the Canadian context?
9)	To what extent has the Initiative implemented and managed processes that maximize efficiency, both for the delivery of R&D projects and for management?
10)	To what extent has GRDI investment been complemented with additional resources from within departments or other sources?

²⁰ The level of duplication of the GRDI with other genomics research initiatives was found to be very low by internal and external stakeholders consulted during the planning process and in a study commissioned by Industry Canada (non-public), which also demonstrated the Initiative's relevance within the Canadian and international contexts.

²¹ Performance Management Network Inc. (2007, January). *Horizontal Results-based Management and Accountability Framework (RMAF) for the Genomics R&D Initiative: Final draft*.

11) Overall, how cost-effective is the interdepartmental aspect of this Initiative? How has the federal genomics R&D supported by the Initiative provided value for Canada?
Relevance: Alignment with government priorities
12) Has the R&D supported by the GRDI generated S&T applications that address and contribute to: a) Government science and technology priorities (e.g., federal S&T Strategy)? b) The mandates and strategic objectives of the individual departments?
Relevance: Alignment with federal roles and responsibilities
13) To what extent has the Initiative supported mandate-driven genomics R&D that generated results that have not been achieved elsewhere?
Relevance: Continued need for program
14) Given the changes in the Initiative's context, is there still a need for an initiative that supports genomics R&D within select federal departments?
15) Given the level of coordination, collaboration and integration of GRDI's R&D activities across departments, is there a continued need for this Initiative to be managed horizontally and delivered within select federal departments?

1.4 Evaluation Approach and Methods

1.4.1 Overall Approach

The evaluation process was planned and conducted in four main phases. In the preparatory phase (Evaluation Phase I), NRC and the IEWG collaboratively gathered the information and data needed for the implementation of the evaluation methods designed during the planning phase. The implementation of the evaluation was conducted in three subsequent main phases.

The design phase (Evaluation Phase II) included the refinement of the evaluation workplan and framework, including an articulation of ethical practices, detailed communication and risk management plans, the development of evaluation instruments, the finalization of selection for project reviews and interviewees, and the validation of the list of potential web survey respondents. Based on the use of multiple indicators and lines of evidence to address the evaluation issues and questions, the third phase (Evaluation Phase III) consisted of the implementation of the evaluation methods. Integrated analysis and reporting of evaluation findings constituted the last phase of the study (Evaluation Phase IV).

As previously mentioned, the evaluation framework, the selection of methods and the associated level of effort were determined using a pilot risk-based approach developed by NRC. Overall, the GRDI's average level of risk associated with evaluation issues was characterized as medium-low.²² However, although risks related to relevance issues were considered to be low, the methods and level of effort required were higher for the collection of evidence-based data that help to answer performance-related questions, primarily those related to the achievement of expected outcomes (or impacts, as identified in the GRDI logic model) resulting from Phase III activities. Activities and outputs based on the full lifespan of the program were considered using available secondary sources of performance data. The evaluation approach and level of effort were also balanced to meet the evaluation timeframe and budget requirements.

1.4.2 Methods

Table 3 (page 18) presents an overview of the data collection methods used and the range of stakeholders consulted to inform the evaluation process. The approach used was primarily grouped into three methods: 1) management, delivery and output review, 2) impact assessment using multiple

²² This approach is based on the premise that the level of risk associated with a program/initiative/policy (strategic and operational criteria) can be used to calibrate the approach used in an evaluation and the level of effort applied to the study when a logical link can be drawn between risk criteria and the issues to be addressed in the evaluation.

project reviews, and 3) impact web survey of project collaborators and users of R&D results. The complete approach is presented in the Detailed Approach and Methods section at the end of the report (Appendix C).

The evaluation approach aimed to maximize the consultation of collaborators and users of R&D results who are external to the government. In particular, the web survey was expected to provide a source of external feedback for most genomics R&D projects performed in collaboration with GRDI-supported scientists from each department in order to compensate for the limited external consultation work performed during the 2006 evaluation.

Overall, a total of 158 individuals were consulted during the evaluation process (16 web survey respondents also participated in project-level interviews). When the affiliation of individuals is taken into account, the evaluation methods captured the views of a total of 69 individuals with an affiliation external to the Canadian federal government, which represents 44% of the total number of individuals consulted. In terms of primary data collected by method, 15 stakeholder interviews and 42 project-level interviews were conducted, and 117 project collaborators and users of R&D results completed the web survey questionnaire (a response rate of 42.4%).

For the sake of clarity, throughout the report, the individuals consulted for the evaluation will be referred to using the following terms:

- **Key informants:** This term refers collectively to individuals from all of the following groups consulted for the evaluation.
- **Internal stakeholders:** As noted, this group of interviewees is internal to the GRDI and involved in the management/coordination of GRDI and genomics R&D.
- **External stakeholders:** As noted, this group of interviewees is external to the GRDI but knowledgeable of the genomics R&D in the Canadian/international context and of the genomics R&D in GRDI participating federal departments.
- **Project review interviewees:** This group of interviewees includes *project leaders/principal investigators*, *project collaborators* (or simply *collaborators*), and *users of R&D results*. They are referred to collectively as “project review interviewees” unless greater specificity (a need to identify the individual as a member of a sub-group) is required; in each of these cases, participation in project reviews is clearly noted.
- **Web survey respondents:** This group includes *project collaborators* (or simply *collaborators*), *financial contributors*, and *users of R&D results* of GRDI projects (Phase III). They are referred to collectively as “web survey respondents” unless greater specificity (a need to identify the individual as a member of a sub-group) is required; in each of these cases, participation in the web survey is clearly noted. In particular, three categories were used to distinguish between respondents internal and external to the federal departments:
 - **Group 1.** Internals close to GRDI projects: Project collaborators within the same unit/department/agency, who tend to be co-investigators, closely involved as team members of GRDI projects or federal scientists that benefitted from GRDI funding in the context of other projects.
 - **Group 2.** Internals: Project collaborators and/or users of R&D results within the same federal department/agency or in other federal departments/agencies.
 - **Group 3.** Externals: Collaborators and/or users of R&D results external to the federal departments/agencies.

Table 3 Overview of data collection methods and sources*

Data Collection Method	Details
Management, delivery and output review: To provide evidence of the relevance, efficiency and economy of the GRDI in light of governance and management practices, measured outputs and its strategic orientation.	Document/literature and file/data review: The review of documents, secondary literature, files and data included: <ul style="list-style-type: none"> GRDI administrative documents, files and data including information provided by departments GRDI governance-related documentation, including terms of reference and policy documents GRDI performance data/reports, reviews and past GRDI evaluations, and other documented R&D outputs Departmental performance data and reports, including available case studies Bibliometric assessment of the scientific outputs of federal scientists supported by the GRDI Canadian and international literature on genomics R&D and biotechnology sectors Stakeholder interviews: Total number of interviews (telephone-based) 15 <ul style="list-style-type: none"> Internal GRDI stakeholders (involved in the management/coordination of GRDI and genomics R&D) . 8 External GRDI stakeholders (knowledgeable of the genomics R&D in the Canadian/international context and of the genomics R&D in GRDI participating federal departments) 7
Impact assessment using multiple embedded project reviews: To capture the contributions of intermediate achievements to longer-term outcomes by assessing the impact of selected R&D projects conducted in Phase III of the Initiative. Each project review included the following methods/data sources: <ol style="list-style-type: none"> Interview(s) with project leaders/principal investigators (1-2) Interview(s) with project collaborators and users of R&D results (1-3) Review of project documentation, data and files provided by project leaders. 	Total number of project reviews (telephone-based): 15 Total number of interviews: 42 <ul style="list-style-type: none"> Principal investigators and co-investigators 17 Project collaborators and users of R&D results 25 Distribution of project reviews by main R&D outcome:** <ul style="list-style-type: none"> Improve science-based regulations, policies and/or decision making 6 Application of results to develop innovative solutions 9 Distribution of project reviews by main impact component:** <ul style="list-style-type: none"> Improved public health and wellness 6 Improved environmental sustainability (manage/limit environmental impacts) 6 Improved competitiveness of Canadian companies 3 Distribution of project reviews by leading department/agency: <ul style="list-style-type: none"> Agriculture and Agri-food Canada (AAFC) 3 Environment Canada (EC) 2 Fisheries and Oceans Canada (DFO) 2 Health Canada (HC) 2 Public Health Agency of Canada (PHAC) 1 National Research Council Canada (NRC) 3 Natural Resources Canada (NRCan) 2
Impact web survey of project collaborators and users of R&D results: To provide additional evidence on a wider range of changes and benefits that relate to projects conducted in Phase III of the Initiative and that relate to other expected outcomes of the GRDI.	Number of valid e-mails 278 Survey population: Number of potential (reached) web survey respondents 276 <ul style="list-style-type: none"> Total number of completed responses: 117 Response rate (margin of error): 42.4%† (6.91%†) Number of reminders: 2 Distribution of respondents by type of relationship to GRDI projects (non-exclusive categories): <ul style="list-style-type: none"> Collaborators (in-kind contribution) 74 Financial contributors (cash contribution) 17 Users of R&D results (past, current or potential users/receptors/beneficiaries) 67 Distribution of respondents by sector: <ul style="list-style-type: none"> Canadian federal government 65 (56%) Canadian universities 15 (13%) Canadian governmental organizations (provincial, municipal and others) 6 (5%) Canadian industry/private company 5 (4%) Canadian not-for-profit organization (NGO and research institutes) 4 (3%) International organizations 22 (19%)

Notes: * Detailed descriptions of the methodological approach and distribution/characteristics of consultations are presented at Appendix C. ** Some projects belong to more than one category. This distribution aimed to characterize the main R&D outcome or impact component of projects. † Calculated for a response distribution of 50% (i.e., 50% yes/50% no); 95% confidence level (19 times out of 20).

1.5 Evaluation Challenges and Limitations

Most of the challenges and limitations that arose during the course of this evaluation are those inherent to any evaluation project, such as those associated with the methods used. These challenges and limitations were mitigated to a large extent by experienced evaluators—both at Science-Metrix and NRC—using best practices in evaluation and project management, including the use of multiple lines of evidence to support findings, internal verifications, regular progress reports and revisions to the project planning and schedule (when necessary). It is worth noting that certain limitations associated with the horizontal nature and design of the GRDI and with evaluation methods were beyond the direct control of the evaluation team. These issues, which had a direct impact on the analyses used to inform the findings of this evaluation, are discussed below and, when relevant, in the results sections of this report.

Evaluation planning and implementation timeframe: The short timeline of the evaluation, as well as the time that elapsed between the planning and implementation phases,²³ made the provision, collection and validation of data more challenging. This had an impact on the type and quality of information that was collected and made available to the evaluators.

Most of the information that was identified during the evaluation planning as being fundamental for the design and implementation of selected methods was made available to the evaluation team. NRC worked closely with departmental representatives to collect information on: potential internal and external individuals for the stakeholder consultations; R&D projects supported during Phase III, including project characteristics, financial profiles and potential interviewees (i.e., GRDI team members, collaborators and users of R&D results); and individuals for the impact web survey (contact information was derived from project contacts used for project reviews).

However, because of the evaluation timeframe, as well as the level of effort required to collect project-level information on Phase III projects, similar data for phase IV were not collected, limiting the capacity of this evaluation to provide the current profile of the Initiative and a comparison between phases III and IV. Accordingly, many analyses were based on the detailed data provided on Phase III projects, and the evaluation team was not in a position to contextualize the findings to the current situation of the Initiative (Phase IV). More time would have allowed for a better validation of the data provided, both in terms of quality and comprehensiveness.

Importantly, the financial profile of the Initiative is incomplete, as the evaluation relied primarily on overall funding allocation figures by participating departments. Some departments provided more detailed financial information on expenditures. However, it was not possible to harmonize these data and develop a complete financial profile of the Initiative that informs on the planned and actual expenditures by category of funds and type of expenditures, including operational and infrastructure/equipment costs.

Also, as one of the key objectives of this evaluation was to make the evaluation results available for the renewal process, the timeline of the evaluation was initially short. However, the delivery of the preliminary findings and draft evaluation report has been further accelerated in order to inform the renewal earlier than anticipated in original planning. This situation reduced the evaluators' ability to fully integrate all lines of evidence for the drafting of preliminary findings and recommendations. The timeframe for the finalization of the final draft evaluation report will provide the time needed to complete the analysis as well as to consider feedback from the IEWG. Specific limitations with

²³ The planning phase ended at the end of March, 2010, and the contract was awarded through a competitive process in early July. Accordingly, the data-gathering preparatory phase (Evaluation Phase I) was conducted over a three-month period.

respect to financial data and other data used to implement methods (interviews, project reviews and the web survey) are presented later in this section.

GRDI's renewal and new policy framework: The review of the implementation of the actions outlined in the management response to the 2006 evaluation recommendations was challenging for the evaluation team. This is because most of the action plan is embedded in the new Policy Framework developed for the upcoming renewal process. In fact, interviewees consulted as part of the planning and evaluation process indicated that the 2006 recommendations have been used as guidelines for the GRDI renewal and have so far been implemented in various ways and to varying degrees across departments. Therefore, when possible, this evaluation highlights the progress made in terms of the management response and focuses on how the new policy framework addresses and responds to the 2006 recommendations.

Financial data and cost-effectiveness data: The evaluation would have benefited from the availability of and access to department-level financial data on all genomics projects in order to produce a complete picture of the context in which the GRDI operates and determine the materiality of the Initiative (i.e., the relative importance of the GRDI funds to the total funds allocated to genomics R&D in each participating department). The 2006 evaluation recommended that departments make improved cost information available for this evaluation, which would allow conclusions to be drawn on the GRDI's cost-effectiveness. Departments have made progress in implementing methods for capturing costs. However, cost data were not readily available across all departments for the evaluation; therefore, this question cannot be suitably addressed.

Funds used for the management of the GRDI and other overhead costs: Data on direct or indirect costs for the governance, management and delivery of the Initiative, both by coordinating group and by department, were not readily available across all departments. This has prevented an assessment of the efficiency of the Initiative's current structure and the suggestion of potential alternatives or new approaches for the future of the Initiative.

Leveraging data: The 2006 evaluation recommended that this evaluation address the issue of leveraging in a way that can reliably conclude on the issue, and that departments put in place the required systems to meet the specific evaluation requirements in regards to data on leveraging (now outlined in the RMAF). Specific approaches were developed based on existing systems of individual departments, and progress has been made on capturing data on leveraging as part of the GRDI's annual performance reporting. However, the data on leveraging are reported without specifying the nature and source of the funds leveraged, nor how the data were compiled. In fact, detailed background data on leveraging from the annual report were not made available to the evaluation team by all departments, preventing the evaluation from addressing the leveraging issue comprehensively. For example, no distinction is made between internal funds (A-base) used to match GRDI funds and external funds leveraged, and there is no mention of whether the leveraged resources are in-kind or cash contributions to GRDI projects. As an alternative, this evaluation used detailed financial profiles (non-public information provided by participating departments) of projects funded during Phase III to determine the extent to which the GRDI investment has been complemented with additional resources.

External stakeholders' awareness of the GRDI: Because of the nature and delivery of the Initiative, which supplements internal resources dedicated to genomics R&D, a significant proportion of the external stakeholders, project collaborators and users of R&D results interviewed or surveyed were unaware of the GRDI or were not in a position to provide input on evaluation questions that specifically pertained to its performance and relevance. Instead, these individuals provided input based on their experiences with specific projects and views on the larger genomics research context. Accordingly, views on the Initiative's efficiency and economy, as well as its design and delivery, were

mostly supplied by internal stakeholders. The evaluation succeeded in consulting more external stakeholders than the 2006 evaluation, but the limitation persists²⁴ and may be intrinsic to the nature and design of the Initiative.

Consultation of external stakeholders (through multiple methods): The evaluation approach was designed to maximize the consultation of stakeholders external to the federal government. Methods included the collection of external views on the GRDI and its R&D research portfolio in order to alleviate, as much as possible, the limitations of the 2006 evaluation. A total of 69 individuals with an affiliation external to the Canadian federal government provided their input to the evaluation, representing 44% of the total number of individuals consulted (158 distinct individuals). However, due to the nature of the GRDI's program delivery and its primary beneficiaries, a number of collaborators and users of R&D results are internal to the participating federal departments or are from other federal departments. In fact, a large proportion of project collaborators and users of R&D results who responded to the web survey or were consulted for project reviews are representatives of the same department or are federal government employees (more than 40% [15 out of 26] of project collaborators and users of R&D results who were consulted for the project reviews and 55% of web survey respondents). In addition, 41% of web survey respondents were project collaborators within the same unit/department/agency, who tend to be co-investigators, closely involved as team members of GRDI projects or federal scientists that benefitted from GRDI funding in the context of other R&D projects (Table 4).

Table 4 Characteristics of web survey respondents by type of relationship with GRDI projects and affiliation

Relationship to GRDI projects	Population distribution		Response distribution		
	Population (#)	Distribution (%)	Response (#)	Distribution (%)	Response rate (%)
Group 1. Internals close to GRDI projects: Project collaborators within the same unit/department/agency, who <u>tend</u> to be co-investigators, closely involved as team members of GRDI projects or federal scientists that benefitted from GRDI funding in the context of other projects.	75	27.0%	48	41.0%	64.0%
Group 2. Internals: Project collaborators and/or users of R&D results within the same federal department/agency or in other federal departments.	47	16.9%	17	14.5%	36.2%
Group 3. Externals: Collaborators and/or users of R&D results external to the federal departments.	154	56.1%	52	44.4%	33.8%
Total (N)	276	100%	117	100%	42.4%

Source: Compiled by Science-Metrix from the list of potential web survey respondents (Phase II projects) provided by departments.

Guidelines for the identification of project collaborators and users of R&D results were provided to by the individual departments for the collection of project-level data; however, these may have been unclear and/or misinterpreted. For example, some of the individuals in the lists provided for the project reviews were tagged as collaborators but were in fact members of the project team (Group 1 in table above), and it proved difficult for the evaluation team to make the distinction. To assess potential bias in the web survey, data have been computed according to the characterization outlined in Table 4, and significant differences between these three groups are presented and discussed in the report. The lists, provided by departments, of project collaborators and users of R&D results were highly variable in number and type (e.g., overall there was no correlation between the number of projects funded in a particular department in Phase III and the number of valid emails provided).

²⁴ The same limitation was noted in the 2006 evaluation: "Few people outside the six departments were knowledgeable enough about the initiative to be able to provide informed feedback." Source: Presentation made by NRC on the 2006 evaluation (2010).

There were also significant differences in response rates by department (Table 5). For example, the low level of input from NRC and PHAC, in contrast to the high levels from DFO and HC, compounded this variability. However, overall, the distribution of responses and response rates can be considered very good—survey results provide a valuable source of performance evidence relating to projects conducted in Phase III of the Initiative and to other expected outcomes.

Table 5 Distribution of survey response rates by primary affiliation of Phase III projects

Department/ Agency	Number of projects (Phase III)	Number of valid emails (bounced emails removed)	Number of respondents	Response rate (%)
AAFC	46	84	32	38.1%
DFO	7	34	17	50.0%
EC	20	37	15	40.5%
HC	6	32	18	56.3%
NRC	8	21	4	19.0%
NRCAN	12	61	29	47.5%
PHAC	4	7	2	28.6%
Total	103	276	117	42.4%

Project reviews: Some of the collaborators and users of R&D results associated with particular projects were not aware of the outcomes or benefits stemming from project results either within or outside of their organization. Project review methods included interviews with more than one collaborator or user of R&D results, which helped to alleviate this limitation. Additionally, while the criteria and approach used to select projects for detailed review were approved early in the evaluation process, some departments requested that the first step of the selection process (the exclusion of projects for which GRDI funds cover less than 40% of the total project costs) be changed by lowering the threshold, noting that this would better represent how GRDI funding is distributed and used in these departments. Finally, because of the unavailability of a number of project leaders, projects were substituted. In these cases, the evaluation team resampled projects using a back-up list or the same semi-random procedure that was used for the initial selection, but took into account the distribution of projects from other departments in order to maximize the representativeness of all five selection criteria (i.e., links with previous phases, R&D outcome, impact component and total project value) in the final distribution.

Document and file review: The project-level documents provided by project leaders were highly variable in number, type and quality across the projects reviewed. The project reviews used evidence from interviews to mitigate this limitation. Initiative-level documentation and data internal to participating departments were sometimes absent or inaccessible. Also, the evaluation relied primarily on material provided during the planning phase. This situation was challenging for the evaluation team, especially when it was necessary to confirm internal management practices and processes captured during interviews. Accordingly, it was difficult to provide a precise picture of how each department manages and uses GRDI funds.

Level of engagement: The planning phase indicated that the GRDI is a low priority at the government and department levels, both for programs and in terms of evaluation priorities within departments. This was also reflected in the level of involvement and response of internal stakeholders in project reviews and interviews. Also, the low level of awareness of the GRDI among collaborators and users of R&D results likely diminished the salience of the evaluation process, resulting in a number of refusals to participate or in delays. This impacted the ability of the evaluation team to finalize the data collection phase, and team members were required to continue interviewing and performing the analysis during the reporting phase. The evaluation team used back-up interviewees and projects in order to reach the targeted level of effort for each method.

2.0 Findings – Performance: Achievement of Expected Outcomes

This section and each of the following findings sections present the main results of the evaluation with respect to the GRDI's performance (sections 2.0 and 3.0) and relevance (sections 4.0, 5.0 and 6.0). Sub-sections address specific evaluation questions. For each sub-section and evaluation question, a summary of results is first presented in the box. Numbered key findings follow the discussion of supporting lines of evidence. A consolidated list of the numbered findings is also presented in Appendix D.

2.1 To what extent has genomics R&D supported by the Initiative: a) produced applications that generated new or improved methods, products, processes or technologies? b) contributed to the improvement of science-based regulations, policies and/or decision making?

Summary: To a great extent. Genomics R&D supported by the Initiative has made considerable contributions to the development and application of new research methods, techniques, standard operating protocols and overall approaches. However, new processes or methods, for the most part, tend to represent advancements in the science rather than commercially ready developments or applications. Project collaborators, users of R&D results and internal and external stakeholders agree that GRDI researchers have advanced the applied knowledge and technological capacity in the field and generally feel that these advancements have contributed to the development of new applications. The direct impact of this research in the regulatory or policy realm is less evident. This was primarily attributed to the timelines involved in seeing scientific developments translated into regulatory/policy uptake, although preliminary efforts are underway.

Web survey respondents were first asked to indicate whether the project they were involved in was intended to contribute to one or both of the result categories indicated in the question above (i.e., a and/or b). Those responding affirmatively were then asked the extent to which they felt that these goals had been realized within their projects. On average, about half of the web survey respondents indicated that their project was expected to yield new applications and/or contribute to improving science-based regulations (Table 6).²⁵

Responses were overwhelmingly positive with respect to the achievement of R&D results—web survey respondents were largely of the opinion that the main targeted R&D results of their project had been achieved (61.3% to a great extent, 32.4% to a large extent; n=111).

Similarly, the vast majority of web survey respondents were positive (though to a slightly lesser degree) about the extent to which projects' expected outcomes were achieved (please see Table 7 for details). There were no statistically significant²⁶ differences in the responses provided by the three respondent groups²⁷ with respect to the perceived outcome of the research supported during Phase III of the Initiative.

²⁵ Note that responses to this question were not mutually exclusive; respondents could indicate that their projects contributed to both outcome categories. As such, answers were not summative.

²⁶ The Kruskal-Wallis non-parametric test was used to determine whether the difference between the groups was significant (p-value=0.05). When the test was positive for the three groups, the groups were compared (in groups of two) by using the non-parametric test called Mann-Whitney. As this test was done as a second step, and required three couplings, the test was considered significant for p-value lower than 0.017.

²⁷ Cross analyses of the responses were conducted based on the self-indicated affiliation of the participants. Respondents were grouped as follows: G1 is associated with internal collaborators with high involvement (same address as the PI), G2 is associated with internal collaborators that were less involved in the project (federal department, same or different from the PI, different address) and G3 are external collaborators (academic institutions, industry, other levels of the government, national or international). Statistical tests were conducted to ascertain significant differences in responses between the three groups. Statistical significance tests demonstrate the

It is interesting to note that when web survey respondents were asked about the nature of their research, nearly two-thirds indicated that they were engaged in genomics research at a fundamental level. This confirms that a large part of funded mandate-oriented genomics R&D is at an early developmental or application stage. Furthermore, web survey respondents were nearly unanimous in their agreement that GRDI-supported projects had contributed to outcomes related to increased knowledge and understanding or increased research capacity (Table 6).²⁸ Another noticeable outcome area perceived by web survey respondents was the improvement of their organization's competitiveness and of Canada's competitiveness in genomics R&D (Table 7).

Table 6 Type of engagement of collaborators and users of R&D results in the various stages of GRDI Phase III projects (multiple choices)

Type of engagement	#	%
To produce applications that generate new or improved processes and/or methods	61	52.1%
To produce applications that generate new products and/or new technologies	46	39.3%
To contribute to the improvement of science-based regulations, policies and/or decision-making	59	50.4%
To increase research capacity (development of expertise/highly qualified personnel and of infrastructure)	67	57.3%
Fundamental genomics research	76	65.0%
Other(s)	5	4.3%
Blank/Empty	1	0.9%
Total (N)	117	

Source: Compiled by Science-Metrix from the impact web survey with collaborators and users of R&D results.

Internal and external stakeholders and project review interviewees were not explicitly asked to respond to this question. However, several external stakeholders noted that over the past 10 years, the field of genomics in general has moved from more basic and preliminary science to the development and application of genomic tools and techniques. Many indicated that this progression had been reflected in the GRDI program itself. The researchers were said to have originally focused on building their capacity (both on the knowledge and technological fronts) but that, increasingly, proposals have come forward that use the basic knowledge generated from earlier phases and apply the knowledge to specific problems or interests within their departments. Phase III of the initiative was viewed as a transition point from capacity building into applied research. One key informant referenced the GRDI supported work on personalized medicine as a good example of this. This research was said to have followed a natural progression from general gene expression profiling to subdividing the different types of cancers, identifying punitive targets and moving towards antibody-based treatments and personalized medicine. Another example cited was agricultural projects that examine the development of more environmentally friendly, healthier soybean lines.

It should be noted that many internal stakeholders could not comment on the work taking place outside of the departments with which they were directly involved. Furthermore, external stakeholders interviewed from other genomics funding initiatives (e.g., at the provincial level) were generally unaware of the Initiative and its objectives and outputs.

likelihood that a result is due to chance versus actual differences in the data. Thus, statistical significance tests used in this analysis examine whether or not there is truly a difference between the responses provided by the three participant groups.

²⁸ Specific outcome questions included "Increased research capacity (development of expertise/highly qualified personnel and of infrastructure)", "Contributed to advanced fundamental genomics research", and "Improved Canada's competitiveness in genomics research and applications (R&D)".

In nearly all cases, projects examined for this evaluation were built on efforts that received GRDI funding in previous rounds. Project review interviewees generally echoed the statements made by internal and external stakeholders with regards to the past development and current state of research in genomics. They credited the GRDI with having provided critical support during a time of tremendous progress in this area, without which federal researchers would not have been able to participate in the growth of this field. Many described how their Phase III projects were now more directed, as they applied the knowledge and technology that had been developed in earlier phases to new applications (e.g., development of microarray assays for ascertaining chemical toxicity) or assisting regulations (e.g., informed municipal decision-making relating to the protection of recreational waters).

Table 7 Level of agreement of collaborators and users of R&D results with respect to the level of achievement of projects' expected outcomes (multiple choices)

	Total (N)	Total (n)*	1 - Strongly disagree	2 - Disagree	3 - Neither agree nor disagree	4 - Agree	5 - Strongly agree	Cumulative score (out of 100)**
Produced applications that generated new or improved processes and/or methods	61	57	0%	2%	11%	40%	47%	83
Produced applications that generated new products and/or new technologies	46	43	0%	2%	12%	47%	40%	81
Contributed to the improvement of science-based regulations, policies and/or decision-making	59	56	0%	2%	7%	52%	39%	82
Increased research capacity (development of expertise/highly qualified personnel and of infrastructure)	67	66	0%	0%	0%	26%	74%	94
Contributed to advanced fundamental genomics research	76	74	0%	0%	3%	26%	72%	92
Contributed to the improvement of health care	28	23	0%	0%	26%	43%	30%	76
Contributed to limiting/managing environmental impacts of human activities	83	77	1%	1%	25%	57%	16%	71
Improved the competitiveness of Canadian industry in my sector	45	38	0%	3%	18%	42%	37%	78
Improved the competitiveness of my organization	28	28	0%	0%	7%	18%	75%	92
Improved Canada's competitiveness in genomics research and applications (R&D)	74	71	0%	0%	1%	34%	65%	91

Note: * Total (n) represents the total number of web survey respondents to each question, excluding blank and NA responses. **The cumulative score was calculated according to the averages found based on 5 point rating scales used during the survey. The score would be 100 if all the web survey respondents had indicated 'Strongly agree' and 0 if all the web survey respondents had indicated 'Strongly disagree'. Generally, a score lower than 70 indicates a relatively low positive impact/level of achievement and a score above 90 corresponds with a very positive impact. The entries are therefore weighted percentages where the value of 100 was attributed to 'Strongly agree', 75 for 'Agree', 50 for 'Neither agree nor disagree', 25 for 'Disagree' and 0 for 'Strongly disagree'.

Source: Compiled by Science-Metrix from the impact web survey with collaborators and users of R&D results.

Finding 1 The GRDI has enabled federal researchers to participate in and contribute to genomics research in a way that has kept pace with developments in the field. Earlier investments in infrastructure and capacity building have positioned researchers in Phase III to begin applying these resources to more directed research projects.

Application-oriented impacts: On a basic science level, a great degree of knowledge and technical/human capacity has been generated. However, new processes or methods, for the most part, tend to represent advancements in the science rather than specific commercial developments or applications. Examples of how each of these has contributed to advancing the capacity and contribution of federal researchers in the genomics area include, but are not limited to, the following.

Commercially-oriented knowledge and technology development:

- new technologies (e.g., DNA microarrays) that were previously unavailable to researchers in federal departments;
- improved methods for monitoring human and environmental health factors (e.g., techniques developed for monitoring the effectiveness of vaccines, biomarkers of toxicity, mechanisms of infection);
- increased understanding of ecological processes relevant to commercial purposes and long-term environmental management (e.g., tools to shortcut the selection processes for tree breeding to maximize resistance to fungal disease and selective breeding programs);
- novel ways of evaluating environmental outcomes that are of commercial relevance (e.g., the environmental impact of offshore drilling wastewater disposal);
- identification and sequencing of new genes and genomes that may be important for future commercial applications (e.g., genes involved in protein expression in seeds); and
- established preliminary products that are now being explored collaboratively with private sector investors for future development potential (e.g., antibody-based cancer therapeutics).

Advancement of applied knowledge and of internal capacity:

- contributions to public repositories for genomics information (e.g., GenBank);
- development of standards, protocols, quality control, assurance metrics and best operating practices that have now been implemented in other laboratories;
- development of new experimental tools (e.g., new gene lines or expression vectors) that collaborators or users of R&D results have employed in other projects;
- development of an improved knowledge base that has resulted in unanticipated spin-off applications or projects (e.g., mechanistic information on plant development processes);
- increased understanding of the advantages and limitations of specific genomics approaches as applied to different types of research projects (e.g., development of quantitative proteomics assays).
- development of in-house capacity for screening and assay developments for future projects (e.g., reference collections and libraries of genomic information); and
- training of internal personnel in the tools and techniques involved in conducting/using genomics research.

Key informants emphasized that it is still early to expect true translational impact from the advances listed above. However, while short-term expectations may not align with immediate commercial impact, the long-term prognosis for these projects is extremely positive. The results generated to date represent a substantial move forward and have positioned these projects to begin generating significant returns in the next 5 to 10 years.

Regulations and/or policy-oriented impacts: Most research has been conducted at the discovery and proof-of-concept level. Internal and external stakeholders indicated that it was really too early for the research to have had any ‘official’ regulatory impact. Even in cases in which the technologies have advanced considerably—i.e., to a point where implementation is scientifically viable—there remains the need to build bridges between researchers and potential users of these results. It was stated that, oftentimes, the latter group is uncertain as to how they can effectively and efficiently implement these new approaches or utilize the new data. In the majority of cases, implications in the regulatory or policy realm were cited as having great future potential for impact, but the nature of these processes and the timelines involved in regulatory change are such that outcomes will likely not be seen for a few years.

Despite these limitations to implementation, some preliminary impacts were identified by key informants. These included:

- increased awareness and incorporation of genomics-related topics into strategic direction of some departments (e.g., DFO’s national biotechnology strategy now includes the theme of Biotechnology and Aquatic Ecosystem Integrity and how genomics R&D may factor into it);
- guided OECD discussions on toxicogenomics by the OECD, contributing to U.S. and Canadian research into genomics testing;
- participation in voluntary genomics data submission guidelines for the U.S. Food and Drug Administration (FDA);
- informed municipal decision-making relating to the protection of recreational waters around Hamilton Harbour; and
- delineation of the zones impacted by produced water discharge from offshore drilling, which has been used by the Canada-Newfoundland and Labrador Offshore Petroleum Board to inform guidelines for offshore waste treatment.

Finding 2 GRDI-funded researchers have made significant contributions to the development and advancement of fundamental genomics research. These advances have led to new and improved applications of this research towards more translational and commercially-oriented projects. Initial impacts are beginning to be seen on the regulatory and policy side, but remain fairly limited.

According to Annual Performance Reports, the 2006 evaluation and the proposed Policy Framework, GRDI-supported research has shown success in generating significant advancements in knowledge creation and technical capacity. This has in turn positioned federal genomics researchers to begin contributing more directly to outcomes, such as direct applications or the support of regulatory efforts. The document and file review revealed that research supported by the Initiative is developing diagnostic tools for the detection, surveillance and management of pathogens and generating knowledge in support of policies, standards and regulations related to the introduction and monitoring of new products such as pharmaceuticals, medical devices and food commodities. GRDI research is also contributing to environmental monitoring and remediation, fisheries management and the regulation of food additives and labeling.

Yet, the extent to which applications have been developed is qualified by the need for the Initiative to accommodate the long-term nature of genomics research. The first three-year phase of the program was dedicated to building the genomics R&D capacity needed to undertake basic research, but it was also focused on supporting the mandates of departments. Over the next two phases, this capacity was used for projects of national interest that have gradually revealed applicational potential. The first fruits of this are apparent in Phase III outcomes, and the ongoing Phase IV is focused entirely on producing outcomes that align with the mandates of the federal government and the participating departments.

Finding 3 Direct application of GRDI research results is limited by several factors. First, most applications remain at the proof of concept stage and are only now reaching a point where translational impacts are possible. Second, timelines for implementation (particularly in the regulatory domain) can be very long.

2.2 How have the scientific knowledge and technologies resulting from the research been transferred (made accessible) to targeted end-users, partners, collaborators and stakeholders?

Summary: Mechanisms for transferring research results differ depending on the nature of the project and the department. Overall, the most common means of transfer included: scientific publications, formal and informal meetings, seminars, posters, talks and conference presentations. Transfers resulting in potential for subsequent commercial application generally occurred via agreements, patent applications, and material transfer agreements. Other examples of transfer included the deposit of results/data into public access databases (e.g., Gen Bank) and the informal provision of experimental materials (e.g., expression vectors). Overall, collaborators and users of R&D results were satisfied with the manner and extent to which research results were communicated to interested parties.

Web survey respondents were asked to comment on the extent to which the results of the project had been transferred to their organization. Three-quarters (75%; n=117) of web survey respondents felt that the research results had been partially (29.1%) or fully (46.2%) transferred. Those who provided a reason as to why transfer had not occurred generally stated that the research was still ongoing or that the aim of the research was not the transfer of results. Related topics surrounding the specific applications resulting from transfer, level of satisfaction with the overall collaboration and level of implementation are discussed in other sections of this report. There were no statistically significant differences in the responses provided by the three respondent groups—internal respondents closely involved in GRDI projects (Group 1), collaborators and users of R&D results from other federal departments (Group 2) and collaborators and users of R&D results external to the federal government (Group 3)—with respect to this issue.

Given the nature of the research being conducted and its current stage (see Section 2.1), it is not surprising that mechanisms for the transfer of research centered primarily on traditional, academic and technical modes of communication of results. These included: scientific publications, client reports, formal and informal meetings, seminars, posters, talks and conference presentations. Depending on the nature of the project, in some cases genomics data was made accessible through GenBank; internal databases of genetic sequences that are available to the scientific community were also used. One such database was used to identify the virus affecting the fish population in the Great Lakes in 2005. The deposit of results/data into available repositories was emphasized as an important contribution, as it enabled other researchers (from all sectors and internationally) to follow up and build on these results. Other means of transferring research results included licensing agreements, patent applications, material transfer agreements and the informal provision of experimental materials (e.g., expression vectors). These are discussed in more detail in the next section of the report.

However, transfer and dissemination activities varied between departments. For example, NRC institutes have business development offices that actively seek industrial developers for any genomics discoveries, while such prospecting is done in HC on an ad hoc basis, with the encouragement of senior management. While most collaborators and users of R&D results consulted for the project reviews were satisfied with the way information was communicated, several indicated that their projects would have benefited from a more formal mechanism for reporting to users.

Bibliometric analyses (discussed in further detail in Section 2.6) indicated that GRDI-funded scientists publish in international, peer-reviewed journals and that their work is well cited vis-à-vis other Canadian researchers and within the international arena. This can be considered evidence of their effectiveness at disseminating findings through the technical literature. The 2006 evaluation

highlighted that, as of Phase II, more linkages have been established between GRDI projects and stakeholders, collaborators and targeted users of R&D results.

The GRDI Annual Performance Reports show that transfer efforts continue to be a high priority and have been ongoing throughout Phase III. Information on R&D outputs as presented in these reports is presented in Table 14 (p. 59).

The proposed Policy Framework highlights the fact that these efforts are agency-specific and reflect the different mandates of Initiative participants. NRC, for example, performs research of importance to Canadian industry, and therefore has offices dedicated to finding commercial developers for new discoveries. They also note that in many cases, researchers have developed their own contacts individually. To date, the documentation did not suggest that there is a current plan for one unified, Initiative-level knowledge transfer strategy. The Annual Performance Reports for Phase III also cited licensing agreements, patent applications and material transfer agreements as examples of the ways through which researchers have transferred their results to interested parties.

2.3 What operational changes and benefits that occurred from the adoption and application of genomics R&D have been generated and transferred through the Initiative at the level of: a) Departments and the federal government? b) Organizations outside of the federal government (universities, companies, and others)?

Summary: Operational changes and benefits have been limited due to the relatively low number of translational results that have been produced to date. The principle operational benefits of the GRDI have consisted of knowledge production in a large number of venues. Skilled personnel have been developed, and information has been provided to regulators, manufacturers and other scientists. As applicational research progresses, more tangible operational impacts can be expected.

Web survey respondents indicated the following operational changes or impacts²⁹ in relatively comparable numbers (open-ended question: 12% to 17%; n=90): increases in knowledge, expertise and training; the provision of useful information to policy-makers and regulators; the advancement of value-added technologies, products and processes; and the generation of new research projects. While concrete measurable effects are limited at present, the breadth of these spheres of influence speaks to the expected pervasiveness of genomics technology. Outside of government, GRDI outcomes were credited with stimulating new R&D and partnerships; supporting the development of standards, guidelines and frameworks; and generating publications. These activities share a common foundational or building-block nature and are consistent with the Initiative's original orientation towards mandate-driven basic research.

From the project reviews, specific examples of direct operational impacts of GRDI-funded research on the users of the R&D results are limited. This is due to the fact that, as discussed throughout this section, most projects are still at the discovery stage, and it is too early to effect operational changes within the government, the departments in question or external stakeholder organizations (e.g., universities, industry). The consensus is that there is a considerable time delay between the 'proof of concept' goals of GRDI-funded projects (within the phases so far) and the applied knowledge developments that influence operations.

²⁹ Operational changes can be defined as changes in efficiency or efficacy of an organization resulting from the use of research results generated through sponsored projects.

Finding 4 Based on projects reviewed, GRDI-funded research is too early in its development to have resulted in a large number of operational changes or benefits. However, some examples do exist that demonstrate the progression of GRDI research to the point where it could be translated and applied at the regulatory level.

In a small number of cases, operational changes have been the direct outcome of the research results. One example involves the work being carried out at EC on DNA microarray fingerprinting. Researchers had been involved in parallel microbial source tracking work with the municipalities of Toronto and Hamilton, investigating the source of *E. coli* contamination at their beaches (using techniques other than DNA microarray, which was still viewed as too experimental for the municipalities to fund themselves). The GRDI funding allowed the researchers to apply the DNA microarray technology to the water samples and *E. coli* that had been collected through the beach study. Through a more detailed characterization of *E. coli* using the DNA microarray, the researchers were able to determine not only the proportion of *E. coli* that is carrying antibiotic resistant or pathogenic genes, but also that at many beaches around the Great Lakes, bird feces are a greater source of *E. coli* contamination than sewage. The results of these studies were communicated to the municipalities and conservation authorities that have since implemented measures to address the source of the *E. coli* contamination (e.g., shoreline modification projects and public awareness campaigns aimed at deterring people from feeding geese at the harbour beaches) and successfully reduced the number of beach closures.

Another example involves work being carried out within DFO on the use of metagenomics for monitoring aquatic ecosystem health. In this case, researchers identified the process required to use genomics to delineate the impact area of produced water discharge, the first time this has been done internationally. The findings of the research project were subsequently used to differentiate regions where wastewater may be discharged over the side of the ship as opposed to underground disposal, which is more expensive for industry and has different environmental impacts. The Canada-Newfoundland and Labrador Offshore Petroleum Board has credited this research as having “underpinned some important decisions.”

As discussed in Section 2.1, many project review interviewees highlighted the fact that reducing or cancelling these projects going forward would inevitably result in a significant loss, given that many of the projects are now positioned to begin focusing on translating the knowledge and technological capacity into tangible outcomes and operational changes.

Finding 5 Results from GRDI-funded projects have been disseminated and used by other researchers both within and outside of the federal government in the advancement of their own projects and objectives. Examples of this include protocols, experimental processes/tools and scientific findings.

GRDI research was seen by all key informants as being positioned to begin contributing to major new developments in areas that will be important to Canadians. The ongoing support of genomics research at the federal level has led to indirect operational changes via the production of highly qualified personnel (HQP), who now foster and promote these new technologies and approaches within their respective research divisions. In addition to this, GRDI funding supports the training and development of HQP who go on to other institutions in Canada (universities, companies) and disseminate and apply their knowledge and skills in the development of genomics technologies and products. While not measurable as a direct outcome, key informants felt that it should be recognized that these individuals nonetheless effect operational changes within their parent organizations.

Finding 6 The research funded through GRDI is positioned to begin exhibiting increasingly more operational impacts as it moves from its proof of principle stage into one that is more translationally oriented.

2.4 To what extent has the Initiative successfully addressed (and satisfied) the needs of the main stakeholders, including the participating departments, the federal government, and partners and collaborators?

Summary: To a great extent. The GRDI has been very successful in addressing and meeting the needs of its main stakeholders, both internal and external to participating departments, which is consistent with the orientation of the program. This is primarily due to the objectives and design of the program, as researchers are expected to work very closely with their departments and collaborators in designing mandate-driven, useful and application-oriented proposals. Effective communication between researchers and other involved parties was identified as a key component to ensuring a productive alignment of scientific and organizational aims.

As indicated in Section 2.1, the overwhelming majority (93.7% to either a great or large extent; n=111) of collaborators and users of R&D results who responded to the web survey indicated that the stated objectives of the research project had been accomplished. Similarly, web survey respondents felt that the project with which they were involved addressed and satisfied their needs as stakeholders to a good or great extent, and considered the collaboration to have been a successful endeavour (80.9%; n=115). Those surveyed decidedly agreed that the outcomes had been useful to their organization and responded that the results had either been partially or fully implemented within their organization (Table 8).

Table 8 Perception of GRDI project collaborators and users of R&D results on the extent to which the projects addressed and satisfied the needs of their organization (Phase III projects)

	Total (N)	Total (n)	1 - Not at all	2	3 – Some-what	4	5 - To a great extent	Cumulative score (out of 100)
Addressed the needs?	116	108	-	-	7.8%	24.1%	61.2%	89
Satisfied the needs?	116	104	-	-	9.5%	33.6%	46.6%	85

Source: Compiled by Science-Metrix from impact web survey with collaborators and users of R&D results

When compared against the web survey respondents' replies regarding specific outcomes from implementation (i.e., health, environmental or competitiveness), it is clear that the results were considered to have had less impact with regards to generating applications than to advancing scientific knowledge and technological capacity (see Table 7). There were no statistically significant differences in the responses provided by the three respondent groups with respect to the extent to which research outcomes satisfied and addressed the needs of relevant parties.

Finding 7 Collaborators and users of the R&D results generated from GRDI funded projects are very satisfied with how the projects have addressed and satisfied their needs. The overall structure and objectives of the program were credited with fostering a strong alignment between the scientific and organizational needs of the two groups.

Web survey respondents were also provided with the opportunity to identify how their needs might have been better addressed and satisfied. Nearly one-quarter of web survey respondents declared that more R&D was needed to fully realize the potential of the project (open-ended question: 23%; n=87). Other methods for improving these aspects were the provision of more funds, increased interaction between group members and collaborators and longer project times (i.e., phases should last more than three years).

All internal stakeholders interviewed agreed that the orientation and implementation of the Initiative is such that there is a deliberate effort to address the priorities and sub-priorities highlighted in the federal strategy and the mandates of the departments (this is discussed in further detail in Section 5.0). However, at the satisfaction level, the responses were more varied. Many projects were viewed as having pushed the scientific and technological development and built up a capacity in genomics R&D that will now position them to meet the needs of stakeholders, although they have not yet been met.

Here again, internal and external stakeholders and project review interviewees were in general agreement that where collaborators and users of R&D results are involved, needs are considered and addressed in the development and ongoing efforts within the projects. As most collaborators and users of R&D results became involved knowing the stage at which projects were at that time, it is generally believed that needs were met. Also, in some cases, users of R&D results contributed financial/in-kind support or licensed technologies that resulted from the research (as discussed in sections 2.1 & 2.2). In those cases, this was presented as evidence that needs were being met.

Many external stakeholders indicated that, given the level or nature of their involvement with the Initiative, they were not in a position to comment on the needs of stakeholders or how they have been met. Those who did feel comfortable commenting on this issue provided general examples of how the Initiative has met the needs of its main stakeholders, such as partners in industry and academia, whose objectives as users of R&D results may naturally align with those of collaborative projects and who may benefit from the funding of smaller, more directed and 'niche' research.

Project review interviewees generally reported a high level of satisfaction with Initiative-supported research outcomes, acknowledging that such discovery-level work is only the first stage in a lengthy process of developing commercial or regulatory applications.

Another barrier to meeting satisfaction was highlighted in one project review—collaborators felt that there had not been sufficient consultation with the users of the research during the project planning stage. As a result, the project was not designed to address stakeholders' needs in the best way. Conversely, effective communication resulting in an increased satisfaction level was illustrated in two projects, in which those involved experienced continuous communication and engagement throughout the project's lifespan. The result in this case has been the development of an ongoing inter-divisional working group for both the scientists and the regulators.³⁰ The need for effective communication was mentioned as a requirement for the successful planning, execution and transfer of the research results that originate from a given project. While this is true for any research initiative with an end goal of translation, it is particularly true in the area of genomics, which requires not only dissemination but 'interpretation' between the highly technical area of molecular biology and the policy or private-sector decision-makers. Follow-up and/or continuous interaction following the project is needed to maximize the transfer and uptake of the applied knowledge produced.

Finding 8 Effective communication between current and potential collaborators, users of the R&D results and the scientists involved in the project was identified as a key factor in ensuring that the needs and expectations of all parties are met.

Finally, according to web-survey respondents who identified themselves as users of R&D projects funded in Phase III, users were not systematically consulted or integrated into the various stages of the research process. Importantly, 42% (n=67) were not engaged in the dissemination/transfer of R&D results stage, 23% were engaged in the project only after its completion and less than half (i.e.,

³⁰ Survey responses indicated that only half of the users of R&D results were involved in the original design phase of the research project.

37%) were engaged throughout all stages of the R&D projects (from the proposal stage to the application of results stage).

Finding 9 Users of R&D were not systematically identified or integrated into the research process. A large portion of collaborators and users of R&D results consulted were engaged in the project only after its completion or were not engaged in the dissemination and transfer of R&D results stage of phase III projects.

2.5 How have the direct outcomes stemming from the Initiative contributed to: a) Improved health care (public health and wellness)? b) Reduced environmental impacts (environmental sustainability)? c) Improved competitiveness of Canadian companies?

Summary: GRDI projects have involved largely basic and proof-of-concept research, a necessary foundation for the vast benefits that genomics research are predicted to yield. Limited, measurable impacts in the areas of Canadian health care, environmental sustainability and competitiveness have already been realized, although these represent a small fraction of what is expected to come in the years ahead. Key development sectors include pharmaceuticals and disease control, agriculture, fisheries and wildlife management.

The majority of web survey respondents selected 'Agree or 'Strongly Agree' when asked whether their GRDI projects contributed to improved health care (74%; n=23), to limiting or managing the environmental impacts of human activities (73%; n=77) or to the competitiveness of Canadian companies in their sector (79%; n=38) (Table 7, page 25). There were no statistically significant differences in the responses provided by the three respondent groups with respect to the contribution of Phase III projects to the three core long-term expected outcomes.

Overall, web survey respondents felt more positively about the contribution of the GRDI projects to R&D-related outcomes than about long-term expected outcomes (health, environment and industry competitiveness). This evidence confirms the level of maturity or advancement of applications and knowledge mobilization, which would require further R&D efforts. Again, web survey respondents most strongly agreed with the statement that the GRDI contributed to the competitiveness of their organization (cumulative score of 92) and Canada's competitiveness in the field (cumulative score of 91).

External stakeholders agreed on the fundamental importance of genomics research and innovation to all three impact areas, though most were unable to identify specific outcomes that have already been realized and applied outside of the scientific realm. However, they did indicate that numerous applications already exist in the commercial realm—particularly in the area of health—as a result of advances in the fields of genomics.³¹ Given the state of the science and the focus/objectives of the Initiative, external and internal stakeholders felt that it would likely only be a matter of a few years before the significant contributions of GRDI-funded research begin to emerge in all three areas. One key informant highlighted two examples of projects that are likely to have generated Canadian genomics breakthroughs that will lead to improved health care: the personalized medicine project and the Brassica seed development project. Another pointed out that many GRDI projects have the potential to produce outcomes in multiple areas. For example, some AAFC studies—which involved looking at soybean allergens—have a direct health impact but can also lead to improved crop quality, reduced environmental impacts, and the production of more competitive products.

With respect to the projects reviewed, as discussed in Section 2.1, outcomes to date have centered more on the advancement of scientific knowledge and technical capacity, meaning that most of the

³¹ This statement is a general overview statement on the state of affairs and not a reflection of the contribution GRDI may have made to these advancements.

impacts are still to come. Some developmental efforts already underway show considerable promise in the three areas listed above. In the health domain, researchers are poised to develop benefits from potential cancer therapeutics, vaccines and improvements to nutritional products.

On the environmental front, examples of projects where impacts have already been observed include:

- The DNA microarray fingerprinting project: This research led to the discovery that the municipalities should consider bird control efforts to reduce *E. coli* levels at beaches, as opposed to costly upgrades to their sewage treatment plants. This has resulted in fewer beach closures around Hamilton Harbour.
- Research on the identification of processes required to use genomics to delineate the impact area of produced water discharge: The developed approach enabled characterization of the effects of the disposal of produced waste water from offshore drilling. As a result, practices have now been put in place by industry to minimize the environmental impacts of the disposal. This has advantages from the environmental perspective, as well as for the competitiveness of the Canadian petroleum industry.

Project review interviewees indicated that Canadian businesses also stand to gain a competitive edge from GRDI-funded projects through projects examining increased crop efficiency, standardized and improved product reporting requirements, streamlined and more effective pharmaceutical lead identification processes and improved forestry management capacity.

Finding 10 Based on projects reviewed, limited examples exist to date of how GRDI-funded research has had direct impacts in one or more of the three strategic areas (health, environment and competitiveness). However, the research is well aligned and positioned to impact these areas in the future. All project review interviewees are unanimous in their belief that such impacts lie not too far ahead for many projects.

The application of basic genomics research requires very long timeframes, and the full extent of the GRDI's contribution cannot be measured at present. However, as noted in the Annual Performance Reports for the Initiative, positive indications of early impacts are already evident in all three key areas. In health care, the development of new treatments (cancer), vaccines (influenza, HIV), drugs, nutraceuticals and pathogen detection techniques (*Salmonella*, *E. coli* and hospital-acquired infections) is underway, and researchers better understand how to limit the spread of diseases. Environmental contributions include the development of more productive and resistant crops, plant and animal pest and disease control, wildlife management and conservation and the detection of microorganisms in soil and water. The genetic characterization of fish species has enabled the successful prosecution of poachers. Canadian competitiveness has benefitted from discoveries that can be developed into innovative products and services in several diverse areas, including forestry (sawfly control), biotechnology (cluster-specific antibodies for cancer treatment), agriculture (high-yield canola) and fisheries (increased efficiency within quota limits).

Finding 11 GRDI-funded research has targeted areas identified as being strategic for Canada and, as such, has positioned genomics researchers to make contributions in these areas in the upcoming years.

2.6 To what extent has the Initiative allowed participating federal departments and Canada as a whole to establish and consolidate their position as credible contributors to genomics research and applications at the national and international level?

Summary: To a great extent. All lines of evidence provide unequivocal support that the Initiative has positioned Canada, and GRDI researchers in particular, as important contributors to genomics research at the national and international levels. Traditional bibliometric indicators show that GRDI-supported research is high in impact and represents a significant portion of Canadian research in this area. Researchers have been invited to serve in a variety

of capacities, both nationally and internationally, as a result of their recognized expertise in the field. Finally, collaborators and users of R&D results testified to the quality of the results produced from the projects in which they were involved. It was noted, however, that the visibility of the Initiative and its scientists could be enhanced within the Canadian landscape.

Web survey results suggested that the Initiative has allowed participants to contribute meaningfully to genomics research and applications: almost all web survey respondents claimed that their project achieved its main R&D objectives (94%; n=111), and when asked to evaluate the usefulness of their outcomes, the vast majority (92%; n=109) chose 'above average' or 'excellent' (there were no 'below average' responses). Questions pertaining to organizational collaborations with GRDI projects generated equally positive responses. Most indicated that the collaboration was a success (81%; n=115), that research outcomes addressed (85%; n=115) and satisfied (80%; n=115) organizational needs, and that the implementation or use of R&D results improved the competitiveness (79%; n=38) of Canadian industry in their respective sector. The juxtaposition of these indicators of internal and external satisfaction demonstrates that GRDI projects are generally successfully executed and of value to stakeholders. There were no statistically significant differences in the responses provided by the three respondent groups with respect to this issue.

Project review interviewees were not specifically asked to comment on this question. However, it is worth mentioning that researchers interviewed in relation to a particular project often referenced the positions they have held, or currently hold, that serve as good indicators of the overall quality and reputation of GRDI-funded scientists. Examples include editors of international journals, conference organizers (national and international), members of scientific advisory boards for genomics-related initiatives, chairs of OECD working groups for genomics-related policy review programmes and consultants to private sector companies.

Internal stakeholders concurred that the GRDI has been successful in meeting its original goal of building capacity in an emerging area of great strategic importance. Funded projects have made contributions to international genomics scholarship, established valuable infrastructure (in some cases, technology and platforms that are unique in Canada) and built expertise.

Finding 12 All lines of evidence show that GRDI-funded researchers are recognized as leaders in their field and important contributors to the national and international knowledge base. Researchers are regular participants in national and international conferences, serve on advisory committees, sit as invited members on international regulatory boards/committees and are routinely invited to present the results of their findings to other organizations.

In general, external stakeholders believe that Canada has some of the top genomics scientists in the world and is a strong environment for conducting genomics research, and that GRDI projects have boosted Canada's reputation and competitiveness. Some stated that while the level of overall Canadian investment in genomics R&D is comparable to other industrialized countries, the field is expected to become increasingly competitive over time.

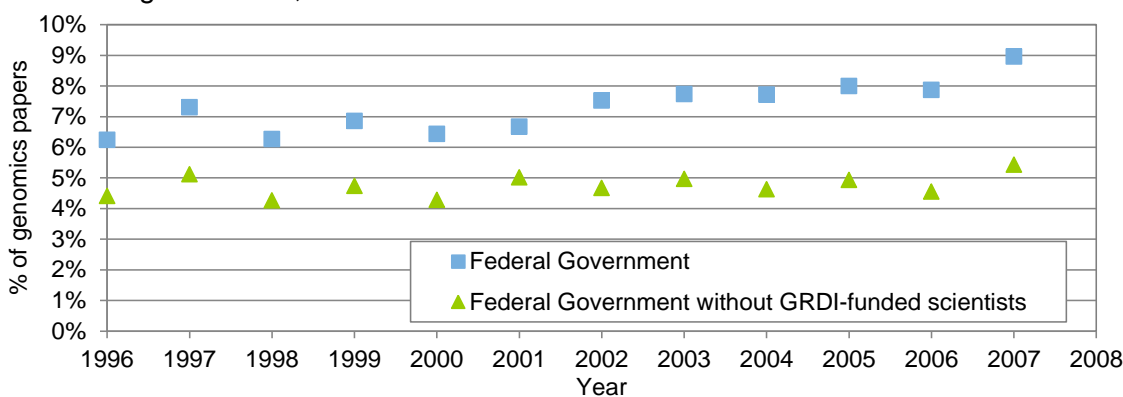
The sense of confidence regarding Canada's international reputation in genomics is supported by bibliometric findings which indicate that GRDI scientists produce, on average, research with more impact than their Canadian academic counterparts (see below).

Finding 13 Responses from some external interviews suggest that the profile and visibility of the program could be enhanced within the Canadian landscape, particularly with regards to other genomics funding initiatives at the provincial level.

Two bibliometric analyses of the scientific output and impact of GRDI-supported federal scientists were conducted in a study authored by Science-Metrix in 2009.^{32,33} The study examined, benchmarked and characterized GRDI-funded research from an internal, national and international perspective. The findings of this study provide a reliable source of quantitative and comparative evidence that helped to determine the extent to which the Initiative allowed participating federal departments and Canada as a whole to establish and consolidate their position as credible contributors to genomics research at the national and international level.

Overall, the findings showed that GRDI-funded scientists accounted for 42% of the federal government's scientific production in genomics. Figure 1 provides a graphical representation of the contribution made by GRDI-funded scientists vis-à-vis federal genomics researchers as a whole. For the period examined, 35% of genomics papers by GRDI-funded scientists were authored with at least one foreign partner, suggesting a strong international reputation among their peers.

Figure 1 Trend in the share of international genomics research within the federal government, 1996–2007



Source: Calculated by Science-Metrix using the Web of Science (WoS)

In terms of scientific impact factor (a proxy of scientific excellence) GRDI-funded researchers stand out from other genomics researchers within the federal government (Table 9).³⁴ While Canadian researchers rate higher than the world average in genomics research, GRDI-sponsored scientists exhibit the highest impact factor of all four groups.

In fact, GRDI-funded scientists have higher scientific impact than their national and international peers, publishing papers that are more cited than the Canadian and world averages (excluding GRDI-funded scientists) in genomics.

Finding 14 Bibliometric analyses show that GRDI-funded researchers outperform their Canadian counterparts in terms of scientific impact, both within and outside of the federal sector.

It is worth noting; however, that the impact factors of these scientists before and after receiving GRDI funding remain relatively unchanged. Thus, while the GRDI may not be fully responsible for this high-impact research (due to collaborators/co-authorship), the findings suggest that the GRDI supports high quality researchers.

³² Science-Metrix. (2009). *Bibliometric analysis of the Canadian federal government Genomics R&D Initiative (GRDI)*.

³³ Ibid.

³⁴ The average of relative citations (ARC) is an indicator of the observed scientific impact that the papers produced by a given entity (e.g., a province, an institution) have on the scientific community. In general, papers reach their citation peak (the year in which they have received the most citations) two to three years after publication.

Table 9 Comparison of the scientific impact of genomics papers produced by GRDI-funded researchers* with those of other genomics papers from the federal government, Canada and the world, 1996–2005

Group	Average Relative Citation (ARC)
GRDI scientists	1.40
Federal government genomics researchers (without GRDI scientists)	1.05
Canadian genomics researchers (without GRDI scientists)	1.28
World genomics researchers (without GRDI scientists)	1.15

Note:* Including papers authored while receiving and not receiving funds from the GRDI. Relative citation counts are unreliable at this analytical level for the most recent years (2006 and 2007); therefore, papers published in those years were not included in computation of the ARC indicator.

With respect to the effect of the GRDI on capacity building, the bibliometric analysis suggests that the funding provided through the GRDI seems to have had a positive effect on the intramural research capacity of the federal government in genomics, which is the core objective of the GRDI. In fact, the bibliometric analysis revealed that the federal government has aligned its research intensity in genomics research with those of Canada and the world since the creation of the GRDI in 1999.

Finding 15 According to recent bibliometric analyses, the funding provided through the GRDI had a positive effect on the intramural research capacity of the federal government in genomics, which is the core objective of the GRDI.

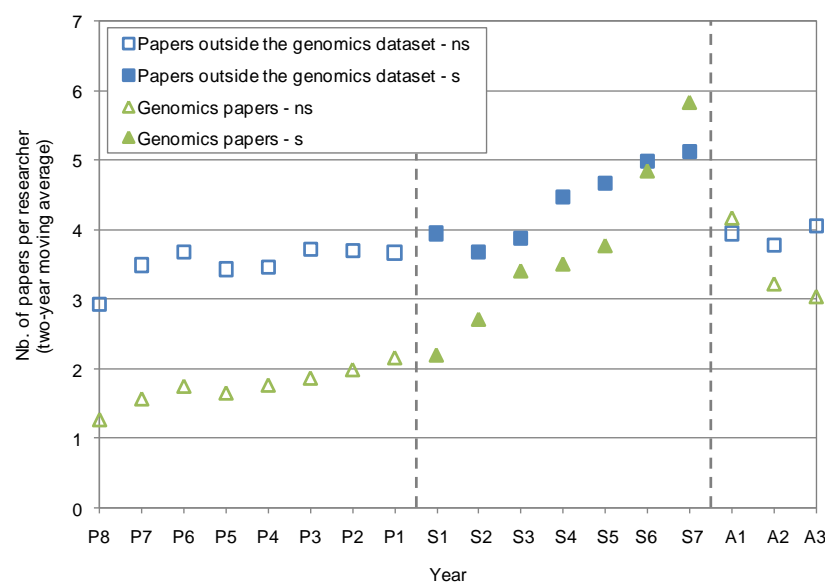
Figure 2 shows that the average number of genomics papers produced per GRDI-funded researcher increased at a greater pace during the period of support, compared to the preceding period. The production of genomics papers increased for nearly 66% of the researchers with GRDI-support, accompanied by a specialization of papers in genomics. Their production is statistically different³⁵ when they were receiving financial support from the Initiative compared to when they were not funded.

Web survey respondents were asked to rate the importance of the GRDI in establishing and consolidating the role of participating federal departments as credible contributors to genomics R&D, nationally and internationally, and Canada's position as a major player in genomics research at the international level. The cumulative score of responses was highly positive for the three groups of respondents (internals close to the GRDI project, internals and externals) (Table 10). However, a significant statistical difference³⁶ was found between the responses provided by the external group (Group 3) and those of the two internal groups (Group 1 and 2): the level of importance of the GRDI to Canada's position as a major player in genomics was rated lower by external web survey respondents. Also, a large proportion of external respondents was not in a position to provide a rating on this question (19% to 30%, or 10 to 16 individuals, selected the category 'Don't know/Not applicable').

Figure 2 Trends in the number of published papers per GRDI-funded scientist, up to 8 years prior to receiving support, up to 7 years with support and up to 3 years after support, 1996–2007

³⁵ Mann-Whitney non-parametric tests were used because data on scientific production and scientific impact are not normally distributed; non-parametric tests were used and the difference was considered to be significant for p-value lower than 0.05.

³⁶ The Kruskal-Wallis non-parametric test was used to determine if the difference between the groups were significant (p-value=0.05). When the test was positive for the three groups, the groups were compared two by two using the Mann-Whitney non-parametric test. As this test was done second, and required three couplings, the test was considered significant for p-values lower than 0.017 (0.05/3).



Note: Letters on the x-axis refer to one of three periods (P = prior to receiving support, S = with support, A = after support). In the legend, ns = papers authored while not receiving support from the GRDI and s = papers authored while receiving support from the GRDI (these papers might include papers authored with other sources of financing).

Source: Calculated by Science-Metrix using the Web of Science (WoS)

Table 10 Perception of GRDI projects' collaborators and users of R&D results on the importance of the GRDI in establishing and consolidating the role of participating federal departments and Canada as credible contributors to genomics R&D

The importance of the role played by the GRDI in establishing and consolidating:	Total (N)	Total (n)	1 - Not important	2- Of little importance	3 - Moderately important	4 - Important	5 - Very important	Cumulative score (out of 100)
The role of participating federal departments as credible contributors to genomics R&D in Canada	116	98	-	-	4.1%	27.6%	68.4%	91
The role of participating federal departments as credible contributors to genomics R&D at the international level	116	95	-	1.1%	5.3%	27.4%	66.3%	90
Canada's position as a major player in genomics research at the international level	116	99	-	2.0%	9.1%	20.2%	68.7%	89

Source: Compiled by Science-Metrix from impact web survey with collaborators and users of R&D results

Finding 16 Both quantitative and qualitative data show that the funding provided by the Initiative is responsible for the positioning of federal genomics researchers as credible contributors to the field at the national and international levels.

Finally, web survey respondents rated the originality/innovativeness, quality and usefulness of S&T knowledge produced and disseminated from GRDI Phase III projects fairly highly (above average) (Table 11). This additional evidence indicates that the Initiative contributed to the positioning of federal government as a credible contributor to genomics R&D.

Table 11 Perception of GRDI projects' collaborators and users of R&D results on S&T knowledge produced and disseminated as a result of Phase III projects: 2005-08

	Total (N)	Total (n)	1 - Extremely poor	2 - Below average	3 - Average	4 - Above average	5 - Excellent	Cumulative score (out of 100)
Originality / innovativeness	117	110	-	-	9.1%	42.7%	48.2%	85
Quality	117	110	-	-	4.5%	36.4%	59.1%	89
Usefulness	117	109	-	-	8.3%	45.9%	45.9%	84

Note: No statistically significant differences can be seen in the responses provided by the three respondent groups (internals close to GRDI projects, internals and externals to the federal government). See Table 5 for details on the characteristics and distribution of the three groups.

Source: Compiled by Science-Metrix from impact web survey with collaborators and users of R&D results

3.0 Findings – Performance: Demonstration of Efficiency and Economy

3.1 Have the recommendations stemming from the evaluation of the GRDI completed in 2006 been implemented, and, if so, to what extent have these had an impact on the delivery and performance of the Initiative?

Summary: Partially. Most of the action plan outlined in the management response to the recommendations has been integrated into a strategic planning process for the development of a new Policy Framework, which will be proposed for the renewal of the Initiative. This Policy Framework will potentially have an impact on the delivery of the Initiative if approved and implemented in the next phase of the Initiative. The recommended actions that were most successfully addressed pertained to the development and implementation of formal and integrated annual performance reporting at the Initiative-level. However, neither the 2006 evaluation nor the updated management response/action plan has been widely disseminated to stakeholders in participating departments.

The 2006 evaluation of the GRDI presented 14 recommendations, each of which was addressed in a subsequent management response. The response also included a proposed action plan in association with these recommendations. Two updates on the progress of implementation of the action plan were made available to the evaluation team: one for the 2007-08 period and one that was compiled in January 2010.

The implementation of most of the proposed action plan was delayed because of a management decision to address recommendations during the development of a new Policy Framework that would be proposed for the renewal of the Initiative at the end of Phase IV (in 2010-11). Nine of the fourteen recommendations were addressed via the development of this Policy Framework. Specific issues included new funding/resource allocation models and levels, encouragement of projects to address government-wide genomics R&D priorities and specific budgets for interdepartmental projects, investigation of opportunities for federal scientists to participate more significantly in Genome Canada projects, better horizontal integration with other biotechnology programs and clarification of the rules on how the funds are used with respect to program management and other overheads. This decision to delay most of the action plan's implementation had a largely positive impact on the strategic planning and surrounding consultation processes performed between 2007 and the present, and it could potentially have an impact on the delivery and performance of the Initiative after the renewal.

Finding 17 The majority of the recommendations from the 2006 evaluation of the GRDI have been considered through the development of a new Policy Framework to be proposed for the next renewal of the GRDI and therefore have not impacted the delivery and performance of the Initiative to date.

This section presents evidence of the impact of the response on the delivery of the Initiative, based on the updates to the action plan and interviews conducted with internal and external stakeholders. Specifically, it examines the progress made since the last evaluation to address specific recommendations, and it reports on the level of awareness of departmental management and research stakeholders with respect to the past evaluation process. The extent to which the proposed new Policy Framework addresses the 2006 recommendations and the implication of the findings of this evaluation are discussed in Section 3.1.

Since 2006-07, the Initiative has reported the progress made regarding the implementation of the five following recommended actions:

- The development and implementation of departmental systems that ensure that costs of the Initiative are captured in way to allow reliable conclusions to be drawn on the cost-effectiveness of the Initiative (Recommendation 6).

- The establishment of formal Terms of References (TOR) for the Genomics R&D Working group (Recommendation 10).
- Ensuring that transparency and accountability continue to be key elements in program proposal and approval processes, that lessons learned are integrated into strategic planning activities and annual planning exercises by the participating departments, and that formal and integrated performance reporting is implemented (Recommendation 12).
- The development and implementation of systems that capture leveraging evaluation requirements identified in the RMAF (Recommendation 13).
- The development and implementation of a common performance measurement approach based on the revised RMAF using appropriate tools to collect analyze and report performance information without imposing undue burden or cost requirements on the departments (Recommendation 14).

Out of all of the recommendations for which progress was reported, lines of evidence collected during this evaluation indicated that the greatest achievements were the successful implementation of a common performance measurement approach and integrated performance reporting (Recommendation 12 and Recommendation 14). The initiative also integrated lessons learned into strategic planning activities and annual planning exercises of the GRDI working groups composed of members from the participating departments. Also, internal stakeholders noted that transparency and accountability continue to be key elements in program proposal and approval process.

Finding 18 Of all of the recommendations from the 2006 evaluation of the GRDI to have since been addressed, the most significant achievement has been the development and implementation of a formal, common performance measurement approach and integrated annual performance reporting.

The GRDI Annual Performance Reports, produced since 2006-07, are the primary source of performance information on the Initiative and are highly regarded by consulted internal and external stakeholders. Over the years, the reporting of the performance of individual departments has gradually moved to a more integrated reporting process, carried out in accordance with the Initiative's strategic outcome areas. The reports' contents detail the progress of GRDI-funded research and are a rich source of R&D output data and outcomes of funded projects. In terms of data collection guidelines, new integrated performance reporting guidelines were developed by the GRDI WG (in consultation with the ADM Committee) to support the collection of performance data in participating departments.

Progress was also made with respect to leveraging measures (Recommendation 13). In fact, as discussed in Section 3.4, leveraging data are included in the Annual Performance Reports, but the data collection processes would benefit from further improvement to achieve more reliable performance management and reporting—especially as difficulties were encountered during the process of carrying out this evaluation when examining leveraging related questions. With respect to the capture of Initiative-related costs (Recommendation 6), this evaluation relied mainly on funding figures, as costing data were not readily available, preventing conclusions from being drawn on the cost-effectiveness of the Initiative.

The Initiative integrated lessons learned into the strategic planning activities and annual planning exercises of the GRDI working groups, which are composed of members of participating departments. Also, transparency and accountability continue to be key elements in program proposal and approval processes, according to internal stakeholders. Common Management Principles were

also developed by the WG³⁷ in consultation with the ADM Coordinating Committee to assist funding decisions and strategic planning activities in an attempt to increase collaboration between departments. However, these principles were not formally finalized and distributed to the departments, as they are currently being considered in the new Policy Framework. Finally, formal TOR for the GRDI WG and ADM Coordinating Committee were developed and disseminated,³⁸ in response to Recommendation 10.

Reach of the 2006 evaluation and performance reporting: While all internal stakeholders were aware of the previous 2006 evaluation, only two (out of eight, one of which is closely involved with the management of the Initiative) were able to provide responses at a more detailed level. The others had never seen the report and recommendations that arose from the 2006 evaluation. It was indicated that this was likely due to senior management's decision to refrain from widely disseminating the report to the different departments. All members of the WG were provided with copies; however, the high turnover in the WG may have resulted in newer members not receiving the file. Also, the last formal requirement to report on progress regarding the 2006 evaluation recommendations was made in 2008. As such, those who have become members within the last couple of years are not likely to be knowledgeable of the evaluation at a detailed level. However, although they are perhaps unaware of this, the new Policy Framework that has been devised responds to each of the recommendations in detail. Furthermore, the performance reporting requirements that each department is now required to follow also stem directly from the recommendations of the 2006 evaluation. Thus, while not all key informants were overtly aware of it, the evaluation has greatly impacted the overall management and strategic direction of the Initiative.

The results and recommendations of the evaluation were made available on the NRC evaluation website in the form of an executive summary, and the evaluation is also referenced on other departmental evaluation websites.³⁹ The management response and action plan are not included in this summary. At the time of this evaluation, the Annual Performance Reports were not publicly available on the web.⁴⁰

Project reviews did not specifically examine the extent to which project leaders are aware of the 2006 evaluation results and recommendations. However, the evaluation team prompted this question a number of times, only to find that project review interviewees were largely unaware of both the results and the follow-up action taken by management to respond to the evaluation process. Also, project review interviewees had limited knowledge of or opinions on GRDI design, management and strategic planning activities (because of their limited interaction with WG members). Some project review interviewees also demonstrated a lack of awareness of the rationale and intended uses of the new performance reporting guidelines.

Finding 19 Very few of the consulted internal GRDI stakeholders had more than a cursory knowledge of the 2006 evaluation report and its recommendations or of the resulting management response/action plans, and none of the related documents have been widely disseminated to stakeholders in participating departments.

³⁷ As discussed in the limitations section of this report, the relevant documentation was not made available during the evaluation process.

³⁸ The TOR for the GRDI WG and ADM CC were approved June 2007 and January 2009, respectively.

³⁹ Performance Management Network Inc. (2006, December). *Horizontal evaluation of the Genomics R&D Initiative: Final report*.

⁴⁰ The GRDI has recently launched a new web site on which all of the Annual Performance Reports can be found.

3.2 How was duplication of effort managed (or avoided) in order to ensure effective use of resources within this Initiative and within the Canadian context?

Summary: Duplication of effort was largely avoided through the processes used to select GRDI-funded R&D projects, due mostly to the importance placed on the peer-review component to the process. Projects are reviewed by individuals both internal and external (in most of the cases) to the department, including experts and senior managers who are aware of research being conducted in other departments, sectors and countries. Many internal and external stakeholders felt that this process is successful, but that the level of communication between departments and between scientists and GRDI management could be improved. Although some project collaboration has taken place between the GRDI and Genome Canada and efforts are being made to increase this collaboration, funding eligibility criteria currently preclude the formation of a more formal partnership. Overall, little duplication or overlap appears to exist between GRDI-funded research and other genomics research in Canada, and GRDI scientists and managers appear to be aware of the importance of pursuing and supporting original research.

As previously noted, the identification and selection of R&D priorities, as well as selection and adjudication processes, are the responsibility of individual departments. Documentation relating to the allocation process in participating departments was not received from all departments; therefore, the evidence presented in this section relies on planning consultations and interviews conducted during the evaluation.

Since the end of Phase II, departments have agreed to implement and ensure a competitive and peer-reviewed process for the allocation of GRDI funds. While some differences have been noted in departments' selection processes, each department has now established a competitive process that involves review by peers and experts both internal and external to that department.

In most participating departments, a letter of intent stage is used to assess the alignment with departmental mandates, priorities and other ongoing research activities. Approved letters are written as full proposals, evaluated by peer reviewers (including peers working in the federal government and, most of the time, external peers) and considered and/or modified according to the peer reviews by an internal expert committee prior to final approval by senior department managers.

Finding 20 The competitive process used by participating departments to select GRDI-funded R&D projects, which is reliant on a combination of peer-review (internal and external to the federal government) and senior management decisions, is the main mechanism for managing and limiting any duplication of effort.

Nearly all internal stakeholders consulted indicated that the processes for project selection were the primary means of avoiding duplication of effort. Project leaders interviewed in the context of project reviews confirmed that GRDI applications combining senior management decisions, external peer-review processes and monitoring processes are designed to mitigate the duplication of effort. Internal stakeholders and project review interviewees agreed that interdepartmental efforts are effective, although some believed that communication between researchers and GRDI management, as well as that between departments, could be improved. Some internal stakeholders have also observed a lack of scientific expertise in the process of judging the quality of projects resulting in decisions being made based primarily on alignment with departmental mandates and needs. In some cases, projects that appeared to have weaker scientific potential were funded because of their adherence to priority criteria. This issue has caused frustration and has led some to question program effectiveness.

The following excerpts from internal stakeholder consultations highlight the role of the selection processes used by each participating department in managing and avoiding duplication within and outside of the federal government.

- NRC proposals begin with a letter of intent, which is vetted by senior executives for their fit with the agency mandate and other operations. Approved letters are written as full proposals,

evaluated by external peer reviewers, and considered and/or modified by an expert committee before final approval.

- HC proposals are first vetted internally and then sent away for external review to assess their relevance to the departmental mandate and alignment with existing capacity to avoid duplication of effort and resources.
- PHAC proposals are reviewed and ranked by external reviewers. This review is conducted in conjunction with HC. As part of Phase III of the GRDI funding, PHAC sought to encourage collaborations between different groups of researchers.
- EC projects are assessed by a director-level committee and funded on the basis of their relevance to the departmental mandate, research gaps and regulatory needs. To avoid duplication, this committee was also responsible for proposing linkages between similar proposals.
- AAFC maintains a competitive process, in which proposals are peer reviewed and then considered, along with the reviewers' comments, by an internal panel. Applications to all funding sources (GRDI, A-base, B-base, etc.) go through the same review process to minimize duplication of effort and resources.
- DFO proposals include the identification of potential peer reviewers who are familiar with the research underway in that sector. It was also noted that the scientific communities conducting genomics research within the fisheries and oceans context are small, and the researchers leading the projects are typically aware of the research that is underway, both within Canada and internationally.
- NRCan letters of intent are assessed by a Canadian Forest Service (CFS) national management committee based on selection criteria that include an assessment of their alignment with departmental priorities. Invited proposals are reviewed by national and international peers for their scientific merit.

Other factors that are intrinsic to the nature of the research supported by the GRDI were identified as contributing to the limitation of duplication.

- The research is mandate-driven, and limited financial resources are available to conduct genomics R&D. Both of these factors help prevent overlap within departments.
- Scientists are experts in their own fields and are involved in many national and international genomics initiatives.
- The senior management committees that determine the final selection of projects for funding include representatives from inter-departmental working groups; therefore, these committees are largely aware of what is going on in other departments.
- Some departments held workshops or internal meetings where the research is presented to other members of the department. These are meant to raise awareness of current research efforts and foster collaboration. In some departments, these meetings are more challenging to organize because the laboratories and expertise are located in multiple sites across Canada.

Efforts to increase collaboration and interaction with Genome Canada are thought to have helped mitigate duplication of effort between Genome Canada and GRDI. Genome Canada's senior management communicates with GRDI ADM Coordinating Committee representatives to ensure that priorities are communicated and shared in order to maximize complementarity and avoid duplication. Ongoing discussions are being held between the GRDI and Genome Canada in the hopes that a formal arrangement will be developed that will better leverage the expertise of GRDI scientists and academic researchers.

Finding 21 Ongoing efforts to increase collaboration and interaction between GRDI and Genome Canada management are reported to help mitigate duplication of effort and optimize complementarity.

From the perspective of Genome Canada and other academic stakeholders, little duplication exists between its projects and GRDI-funded projects, as it does not directly support federal departments. Some overlap can be seen in the science performed in different sectors and organizations. However, some duplication in science is not necessarily negative, as research endeavors to advance knowledge need to be addressed through a large-scale, concerted effort. Overall, the GRDI, though much smaller in scale, is seen as complementary to Genome Canada and other Canadian research funding opportunities.

From the perspective of external stakeholders, some duplication exists in the Canadian genomics research environment in certain fields (e.g., cancer therapeutic development). However, these stakeholders have observed that GRDI committees are recognizing the increasing importance of funding projects that carry out novel investigations or that belong to a niche. They have begun to actively de-emphasize projects that duplicate efforts already made or that seek supplemental funding for project teams that are already in place. A project review interviewee noted the abundant discussions that took place between collaborators to ensure against any duplication of research efforts. This individual also observed that scientists avoid duplication through clear communication with colleagues and keeping up-to-date with the genomics literature.

An external stakeholder indicated that some overlaps exist between the funding provided by Genome Canada and the Tri-Councils; however, little overlap exists between the GRDI and other sources of funding. The GRDI contributes to the genomics landscape by: 1) recognizing that genomics promises to generate benefits by creating wealth, 2) building the foundation for large initiatives and teams in R&D areas that bring together inter-institutional (or inter-laboratory) and multi-departmental efforts and 3) bringing the private sector into the R&D process, as the GRDI focuses on products or solutions of importance to the Canadian economy or the health of Canadians and moves the research pipeline further towards socio-economic benefits.

Importantly, the external stakeholders consulted recognized that the greatest value-added associated with the GRDI is the consistency of efforts dedicated to mandate-driven and applied research to address issues of importance to Canada. As genomics R&D requires long-term investigations to move from basic research to applications and benefits, the multi-year support of the GRDI stands out from the academic model, which is characterized by its dependence on short term funding, the instability of expertise (students, post-docs, etc.) and a dedication to particular R&D areas.

3.3 To what extent has the Initiative implemented and managed processes that maximize efficiency, both for the delivery of R&D projects and for management?

Summary: To a moderate extent. During the last five years, GRDI management (i.e., the interdepartmental working group and the ADM Committee) has established and carried out practices aimed at heightening the effectiveness of the horizontal Initiative, increasing transparency and reducing redundancy; these have included priority setting, the selection of projects to align with these priorities, increased coordination activities between departments and enhancing performance measurement and reporting. The results of these efforts are embodied in the Annual Performance Reports (produced since 2006-07), the development of a program Results-based Management and Accountability Framework (RMAF) (2006), and the preparation of a draft Policy Framework (2009). While the ADM Coordinating Committee and the WG administer and deliver the overall Initiative (with the support of representatives involved in the coordination of the GRDI in their respective departments), individual departments are responsible for the management of R&D projects and have developed their own processes. Overall, internal and external stakeholders ranked most management practices tied to the GRDI very highly and feel that given the amount of money invested, the Initiative has resulted in a very strong return on investment. Issues that reduce the efficiency of the

Initiative were also noted, including the inability to use GRDI funds to retain HQP, a lack of communication between GRDI management and program staff, and difficulties with long-term planning due to uncertainty surrounding project funding and program continuity. It should be noted that these issues were identified at a departmental level and do not necessarily reflect Initiative-wide concerns.

Management of the GRDI: Broad (interdepartmental) management of the Initiative focuses on maximizing program efficiency across participating departments and is led by several common oversight bodies. The ADM Coordinating Committee oversees collective management and ensures that priority-setting mechanisms are established within departments, that government objectives are addressed and that organizations collaborate horizontally. The Committee meets three or four times per year to carry out strategic planning activities.⁴¹ The GRDI WG supports the ADM Committee through the provision of recommendations and advice regarding strategic priority setting, overall management and evaluation and reporting requirements; the WG is currently supported by a Common Functions Advisory Committee, comprised of 25 expert federal scientists, whose role is to provide advice on the “rationalization of resources and expertise that are common across departments”.⁴² NRC coordinates interdepartmental GRDI management activities: it chairs both the ADM Coordinating Committee and the WG, leads the development and implementation of the GRDI RMAF and the Annual Performance Reports (APRs) and was successful in the development and approval of the TB Submission to renew GRDI funding from 2008 to 2011.^{43,44}

The 2006 *Horizontal Evaluation of the Genomics R&D Initiative* concluded that very little evidence existed of “adequate systems to capture good and complete performance information.”⁴⁵ Since then, formal performance reporting has been implemented, primarily for the purposes of the GRDI APRs, the first of which was published in 2006-07. In response to the 2006 evaluation’s recommendations and in anticipation of the APRs, tools were developed and used to collect, analyze, and report performance information, with some variations in methods used according to departmental processes.⁴⁶ Terms of Reference (TOR) for the Working Group were developed and approved following a recommendation stemming from the first evaluation.⁴⁷ The Initiative’s RMAF⁴⁸, which was in development while the first evaluation was being carried out and which was completed in 2006, set common measurement and accountability requirements for the participating departments and established a program logic model, with targeted results in four program areas: management, genomics R&D capacity building, R&D and outreach. The RMAF also included a Performance Measurement Plan.⁴⁹ Finally, the draft Policy Framework was released in December 2009, an effort led by the ADM Coordinating Committee with support from the WG. It listed strategic priorities and mechanisms for improved interdepartmental integration, as well as three components to be supported by the renewed GRDI: 1) shared priorities to address national issues, 2) department priorities and mandates and 3) common functions to optimize GRDI effectiveness.⁵⁰

⁴¹ Working Group for the Genomics R&D Initiative. (2008). *GRDI Input to NRC DPR (2007-08): Updated 7 January 2008*.

⁴² Working Group for the Genomics R&D Initiative. (2009). *Genomics R&D Initiative Annual Performance Report 2008-09*.

⁴³ Performance Management Network Inc. (2009). *Genomics and Health Initiative: Case study of the Agricultural Genomic Research Program*.

⁴⁴ GHI Coordination Office. (2009). *NRC Genomics and Health Initiative Integrated Performance Report, 2007-2008*.

⁴⁵ Performance Management Network Inc. (2006, December). *Horizontal evaluation of the Genomics R&D Initiative: Final report*.

⁴⁶ Working Group for the Genomics R&D Initiative. (2007). *Horizontal evaluation of the Genomics R&D Initiative: Management Action Plan*.

⁴⁷ Working Group for the Genomics R&D Initiative. (2007). *Genomics R&D Initiative Interdepartmental Working Group – Terms of Reference*.

⁴⁸ Performance Management Network Inc. (2007). *Horizontal Results-based Management and Accountability Framework (RMAF) for the Genomics R&D Initiative: Final draft*.

⁴⁹ According to the Policy Framework, a new RMAF and Logic Model are expected in 2009-10.

⁵⁰ GRDI ADM Coordinating Committee. (2009). *Proposal for an integrative approach to address Canada’s biological challenges in food, environment, energy and health: Strategic leadership through collaboration: Draft report*.

Departmental management and delivery of R&D: While the ADM Coordinating Committee and the WG administer and deliver the Initiative as a whole, with the support of representatives involved in the coordination of the GRDI in their respective departments, individual departments are responsible for the management of R&D projects. As such, each participating agency has its own management processes, as described below.

- NRC oversees projects through a number of mechanisms, including regular meetings with scientific representatives and business development officers; quarterly scientific management committee meetings; and a Steering Committee, composed of management representatives, which meets three or four times yearly. Additionally, PIs are required to submit quarterly project progress reports detailing activities, milestones, and important dates.
- HC requires semi-annual and annual reports to ensure that objectives and milestones are in alignment with those initially presented in the proposal. External experts consult with project leaders on the equipment and infrastructure that are necessary for carrying out projects.
- EC monitors projects through annual progress reports. The process of submission has become more formal and transparent in recent years, with individual projects being assessed and funded on the basis of relevance to the departmental mandate, research gaps and regulatory needs.
- AAFC requires annual reports to document research progress and to make sure that milestones are met. The science office tracks outputs (i.e., publications and technology transfer). All AAFC GRDI researchers meet annually to present their work, and scientists are appraised annually.
- PHAC does not have annual reporting mechanisms in place. For the PHAC project reviewed, a final report was submitted at the end of the three-year project, and the project team used an informal reporting and progress-sharing methods, performed on a quarterly basis.
- DFO has established internal reporting structures, including an electronic database, which is used to meet GRDI reporting requirements. The perceptions of the efficacy and usefulness of this system vary between users.
- NRCan requires Annual Progress Reports to be submitted for review by the CFS Genomics Management Committee to monitor progress against milestones as identified in the original research proposal.

Facilitators and Barriers to Program Efficiency and Effectiveness: Internal stakeholders and project review interviewees noted the factors that either facilitate or reduce the efficiency and effectiveness of the GRDI.

Facilitators

- No overhead costs are associated with the coordination of the overall horizontal initiative—management is carried out by existing employees within already allocated roles. However, within NRC's allocation, a portion of funding is used to offset some expenses associated with the operation of the NRC-GHI Coordination Office. Similarly, processes for the allocation and distribution of funds are managed within existing research management structures; some internal stakeholders noted that the process used to allocate GRDI funds within participating departments has become more formal and structured.
- Because the leveraging of internal and external funds is a required part of the program in most departments, projects benefit from more than just the initial GRDI investment.
- Duplication of effort within departments is avoided through the coordination of scientific activity and by bringing together individuals with different expertise. This process, which pools together existing strengths and optimizes resources, maximizes both efficiency and cost-effectiveness.

- Key informants have observed the importance of collaboration to the success of large-scale, interdepartmental projects; as a result, collaboration has been increasingly stressed in project management as well as in evaluation committees.
- Scientific advisory boards for projects help to ensure an objective perspective by involving external individuals who are familiar with the technical aspects of the work.
- Similarly, some internal stakeholders noted that external peer review, when combined with internal evaluation, is one of the components of the Initiative that most contributes to the effectiveness of projects.
- Most internal stakeholders believed that reporting requirements at the various departments are adequate and do not place an undue administrative burden on staff.

Barriers

- Issues with communication were cited by internal stakeholders, and “Internal communications (between participating departments and GRDI management)” was one of the lowest ranked indicators by internal stakeholders, receiving an average rating of 3.3 out of 5.
 - Some would like to see management (notably WG) improve its efforts to communicate with program staff, particularly with respect to strategies, priorities for subsequent rounds, metrics for measuring performance or impact and best practices for various administrative processes.
 - Some also felt that better guidance should be provided from senior management in terms of proposals’ budgetary requirements (e.g., providing a model of good value and appropriate ratio of return, or detailing optimum levels of investment and leveraging).
- In some departments, the fact that GRDI funds cannot be used for salary support was a frequently noted source of dissatisfaction for internal program stakeholders and project review interviewees, and one that is thought to undermine project efficacy. Internal stakeholders were frustrated by the fact that HQP are trained in key areas, but the program does not allow these individuals or lead scientists to be retained, as federal departments cannot offer them competitive salaries and there are few positions in government for these highly skilled workers. This results in gaps in scientific leadership and significantly limits overall capacity (especially in subsequent rounds when infrastructure has already been established) for research continuity and long-term planning. The 2006 formative evaluation also referenced the extensive turnover in program managers in most of the departments, which has likely impacts on the achievement of key results.⁵¹
- Key informants noted that uncertainty surrounding the program complicated project planning.
 - Both internal stakeholders and project review interviewees mentioned the instability and uncertainty that is present in the last weeks of a fiscal year. Given the frequent redistribution of funds in the government context, planning for projects (such as hiring HQP) can be difficult when it is uncertain whether funding will be secured.
 - In some departments, the amount of lead time given for proposals and competition announcements is thought to presently be too short. Again, this would also require better communication from upper management to raise levels of awareness of competition deadlines.

⁵¹ Performance Management Network Inc. (2006, December). *Horizontal evaluation of the Genomics R&D Initiative: Final report*.

- Some program documents have referenced the program's three-year funding cycles as a further contributor to uncertainty^{52,53,54}, and a "considerable delay" related to the release of funding was reported during the first year of Phase IV (fiscal year 2008-09), suspending the recruitment of HQP and the establishment of new projects. However, departments were able to successfully mitigate the effects through cash management decisions.⁵⁵
- Many internal and external stakeholders asserted that monies appear to have been distributed effectively and outcomes are maximized.

Finding 22 Stakeholders are largely satisfied with GRDI management processes and believe that efforts to increase program efficiency have been successful. Factors inhibiting the efficiency of the Initiative varied by department (no initiative-wide guidelines pertain to the use of funds). Some examples included: the inability to use GRDI funds for salary support, lack of communication between program management and departmental staff, and uncertainty associated with continuity of program funding.

3.4 To what extent has the GRDI investment been complemented with additional resources from within departments or other sources?

Summary: To a moderate extent. Overall, GRDI investment has successfully leveraged additional resources for GRDI projects. According to the GRDI Annual Performance Reports (2006-07 to 2008-09), GRDI investments were supplemented by funds (cash contributions) from within departments or from other sources at a ratio of 1.5 times the GRDI investments. However, an analysis of the financial profile of projects funded during Phase III (2005-08) indicated that the resources leveraged came primarily from within the respective departments. Only a comparatively small proportion of leveraged resources (both cash and in-kind) came from sources external to the federal government: approximately half of the funding was provided by the GRDI, approximately one-third came from internal (A-base) sources and the remainder came from external sources. Variability between departments was high, which may be due in part to the parameters established in each department for GRDI investment (e.g. some departments required matching internal funds for GRDI projects while others targeted GRDI funds to particular research areas within their overall genomics R&D programs and used internal funding to support other genomics R&D areas), and also the availability and accessibility of appropriate data. A number of projects funded in Phase III, or departments as a whole, greatly relied on GRDI investments to support the genomics R&D projects that are designated as part of the Initiative: GRDI funds represented between approximately 30% and 90% of total project values for involved departments. As the total level of investment made by each participating department in genomics R&D is indeterminate due to financial tracking systems currently being used within some departments, the relative importance of funds leveraged and their impact on the materiality of the GRDI and on federal genomics R&D cannot be established.

Leveraging and collaboration are widely regarded in the GRDI performance framework to be associated with improved quality, impact and reach of research, as well as enhanced use of research resources. Therefore, the level of resources leveraged by GRDI investment for GRDI-supported projects and the level of interaction with multiple collaborators are used as measures for reporting on the performance of the Initiative. These are examined here to assess the extent to which the Initiative leveraged resources and expertise, both internally and externally, to maximize the quality and relevance of research funded.

All internal stakeholders consulted indicated that in addition to the GRDI funding, internal resources (A-base or other federal funds) were allocated to the projects, as were external resources (cash and in-kind contributions) from collaborators. Although specific numbers were not provided (with the

⁵² Working Group for the Genomics R&D Initiative. (2009). *Genomics R&D Initiative Annual Performance Report 2008-09*.

⁵³ EKOS Research Associates Inc. (2009). *The National Research Council – Genomics and Health Initiative Cancer Project*.

⁵⁴ Performance Management Network Inc. (2006). *Horizontal evaluation of the Genomics R&D Initiative: Final report*.

⁵⁵ Working Group for the Genomics R&D Initiative. (2009). *Genomics R&D Initiative Annual Performance Report 2008-09*.

exception of those for NRC), most internal stakeholders believed that the amount of leveraged funding represented two to three times the original investment. It is important to note that interviewees' perceptions of funds leveraged were greater than those presented in the GRDI Annual Performance Reports (Table 12) and those compiled by the evaluation team based on financial data for Phase 3 projects. This may be due to varying perspectives on what was leveraged as well as the reliability of data provided.

Data on leveraging can be found in the GRDI Annual Performance Reports, which were produced from 2006-2007 to 2008-2009. These represent an overview of estimated funds (cash only) leveraged for each participating department (Table 12). Overall, when a leverage ratio is calculated using the total amount or value of R&D projects (C/A), genomics R&D projects have leveraged a total amount of funds that represented two-and-a-half times the GRDI investment. When the leveraging ratio is calculated using the total amount of funds leveraged (B/A), leveraged funds represented one-and-a-half times the GRDI investment.

Table 12 GRDI and leveraged funds (\$000): 2006-07, 2007-08 and 2008-09

Department/ Agency	A. GRDI \$	B. Leveraged \$	C. Total (A+B)\$	GRDI leveraging ratio (B/A)	Overall ratio (C/A) ¹
NRC	\$ 18,000	\$ 40,625	\$ 58,625	2.3	3.3
AAFC	\$ 18,000	\$ 16,850	\$ 34,850	0.9	1.9
HC / PHAC	\$ 12,000	\$ 6,826	\$ 18,826	0.6	1.6
NRCan	\$ 6,000	\$ 15,404	\$ 21,404	2.6	3.6
EC	\$ 3,000	\$ 2,665	\$ 5,665	0.9	1.9
DFO	\$ 2,700	\$ 4,460	\$ 7,160	1.7	2.7
Total	\$ 59,700	\$ 86,830	\$ 146,530	1.5	2.5

Note: 1. Leveraging ratio as calculated in the GRDI Annual Performance Reports

Source: Compiled by Science-Metrix from GRDI Annual Performance Reports (2006-07, 2007-08, 2008-09)

Internal stakeholders consulted during the planning and evaluation phases were critical of the validity of these leveraging data, as a measure of the extent to which GRDI investment has leveraged additional resources for GRDI projects, especially regarding the consistency and accuracy of processes used by departments to track and estimate in-kind contributions. Nevertheless, the usefulness of such data and the recent efforts made to increase the quality of the data collected were recognized by internal stakeholders.

Finding 23 According to GRDI Annual Performance Reports (2006-07 to 2008-09), GRDI investments were supplemented by resources from within departments or from other sources at a ratio of 1.5 times the GRDI investments.

For evaluation purposes, information on the data sources and methods used to compile these figures would have been useful for characterizing the resources leveraged by the Initiative. However, this information was not readily available. As an alternative source of data that would allow for a further examination of leveraging, the evaluation team compiled financial profiles provided for genomics R&D projects supported during Phase III of the Initiative.

This compilation allowed the financial profile of projects to be characterized and provided evidence of the extent to which GRDI investments have been complemented with additional resources coming from within participating departments or other sources. Delineations between cash and in-kind contributions could not be made for all projects based on data available. As such, they have been pooled together into two source types: internal (A-base) and external (other federal government

sources and resources outside of government). As departments use different definitions and approaches for capturing leveraging information, the information provided varied between departments and represents an underestimate for some. This information should be considered to reflect general trends, as opposed to specific figures.

The extent of additional funding leveraged was generally project-specific. In terms of internal contributions, most departments complemented the GRDI awards with A-base allocations to ensure institutional commitment and enhance monetary impact. Overall, funding for GRDI projects was approximately half from GRDI funds, one-third from internal contributions and the remainder from external sources. The complementary investments may be underestimates based on the exclusion of some in-kind internal contributions.

Finding 24 Internal contributions that complemented the GRDI funds corresponded to an average of one-third of the total project value (Phase III). A number of projects relied greatly on GRDI investments to support genomics R&D projects designated as part of the Initiative.

Compared to internal resources, GRDI investments have leveraged fewer external resources (financial and in-kind contributions from various external organizations, including other federal departments and B-base funds). The notable exceptions to this include: DFO (leveraged more than twice as much external as internal resources); NRCan (leveraged about 1.5 times as much external as internal resources); and EC (leveraged almost as much external as internal resources). Based on the data provided, these also appear to be the departments that have leveraged the greatest proportion of project funds overall; approximately two thirds of the project funds within these three departments were leveraged from internal or external sources.

Finding 25 A small proportion (16%) of the funds leveraged for GRDI projects (Phase III) were from sources external to the participating department. According to internal stakeholders, external contributions increased in Phase IV and are expected to grow as the potential of genomics is now better demonstrated.

Most of the resources leveraged were from partnerships in projects funded through Genome Canada, federal departments, international organizations and the Canadian Tri-Council (mainly NSERC and CIHR) (Figure 3). Provincial and university contributions represented a small amount of additional resources, and even fewer contributions came from the private sector.

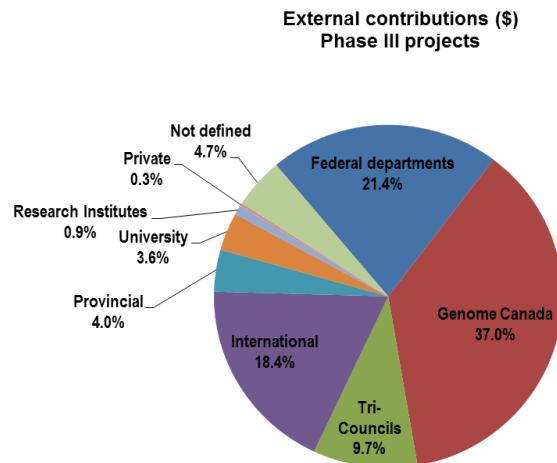
Based on this examination of external sources and evidence from the detailed project reviews, a number of projects were involved in larger academic projects supported by Genome Canada and Tri-Council partnership programs. In fact, federal scientists possessing genomics R&D expertise (whether or not they are supported by the GRDI) are often solicited as partners in the context of academic and provincial funding programs. As such, GRDI funding was a frequent contributor to research funding programs that required external matching funds. According to one external stakeholder, the federal genomics R&D capacity—particularly in fields of Canadian strength, such as natural resources and the environment—is a key part of overall research capacity at the national level and crucial for international competitiveness:

All happens through partnership. And partnership with the industry in our field is hopeless. With no federal partners, 80% of our research budget will be impossible to obtain... The Federal government gives us the on-site expertise and networks of contacts, as well as the contextualization of research in genomics, and importantly, it provides direction for needs and potential applications.

The involvement of GRDI projects in larger academic projects represents a different model than that usually presented when reporting on leveraging. In fact, in this situation, the GRDI projects are considered as contributors to larger projects, not the inverse. Accordingly, it is difficult to estimate the extent to which GRDI projects benefited from these projects' resources and expertise, as only the total value of large-scale projects is included in GRDI leveraging figures. Overall, GRDI investments

are leveraged outside of the federal setting and are highly beneficial for the Canadian research community. For the purposes of enhanced accountability, though, detailed information should be captured on the cash and in-kind contributions for GRDI activities stemming from these projects, rather than just the total value of Genome Canada or Tri-Council projects.

Figure 3 Distribution of sources of external resources for Phase III GRDI projects: 2005-08 (33 R&D projects; Total value of \$11.7M)



Source: Compiled by Science-Metrix from projects' financial profiles, provided by participating departments for all genomics R&D projects supported by the GRDI in Phase III of the Initiative (2005-08).

Information is not available on the leveraging performance of comparable initiatives that supplement internal resources and are designed to build internal R&D capacity in the context of the federal government. However, it is possible to compare leveraging ratios using available data from funding programs that support external research (Tri-Councils). External contributions established for an inter-agency granting program, the Network of Centres of Excellence (NCE), correspond to 0.8 times the NCE investments and 1.8 times the amount calculated using the total amount or value of NCE budgets (NCE and external contributions).⁵⁶ These leveraging ratios are comparable to GRDI Phase III projects; however, when leveraging figures from the Annual Performance Reports are compared to NCE ratios, the GRDI leveraging performance is superior. In any case, this comparison provides more evidence that, although its primary sources of supplementary funds are internal to the federal government, overall the GRDI is successfully leveraging its investments.

Finding 26 GRDI investments are a valuable resource to be leveraged by those carrying out genomics R&D projects in the academic sector, and they position federal genomics expertise and facilities as key resources in a variety of genomics projects. Leveraging data would be more useful if there were consistent understanding and approaches for collecting leverage information across participating departments and agencies.

⁵⁶ Based on a total NCE contribution of \$315.8 million and a total external contribution of \$258.1 million (in-kind and cash external contributions) over the four-year period. Source: NCE Annual Reports (2004-05 to 2007-08).

3.5 Overall, how cost-effective is the interdepartmental aspect of this Initiative? How has the federal genomics R&D supported by the Initiative provided value for Canada?

Summary: Stakeholders' opinions of the cost-effectiveness and utility of the horizontal nature of the Initiative were mixed. They believed that the value of the Initiative lies in the allocation of funding to the support of multiple department mandates. However, while the science and potential of genomics R&D have advanced considerably, departmental funding allocations have remained unchanged since the Initiative's inception. The level of multi- or inter-departmental collaboration in projects supported by the GRDI in Phase III was found to be fairly low, and some internal stakeholders were concerned that this low level of collaboration may have diminished resource use efficiency and research returns. However, others believed that the interdepartmental delivery of projects is not necessarily appropriate for all types of research investigations. Additionally, some internal stakeholders were concerned that moving towards a more horizontal delivery approach will further limit the resources available from the GRDI for some departments. Nevertheless, a large proportion of collaborators and users of R&D results involved in Phase III projects perceived the cost-effectiveness of those projects to have been high and the ultimate merit of these projects in relation to the GRDI investment to be significant.

Since the inception of the GRDI, the main horizontal characteristic of the Initiative has been the allocation of funds to multiple departments, which allows mandate-driven research projects to be conducted in support of departmental objectives in various sectors of activity. In fact, the GRDI has been an important mechanism for connecting federal government departments and providing funding for each to build capacity in genomics research, something these departments might not have done on their own given that the research was until only relatively recently still in the experimental stages.

The total amount of the GRDI funding, as well as distribution of funding, among participating departments was established at the inception of the Initiative in 1999 (Table 1). The 2006 evaluation raised issues regarding the unchanged level and distribution of funding over the years, as there had been no accounting for inflation or the increasing costs of research equipment and related research activities. This situation was also noted by internal stakeholders consulted in the context of this evaluation. The level of funding has not changed since the last evaluation (over the Phase III and Phase IV periods), and the main funding allocation issue raised during key informant consultations is the distribution of GRDI funding in participating departments, a formula that has remained fixed over the last ten years.

In the original allocation scheme, departments did not receive equal amounts of funding, with some receiving significantly more than others.⁵⁷ However, according to many internal and external stakeholders consulted and from other evidence collected in the context of this evaluation (level of R&D outputs, potential of applications and distinctive scientific strength of departments), the level of funding allocated to departments for genomics R&D would need to be revisited to better reflect levels of scientific advancement, capacity and performance, as well as the potential and relative importance of mandate-driven research conducted in all sectors. Accordingly, a review and refinement of the departmental allocation formula may potentially improve the overall cost-effectiveness of the Initiative.

Finding 27 Preliminary evidence collected in the context of this evaluation suggests that the fixed departmental funding distribution established at the inception of the Initiative may not represent the current level of scientific advancement in genomics and the potential of mandate-driven research conducted across the

⁵⁷ The original departmental/agency GRDI allocation formula likely reflected the maturity of the scientific knowledge and capacity at the time the Initiative was implemented, when applications of genomics were at comparatively earlier stages in some sectors. However, the rationale behind this distribution formula and decision relative to the status quos over the last decade is not known.

departments. This evidence suggests that a review of funding allocations provided to departments could contribute to the overall cost-effectiveness of the Initiative.

Again, the interdepartmental nature of the Initiative has little discernible impact on individual genomics R&D projects' approval and management. Each participating department maintains its own implementation and oversight procedures.

Interdepartmental collaborative efforts in projects supported by the GRDI initiative were reported as being relatively low in the 2006 evaluation. An examination of the participation of multiple departments in Phase III GRDI projects by compiling collaborators and users of R&D results listed in project profiles confirms that this has remained the case. Consistent with the objective of the GRDI to build and sustain genomics capacity and support departmental mandates, a large proportion of the internal collaborations of departments are with other units (regulation, policy, laboratories and research institutes) within the same department. To a lesser extent, projects involved collaboration with a different department. Interestingly, the interdepartmental collaborations were more present for departments with mandates in the environmental and natural resources sectors (AAFC, EC and NRCan). AAFC and NRC are the main source of collaborators for the GRDI projects of other departments. In the context of its own GRDI projects, NRC collaborated mainly with AAFC and internally with other with NRC institutes (

Figure 4, next page).

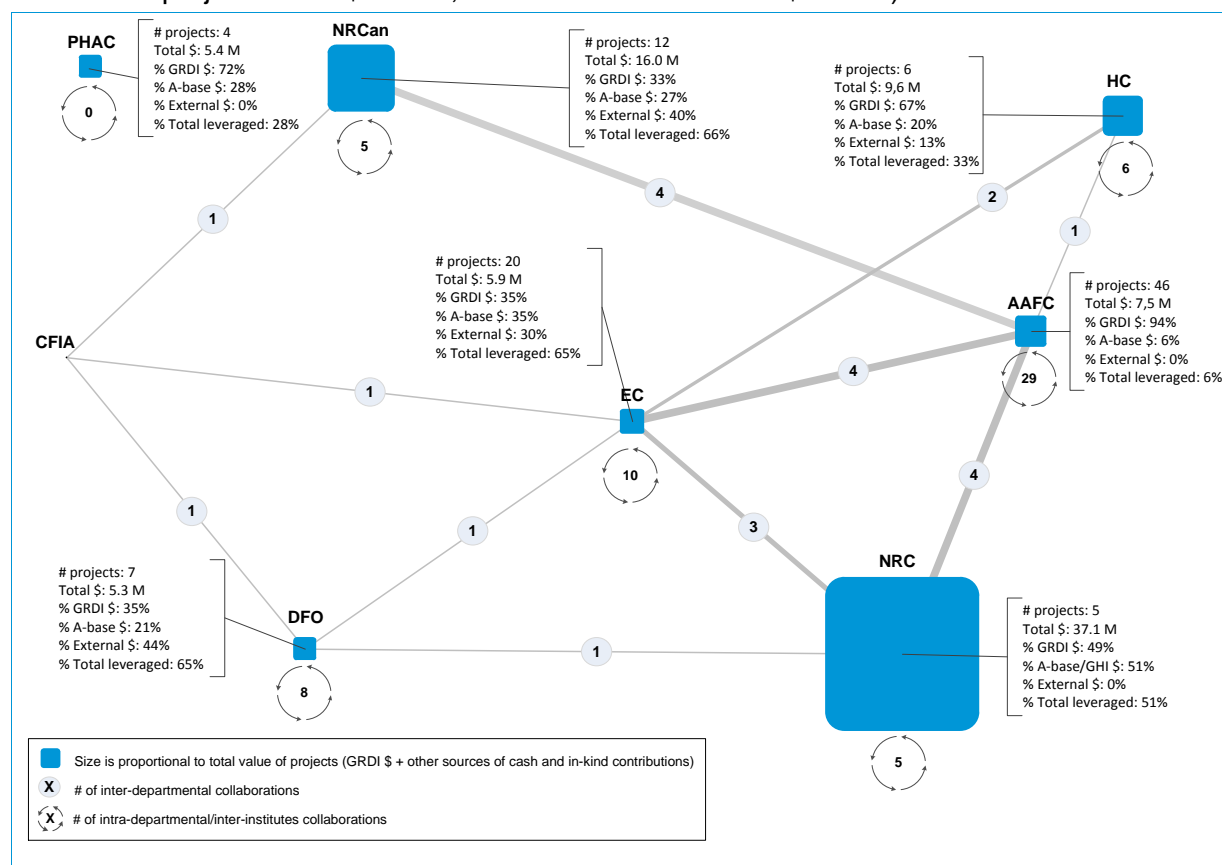
Finding 28 The level of interdepartmental collaboration in projects supported by the GRDI in Phase III was fairly low. In these cases, scientists had a relationship with the collaborators before applying for GRDI funding. However, it has been recognized that the GRDI provided the mechanism to undertake an interdepartmental project or to facilitate interdepartmental collaborations.

According to some of the scientists interviewed for project reviews, for some of the GRDI projects involving more than one federal department, the existing genomics capacity of one department was leveraged by another to deliver upon their mandate. In these cases, the scientists had a previous relationship before applying for GRDI funding; however, it has been recognized that the GRDI provided the mechanism for them to undertake an interdepartmental project. A number of project leaders consulted for the project reviews expressed the opinion that further functional interdepartmental cooperation might enhance resource use efficiency and research returns.

The interdepartmental aspect of the program does not affect many of the researchers participating in projects, as they do not have any new relationships with other departments or even within their own department. There are mixed views as to the utility of the horizontal program, including the value of increased communication between federal scientists, as some researchers do not feel that a logical link exists between their research and that being performed at other participating departments. In addition, some are concerned that moving towards a more horizontal delivery approach will further limit the resources available from the GRDI for some departments, as it would focus on larger issues, such as human health, and would not include the objectives of a large number of projects.

Finding 29 There are mixed views as to the cost-effectiveness of the horizontal nature of the Initiative. It is recognized that in some research areas, true interdepartmental efforts would probably enhance resource use efficiency and research returns. However, some are concerned that moving towards a more horizontal delivery approach will further limit the resources available from the GRDI for some departments.

Figure 4 Inter-departmental collaborations in Phase III GRDI projects: 2005-08 (Total project value: \$86.8 M; GRDI total investments: \$30.4 M)



Notes: Intradepartmental or inter-institutional (within the same department) collaboration were accounted for when a collaborator had a different address (from a different region). CFIA was not funded by the GRDI but was a source of collaborators for three GRDI projects.

Source: Compiled by Science-Metrix from projects' detailed profiles, provided by participating departments for all genomics R&D projects supported by the GRDI in Phase III of the Initiative (2005-08). NRC Intradepartmental or inter-institutional collaborations were compiled from data provided by the NRC.

In specific project contexts and under the appropriate conditions, the idea of facilitating more interdepartmental collaboration and communication is perceived to add value to the Initiative. Project review interviewees felt that this approach should be pursued not only for the sake of horizontal program management objectives but also to maximize the potential impacts of the research being conducted across multiple departments. Importantly, there is an ongoing need for departments to maintain and increase their own capabilities relating to genomics R&D to leverage investments made over the last 10 years.

Finding 30 The interdepartmental delivery of projects is not perceived to be suitable for all research areas and sectors.

Cost-effectiveness of horizontal management structure: Internal and external stakeholders and project review interviewees felt that they were not in a position to provide informed opinions on the horizontal management structure's cost-effectiveness. While general opinion indicated that the Initiative was managed in a cost-effective manner, in the absence of comparative efficiency benchmarks or access to internal management deliberations, these key informants had little hard evidence upon which to base this claim. The main rationale behind the perceived cost-effectiveness is the low level or absence of administrative costs associated with the governance, management and

coordination of the Initiative. The salaries of the individuals involved in horizontal management activities are not covered by GRDI funds but by participating departments. However, it is not possible to estimate the costs associated with in-kind contributions (time and salary equivalent). The only GRDI funding associated with horizontal management was provided to NRC's GHI Coordination Office and corresponds to approximately \$560,000 per year (totalling nearly \$1.7 million provided between 2005 and 2008).

Also, given the limited level of funds available, internal stakeholders indicated that keeping the administrative outlays low improves the cost-effectiveness of the Initiative by maximizing the amount of money invested strictly in research. However, some concern was raised about the future cost-effectiveness of the Initiative if additional GRDI funding is dedicated to formal, interdepartmental management for the coordination of activities and research collaboration in participating departments.

Internal stakeholders' opinions were again mixed with respect to the idea of creating a dedicated funding competition process for interdepartmental projects that target specific research priorities within the GRDI funding structure. While it is recognized that such a process would pool the expertise of multiple departments for selected priorities, concerns were expressed about a possible decrease of the level of allocation to individual departments. The risk of losing past investments and current opportunities have been identified, especially in the case of departments that both receive a low proportion of the GRDI and have a focus that is not required in areas targeted by interdepartmental competitions.

Although the scientists interviewed as part of the project review process could not comment on the cost-effectiveness of the interdepartmental management structure, many did comment that in light of the interdepartmental nature of the Initiative, more detailed information could be made available to departmental researchers about projects that are being funded in other departments and their progress in order to facilitate collaboration and exchange. Also, in some departments, communication between those involved at the project level and the GRDI WG departmental representatives was perceived as poor. Most project review interviewees consulted were unaware of ongoing GRDI WG efforts (e.g., the creation of the Policy Framework in response to the 2006 evaluation).

Cost-effectiveness of GRDI: For the reasons outlined in the limitations section above, it is not possible to perform a cost-effectiveness analysis of GRDI funding overall. However, the cost-effectiveness of GRDI-supported R&D projects was perceived to be very high by the project leaders interviewed for the project reviews, and they cited similar reasons to those outlined above (e.g., low overhead, shared resources). Similarly, web survey respondents, both internal and external to the federal government, also perceived the cost-effectiveness of GRDI-supported R&D projects as very high (Table 13). Internal web survey respondents closely involved in GRDI projects (Group 1) are more positive than collaborators and users of R&D results from other federal departments (Group 2) and external to the federal government (Group 3). However, the overall score is fairly high, indicating that web survey respondents largely believe that the projects were conducted in a cost-effective manner (areas of improvement and barriers to projects' effectiveness and efficiency are presented in Section 3.3).

Finding 31 The cost-effectiveness of R&D projects is perceived to be high by a large proportion of collaborators and users of R&D results involved in Phase III projects.

Table 13 Perception of GRDI projects' collaborators and users of R&D results on the cost-effectiveness of Phase III projects: 2005-08

	Total (N)	Total (n)	1 - Not at all	2	3 - Some-what	4	5 - To a great extent	Cumulative score (out of 100)
Group 1. Internals close to GRDI projects	47	45	0.0%	0.0%	2.2%	33.3%	64.4%	91
Group 2. Internals	16	11	0.0%	0.0%	0.0%	72.7%	27.3%	82
Group 3. Externals	41	31	0.0%	0.0%	9.7%	35.5%	54.8%	86
Total	104	87	0.0%	0.0%	4.6%	39.1%	56.3%	88

Source: Compiled by Science-Metrix from impact web survey with collaborators and users of R&D results

The GRDI funding figures presented in Table 14 relative to quantified “outputs” show that the number of outputs that have been produced and activities fostered by the departments is considerable.⁵⁸ The levels of dissemination achieved by publishing or presenting research results and of patenting activity and participation in national and international committees/networks are impressive when compared to the GRDI investments over the period examined. Also, the extent of departmental financial commitment that complemented the GRDI funding and funds leveraged outside the government also indicate that the overall R&D output and outcomes stemming from the Initiative are good value for the GRDI investments made. Section 3.4 provides more detailed analysis on leveraging.

Finding 32 The value generated by genomics R&D projects relative to the GRDI investment is significant.

The internal and external stakeholders consulted feel that the value of the Initiative is high relative to the amount spent on it. The Initiative has had a positive effect by enabling capacity (infrastructure and expertise) and high quality research results, and it has moved genomics from basic research to the proof of concept stage. The Initiative also provided an essential source of funds that allowed the kind of high-risk⁵⁹ and mandate-driven research to be conducted that would not be attractive to academic and industry researchers. This level of advancement now allows federal departments to demonstrate the potential of genomics to potential users and, in turn, generates interest and attracts external commitments to research projects.

Finding 33 The provision of funding to the support of multiple department mandates constitutes the main added value of the horizontal nature of the Initiative. It enabled the federal government to establish genomics R&D capacity and to demonstrate its potential to address issues in niche areas.

⁵⁸ Note that compiling the outputs across the three Annual Performance Reports proved to be challenging; thus Table 14 only presents a limited selection of these and excludes reporting on outcomes. Also, it underestimates the research outputs and activities that were derived from the GRDI projects after the annual performance data collection period.

⁵⁹ Genomics projects undertaken through the GRDI are considered high-risk due to their early stage of development and unknown potential to yield concrete outcomes/impacts.

Table 14 GRDI resources, leveraged funds and R&D outputs by department and agency, 2006–07 to 2008–09

R&D Resources/Outputs	NRC	AAFC	HC/ PHAC	NRCan	EC	DFO	Total
GRDI funds	\$ 18,000	\$ 18,000	\$ 12,000	\$ 6,000	\$ 3,000	\$ 2,700	\$ 59,700
Leveraged funds	\$ 40,625	\$ 16,850	\$ 6,826	\$ 15,404	\$ 2,665	\$ 4,460	\$ 86,830
Total funds	\$ 58,625	\$ 34,850	\$ 18,826	\$ 21,404	\$ 5,665	\$ 7,160	\$ 146,530
Papers in refereed journals	226	160	93	106	48	20	653
Papers in refereed conference proceedings	158	23	15	86	10	6	298
Conference presentations and posters	412	272	100	261	28	17	1,090
<i>Invited presentations</i>	223	136	64	51	28	17	519
<i>National conference/workshop participation/presentations</i>	39			130			169
<i>International conference/workshop participation/presentations</i>	150		15	80			245
<i>Poster presentations</i>		136	21				157
Technical reports	33	9	6	2	14	4	68
Book chapters/editions		19	9	13	1	4	46
Other publications/peer-reviewed related activities	86	250		1	27	2	366
Participation in national committees, and networks related to projects	5			30	4	19	58
Participation in international committees and networks related to projects	10			34	4	6	54
Genomics-related databases and libraries resulting from projects	5	1 + (*)	31	1 +(*)		1 +(*)	39
Spin-off companies	1						1
Disclosures		7					7
Active patents (2008-2009)	9						9
Licenses issued or licensing agreements	3	2					5
Material transfer agreements (MTAs)	14		5				19
Formal collaborative agreements	95		6		10		111
Standard operating protocols			1		12		13

Note: (*) 1+: Numerous or several items; no specific numbers were provided in the GRDI Annual Performance Reports

Sources: Compiled by Science-Metrix from GRDI Annual Performance Reports

4.0 Findings – Relevance: Alignment with Government Priorities

4.1 Has the R&D supported by the GRDI generated S&T applications that address and contribute to: a) Government science and technology priorities (e.g., federal S&T Strategy)? b) The mandates and strategic objectives of the individual departments?

Summary: Yes. The mandate-driven R&D supported by the GRDI generated scientific knowledge and application that addressed and contributed to both government S&T priorities and strategic objectives of participating departments. A strong alignment between the objectives and results of GRDI research, government priorities (as articulated in the federal S&T Strategy) and individual departmental mandates is one of the defining characteristics of the Initiative. GRDI-funded projects must demonstrate a clear correlation between project goals and these broader objectives in order to be recommended and approved, both by peers and senior management. The GRDI's governing bodies work to ensure that this high degree of alignment is reached. The views of internal and external program stakeholders consulted further establish the strength of this link.

In 2007, the Government of Canada published its comprehensive S&T Strategy, *Mobilizing Science and Technology to Canada's Advantage*.⁶⁰ Its vision is to “build a sustainable national competitive advantage based on science and technology and the skilled workers whose aspirations, ambitions, and talents bring innovations to life.” The strategy states that the advantages of this agenda are entrepreneurial advantage, knowledge advantage, and people advantage. The primary principles of the S&T Strategy are to: promote world-class excellence; focus on priorities; encourage partnerships; and enhance accountability.

The evidence shows that the GRDI aims to contribute to the overall vision of the strategy, its principles, and all three of the advantages through its strategic direction and activities. This alignment is written into the key objective of the GRDI, which is to “sustain intramural genomics research in support of key federal public policy objectives in areas of national interest (human health, agriculture and food safety, environment and natural resources management), to strengthen innovation, promote global competitiveness, and ensure sustainability for the benefit of all Canadians.”⁶¹ The RMAF Logic Model⁶² further delineates the objectives of the Initiative, which are organized into four program areas (and by key performance indicators): *management* (enhanced governance, coordination and partnerships); *genomics R&D capacity* (increase and training of HQP; advancements in state-of-the-art infrastructure; increased participation in national and international genomics initiatives); *research and development* (access to and sharing of technology and scientific knowledge; application of research results to develop innovative, new or improved methods, products, processes or technologies); and *outreach* (increased awareness and understanding of genomics research results and applications).

The GRDI answers to three of the four S&T priorities identified in the S&T Strategy (the exception being information and communications technologies). The *environmental science and technologies* priority is being addressed through research conducted in many of the participating departments—namely AAFC, NRC, DFO, and EC—on issues such as sustainable food supply and bioproducts. Researchers at NRC, NRCan, DFO and AAFC are tackling the *natural resources and energy* priority through research on biofuels, the management of tree diseases and insect pests, and the protection of marine resources, for example. Finally, the *health and related life sciences and technologies* priority is being

⁶⁰ Government of Canada. (2007). *Mobilizing science and technology to Canada's advantage: Summary*. Retrieved from [http://www.ic.gc.ca/eic/site/ic1.nsf/vwapj/STsummary.pdf/\\$file/STsummary.pdf](http://www.ic.gc.ca/eic/site/ic1.nsf/vwapj/STsummary.pdf/$file/STsummary.pdf)

⁶¹ Working Group for the Genomics R&D Initiative. (2009, December). *Genomics R&D Initiative Annual Performance Report 2008-09*.

⁶² Performance Management Network Inc. (2007, January). *Horizontal Results-based Management and Accountability Framework (RMAF) for the Genomics R&D Initiative: Final draft*.

addressed at NRC, HC and PHAC through R&D on topics including chronic and viral diseases, pathogen detection and research supporting the effective regulation of health-related products. Although a limited number of the projects reviewed for the evaluation have generated applications to date, documents show that those few applications that have been realized have contributed to outcomes and priorities (see Section 2.0).^{63,64,65}

Finding 34 Research supported by the GRDI—both in terms of project objectives and research results—is in clear alignment with the vision, principles, advantages, and S&T priorities presented in the federal S&T strategy, and it is also required to demonstrate a strong link to individual departmental mandates.

The GRDI Annual Performance Reports (2007-2008 and 2008-09) indicate the connection between GRDI research results and the three advantages envisioned in the S&T Strategy, describing how an *entrepreneurial advantage* is gained through the alignment of research and federal economic development objectives through the many partnerships with universities and the private sector, as well as evidence-based regulation that leads to commercial applications; a *knowledge advantage* is gained by making discoveries that address the problems that are most pressing for Canadians; and a *people advantage* results from the collaborative relationships formed for GRDI-funded projects and the attraction, training, and retention of HQP.

Alignment with objectives and priorities is also a key part of the GRDI's governance structure and decision-making processes. The ADM Coordinating Committee (ADM CC) is mandated to “ensure that effective priority setting mechanisms are established within departments, and that government objectives and priorities are addressed,”⁶⁶ and the Working Group (WG) supports the ADM CC's strategic priority setting and overall management. The NRC-GHI Coordination Office provides guidance in this effort and NRC chairs the ADM CC and the WG. The Chair of the ADM CC is the VP Life Sciences; the Chair of the WG is the Director NRC Genomics and Health Initiative (and its GHI Coordination Office).

Additionally, projects must of necessity be linked to departmental strategic outcomes as well as federal S&T priorities, as they are required to clearly demonstrate an alignment in order to be funded. Evidence suggests that departmental mandates are even more crucial in the decision-making process, especially as the Initiative's initial funding was characterized by projects arising from within individual departments. Internal and external stakeholders felt that projects aligned with the federal S&T priorities and that a strong emphasis is placed on departmental mandates in the selection of projects that receive funding, and the review of GRDI projects further demonstrated that each agency had application and monitoring processes in place that would ensure that GRDI projects align with their mandates. The draft Policy Framework⁶⁷ has envisioned an even closer alignment with government priorities and mandates through a greater interdepartmental focus, shared outcomes, and interdepartmental project frameworks.

It is worth mentioning that only about 43.5% of web survey respondents were familiar with the GRDI objectives, and 25% were unfamiliar with them. Not surprisingly, those who were least knowledgeable of the objectives tended to be external collaborators, suggesting that many outside collaborators and users of R&D results are unaware of the broader priorities and mandates driving the research.

⁶³ GHI Coordination Office. (nd). NRC Table 3-8: Horizontal Initiatives.

⁶⁴ GRDI ADM Coordinating Committee. (2009, December). *Proposal for an integrative approach to address Canada's biological challenges in food, environment, energy and health: Strategic leadership through collaboration: Draft report.*

⁶⁵ Working Group for the Genomics R&D Initiative. (2009, December). *Genomics R&D Initiative Annual Performance Report 2008-09.*

⁶⁶ Working Group for the Genomics R&D Initiative. (2009, December). Ibid.

⁶⁷ GRDI ADM Coordinating Committee. (2009, December). Ibid.

5.0 Findings – Relevance: Alignment with Federal Roles and Responsibilities

5.1 To what extent has the Initiative supported mandate-driven genomics R&D that generated results that have not been achieved elsewhere?

Summary: To a great extent. Research funded by the GRDI answers to a specific need that is not being fulfilled by the other genomics R&D being conducted in Canada. This is primarily due to the Initiative's strategic alignment with federal government and departmental objectives and priorities, an alignment particularly well suited to research that is sustained or exploratory, conducted in support of regulation, or addresses specific issues of importance within the Canadian context.

The multiple lines of evidence gathered for this evaluation point to the uniqueness of GRDI-funded research. A key criterion of the program's competitive process for the selection of projects is that they align with federal and departmental objectives. Because it is so inherently mandate-driven (see Section 2.1) and because there is no other broad mechanism in place in Canada to generate similar results, it is unlikely that this research would either be conceived of or pursued elsewhere, with a few possible exceptions noted by internal and external stakeholders.

Genomics is a "key enabler in most areas of distinctiveness related to government R&D as described in the Federal S&T Strategy"⁶⁸ and governments—federal, provincial and municipal—are among the heaviest users of genomics knowledge and resulting tools.⁶⁹ The evidence shows that government-led genomics research fulfills needs in a number of niche areas. For example, research to support regulation is far more likely to be carried out by federal laboratories, mostly because federal scientists are in the best position to work side-by-side with regulators. Research that is specific to the Canadian environment or that addresses challenges in the Canadian context in some way is also of great interest to the federal science-based departments. More specifically, however, documents highlight the groundbreaking achievements and international leadership of GRDI scientists in areas such as the research on the genetic control of leaf rust at AAFC⁷⁰ and the Brassica research at NRC,⁷¹ for example, both of which are issues of economic and environmental importance in Canada. Furthermore, the primary focus of the Initiative in previous phases was on building and maintaining capacity; the generation of outcomes and results is now happening rapidly as the research tools that have been developed are beginning to be applied.

Overall, key informants felt that the GRDI "specializes" in mandate-driven research. Furthermore, many of those associated with particular projects asserted that these projects would not likely have been undertaken if the GRDI had not supported them. Of the respondents to the web survey, over half (56%; n=117) stated that their project could not have been achieved elsewhere, the main reason (provided by 33% of these web survey respondents) being that the GRDI supports exploratory and longer-term investigations, and the particular topic, scope and scale of their project necessitated this kind of sustained support. Another 33% of these web survey respondents noted the unique and complementary expertise and infrastructure—possessed by the federal laboratories but also by project collaborators, in combination—that was needed to carry out the research. Many remarked in

⁶⁸ Ibid.

⁶⁹ Performance Management Network Inc. (2007, January). *Horizontal Results-based Management and Accountability Framework (RMAF) for the Genomics R&D Initiative: Final draft*.

⁷⁰ GHI Coordination Office. (nd). *NRC Table 3-8: Horizontal Initiatives*.

⁷¹ Performance Management Network Inc. (2009, May). *Genomics and Health Initiative: Case study of the Agricultural Genomic Research Program*.

particular that the topic under investigation was an area for which the participating department had already accumulated considerable and valuable data and expertise.

Additionally, of respondents that were aware of the GRDI (n=66), about 75% of project collaborators and contributors responding to the web survey claimed that their decision to be involved in the project was positively influenced by the fact that their project was partially funded by the GRDI. Of these web survey respondents, 69% noted that the project would not have proceeded at all without the GRDI support, and 41% stated that they themselves would not have been involved. Similarly, many of those interviewed in relation to the project reviews observed the unique opportunity presented by the GRDI, as it represented the only means by which their project could have been brought to fruition. Even those individuals who believed that their collaboration could have occurred without the GRDI were sure to acknowledge its value in facilitating their efforts. In general, key informants agreed that Canada needs a federally supported genomics research initiative, that the GRDI successfully fills this need, and that this is a proper role for the federal and provincial governments to play.

While most agreed that the GRDI offers the best prospect for carrying out mandate-driven genomics research, some possible alternatives were noted. For example, some of the project review interviewees noted that certain private sector firms might pursue research in the same areas as that undertaken by GRDI scientists, but only if commercialization is one of the desired outcomes. Additionally, approximately 23% of web survey respondents (n=117) noted that the project with which they were associated generated impacts (outcomes) that could have been generated elsewhere, such as at an academic research organization, a private company or another federal department in Canada (14%); an international organization (4%); or through other means (5%). However, about half of these web survey respondents also noted that the project, if had not been conducted by the participating departments, would have generally suffered in comparison due to, for example, a limited access to resources, less rigorous results analysis, or changes to its focus.

In addition, many internal and external stakeholders as well as web survey respondents made the distinction that just because other institutions or firms have the capacity to carry out the research, it does not mean that they have an interest in doing so. Noted disincentives for researchers in academia and industry in carrying out research that is more mandate-driven included a lengthy gap between basic research and commercial application and the regulatory dimension.

Some external stakeholders voiced their skepticism that senior managers of federal departments and programs can accurately identify the areas of highest priority for funding in genomics, noting that the identification of current research gaps or uncertainties associated with setting priorities might be addressed through frequent communication with participating scientists and external scientific experts.

Finding 35 The GRDI represents the single most important mechanism in Canada through which mandate-driven R&D results in genomics can be generated. Key informants agree that this sort of Initiative is an appropriate and necessary role for the federal government.

6.0 Findings – Relevance: Continued Need for Program

6.1 Given the changes in the Initiative's context, is there still a need for an initiative that supports genomics R&D within select federal departments?

Summary: Yes, there is a continued need for an initiative that supports genomics R&D within participating departments. The contextual changes seen during the last decade—signified by the rapid evolution of the field of genomics and broader political, economic, and environmental factors—have preserved, and even intensified, the need for the Initiative. Key informants generally agree that, given the GRDI's achievements to date, as well as the importance of genomics R&D to future developments in many key areas, the Initiative offers significant value to Canadians; therefore, the federal government's current level of commitment should be maintained or increased.

Ample evidence can be found in the background literature as well as in the perspectives of key informants consulted for this evaluation of the key contextual changes that have impacted the GRDI in important ways. First, the Initiative is operating in the midst of a second revolution in genomics. Since the term 'genomics' was originally coined two decades ago, genomics has rapidly evolved from its origins as a field of information science to a discipline of biological and biomedical research and an applied science. Driven by technological advances in sequencing and bioinformatics, new computational and analytical research tools have emerged that are characterized by greater speed, specificity, accuracy, and effectiveness than ever before, and public genomics and genetic databases are filling up with larger and more complex datasets.⁷² Second, the public is now more aware than ever before of the potential applications and impacts of genomics in a number of influential areas (such as health, safety, food, and energy security), intensifying expectations and concerns about the practical consequences of these applications. Third, the international genomics research environment has become increasingly competitive, but the financial circumstances that shape the Canadian government's budgetary decisions have changed in recent years. Compounding this is that although the costs to generate genomics-related information have been on the decline, it ultimately remains a very expensive science to perform.^{73,74}

The evidence gathered for this evaluation points to the continued need to support genomics R&D within departments. What follows are some of the more salient reasons for this continued need, as presented in the literature and provided by key informants.

- Considerable ground was laid during the first phases of the Initiative, primarily in capacity-building and the support of preliminary or experimental research, a fact that was underscored in the 2006 formative evaluation of the GRDI.⁷⁵ The evidence from GRDI projects reviewed and interviews with key informants in this present evaluation indicates that the Government of Canada is now well positioned to see a return on this investment, as it is now in the critical stage of applying the knowledge that was gained to real problems, where the impacts and benefits are sure to accrue. The GRDI provided a much-needed framework for that foundational effort and continues to provide a context in which Canadians can view the importance and application of genomics research on a national scale. Key informants fear that, should the government's support of the GRDI end, this agenda would likely dissipate.

⁷² Organisation for Economic Co-operation and Development (OECD). (2009). *The Bioeconomy to 2030: Designing a Policy Agenda*.

⁷³ GRDI ADM Coordinating Committee. (2009, December). *Proposal for an integrative approach to address Canada's biological challenges in food, environment, energy and health: Strategic leadership through collaboration: Draft report*.

⁷⁴ US National Human Genome Research Institute. (2003). A vision for the future of genomics research: A blueprint for the genomic era. *Nature*, 422, 835-847.

⁷⁵ Performance Management Network Inc. (2006, December). *Horizontal evaluation of the Genomics R&D Initiative: Final report*.

- The evidence shows that the pace of genomics research is only going to accelerate, and that the technological and performance increases that have been seen are expected to continue for at least another 15 years.⁷⁶ A number of key informants stressed the fact that Canada cannot afford to miss out on the opportunity to excel in this area. Furthermore, they assert that keeping up-to-date with the latest genomics breakthroughs will ensure that Canada is able to use mandate-driven genomics research to address key national challenges (e.g., public health issue, aging populations, environmental threats, energy needs).
- Genomics R&D remains prohibitively expensive. Individual departments cannot feasibly carry out this research on their own and without additional support, and no other research groups will perform mandate-driven genomics research (see Section 5.1), so it is likely that discontinuing the GRDI would lead to the disappearance of these kinds of mandate-driven research projects. Relative to other countries, Canada has been a significant investor in genomics research: a 2008 study of public genomics R&D funding between 2003 and 2006⁷⁷ found that Canada ranked second in the world in its expenditures on genomics research (following the US and tied with the UK). Canada also ranked third in two other measures: public genomics research funding per capita and public genomics funding by GDP per country. In total, Canada supplied about 6% of total genomics research funding in 2006; this percentage increased over the period studied, as did its genomics intensity measures. Canada also ranked second in top countries for private genomics firms, after the US. However, some key informants expressed concern that given the more recent economic downturn and its effects on the funding climate in Canada, the government's level of commitment to funding genomics R&D has appeared to decline from that seen in the first years of the GRDI.
- Analyzing the influx of new genetic data effectively requires high-level technical skills and on-site expertise in these technologies, which some key informants stressed are not particularly easy to find. The GRDI has provided federal departments with essential leveraging capacity to get the required HQP, to allow them to work with state-of-the-art equipment and infrastructure, and to enable federal scientists to make significant contributions to the field. Canada was said to have an urgent need for even more HQP in the field and the GRDI was cited as a proven mechanism for this through its capacity-building agenda.
- The GRDI was also identified as an important mechanism for building networks of partnerships between scientists and users of R&D results in all sectors. In particular, external stakeholders noted the importance of the linkages created between the federal laboratories and universities, especially as private sector-academic partnerships are rare in genomics. Similarly, an external stakeholder from Europe noted that these types of government-university partnerships in genomics are not seen in Europe to the degree they are in Canada.

The new GRDI model envisioned in the draft Policy Framework⁷⁸ is all the more focused towards strategic priorities to better serve national economic and social goals. Integrated management of selected common functions is expected to provide the most efficient direction of resources, a key objective in the current economic context.

Finding 36 Although the last decade has seen many significant changes to the context in which the GRDI operates, none of these have diminished the relevance of the Initiative, and key informants strongly agree on the continued need for the program.

⁷⁶ Pohlhaus, J. R., & Cook-Deegan, R. M. (2008). *Genomics research: World survey of public funding* (BMC Genomics).

⁷⁷ Ibid.

⁷⁸ Interdepartmental Evaluation Working Group. (2008). *GRDI input to NRC DPR (2007-08): Updated 7 January 2008*.

6.2 Given the level of coordination, collaboration and integration of GRDI's R&D activities across departments, is there a continued need for this Initiative to be managed horizontally and delivered within select federal departments?

Summary: Yes. The success of the Initiative to date suggests that the existing horizontal structure has been effective at addressing both departmental and federal level genomics priorities. Key informants agreed that it is important to address departmental and federal needs and that the unique structure of the GRDI is effective at fulfilling this role. Furthermore, a horizontal management structure was said to enable the interdepartmental collaborations and sharing of resources that will be important to address federal level priorities. More effective mechanisms for communication between senior management and program level staff were identified as needed in order to support better interdepartmental collaboration, as well as the transparency and consistency of the management and delivery of the Initiative. The proposed Policy Framework highlights ways in which a coordination office could address these issues and underscores the need for the Initiative to continue to be managed in a horizontal manner.

The findings presented in this report demonstrate the overall success of, and continued need for, a federal genomics research program. Through the GRDI, investments in this area have enabled federal researchers to participate and contribute to genomics research in a way that has kept pace with developments in the field. GRDI-funded researchers have made significant contributions to the development and advancement of fundamental genomics research and are recognized as credible contributors to the field at the national and international level. Collaborators and users of the research generated from GRDI-funded projects are very satisfied with the results to date. GRDI researchers have generated significant contributions to the development and advancement of fundamental genomics research.

Phase III investments were said to have supported much more targeted research projects. According to this evaluation, the advancements made by GRDI researchers are now being focused on new and improved applications of this research towards more translational and commercially-oriented projects. Initial impacts are beginning to be seen on the regulatory and policy side but remain fairly limited due to the need for more research and acceptance/readiness within the receptor communities. Yet most internal and external stakeholders consulted stated that GRDI-funded research projects are now well positioned to capitalize on the knowledge and capacity that has been built. The research funded through GRDI is positioned to begin exhibiting increasingly more operational impacts as it moves from its proof of principle stage into a more translationally-oriented one.

Finding 37 The current, horizontally managed structure of the Initiative has enabled the creation of a core capacity (both human and technological) in many areas of applied genomics. The success of this Initiative is evident in the current and predicted impacts of GRDI-funded research.

As presented in Section 3.5, the primary advantage to the horizontal nature of the GRDI is the allocation of funding to support multiple departmental mandates. Key informants were very emphatic in their belief that the delivery of the program at the departmental level enables the development of strong, niche areas of research that would otherwise not be considered yet are of tremendous importance to Canada. The GRDI was said to represent the single most important mechanism in Canada through which mandate-driven R&D results in genomics can be generated. It was also noted that, in addition to demonstrating a strong link to individual departmental mandates, research supported by the GRDI is in clear alignment with the vision, principles, advantages and S&T priorities presented in the federal S&T strategy. The unique structure of this Initiative was said to be an important factor when considering many of the big picture issues facing Canadian society in the coming years. In some cases, research projects will need to leverage the individual expertise and capabilities present within many departments to solve issues related to health and environmental issues. However, interdepartmental delivery of projects is not necessarily suitable or necessary in all research areas and sectors.

Finding 38 The unique horizontal management and departmental delivery structure of the Initiative is positioned to provide the required mechanisms for supporting both departmentally-mandated research and multi-disciplinary, interdepartmental research projects.

Despite positive views of the existing management structure of the Initiative, areas were identified where improvements could be made in order to increase its overall efficacy and efficiency. Issues identified by internal stakeholders and project review interviewees centered on communication between senior management bodies and program level staff. In most cases, better communication of ongoing research projects among project participants (e.g., a central, web-based venue with a search function) was identified as one way in which better interdepartmental collaboration could be fostered. Additionally, better communication of the results and impacts generated from GRDI funded projects was also identified as a means by which management could increase the profile and visibility of the Initiative (e.g., online accessibility to annual performance reports). From the operational perspective, key informants identified a need for more effective communication of the overall strategic direction of the Initiative in order to promote more targeted alignment of research proposals with the GRDI objectives. Finally, the need for more timely and consistent communication regarding management aspects of the Initiative was identified. Specifically, they identified issues such as best practices, funding allocations, management guidelines, renewal decisions, evaluation outcomes and executive committee decisions. Effective communication to all departments and at all levels would ensure a more open and uniform approach to the delivery of the GRDI among departments. Key informants felt that improving these aspects would benefit the Initiative as a whole in that it would enable better alignment and integration of funded projects with the stated priorities.

Finding 39 More effective channels of communication between senior management of the Initiative and program-level staff are needed. Mechanisms such as online information centres for management protocols, Initiative news and ongoing activities could increase collaborative efforts, as well as the overall transparency and consistency of the management and delivery of the Initiative.

Many of the topics discussed above were also raised in the 2006 evaluation and have been under consideration by the WG and the ADM Coordinating Committee during the development of the new Policy Framework.⁷⁹ In most cases, recommendations to foster more interdisciplinary research projects have been addressed via the proposal to allocate specific funds in support of interdepartmental, targeted research towards federal priority areas. Projects that received these funds would be required to show how expertise and capabilities from multiple departments would be combined to address the identified strategic area. The Framework also recognizes the continued need for departmental level research that addresses the mandates of specific departments. Funding for projects that fall within these areas will also be allocated and distributed according to existing protocols and procedures. In addition to this, the Framework proposes a more centralized coordination office for the GRDI as a whole that would work to address the various communication issues that have been raised. This office would be responsible for, among other things, coordination and dissemination of all Initiative-related materials and information throughout the relevant communities.

Finding 40 The new Policy Framework proposed by the WG and the ADM Coordinating Committee—as it is currently written—will require the Initiative to continue to be managed horizontally and delivered within select federal departments.

⁷⁹ The fact that most key informants were unaware of or unclear about the Framework that is being developed/proposed further supports the need for a more uniform communications approach between the GRDI management and the program-level staff.

7.0 Conclusion and Recommendations

This evaluation finds that the GRDI as a whole is relevant and effective. In spite of the continued need and success of the Initiative, certain outstanding issues within its design and delivery should be addressed in order to ensure the long-term success of the Initiative. Recommendations are presented below with key supporting findings and additional considerations.

Recommendation 1: Develop opportunities to support specifically interdepartmental genomics R&D projects with shared resources in high profile priority areas.

Given the economic context and fixed resources available for research at this time, the support of such integrated projects should be small in scale in order to minimize the reduction of funds for ongoing departmental mandate-driven genomics R&D and to leverage the existing research programs and capacity and advancements of applications. In addition, the selection of high-profile areas of priority for Canada should build on existing complementary strengths, shared departmental priorities and strategic outcomes, and progress made by departments.

As per the following findings:

- The unique horizontal management and departmental delivery structure of the Initiative is positioned to provide the required mechanisms for supporting both departmentally-mandated research and multi-disciplinary, interdepartmental research project (Finding 38)
- GRDI-funded research has targeted areas identified as being strategic for Canada and, as such, has positioned genomics researchers to make contributions in these areas in the coming years. (Finding 11)
- As was also identified in the 2006 evaluation, this evaluation found that there is a continued need and opportunities for further interdepartmental R&D efforts.
- A lack of awareness of departmental genomics R&D/GRDI activities and capabilities was the main barrier to interdepartmental collaboration.
- The level of interdepartmental collaboration in projects supported by the GRDI in Phase III was fairly low. In these cases, scientists had a relationship with the collaborators before applying for GRDI funding. However, it has been recognized that the GRDI provided the mechanism to undertake an interdepartmental project or to facilitate interdepartmental collaborations. (Finding 28)
- There are mixed views as to the cost-effectiveness of the horizontal nature of the Initiative. It is recognized that in some research areas, true interdepartmental efforts would probably enhance resource use efficiency and research returns. However, some expressed concern that moving towards a more horizontal delivery approach will further limit the resources available from the GRDI for some departments (and would be detrimental to maintaining progress and capacity in niche areas). (Finding 29)
- The interdepartmental delivery of projects is not perceived to be suitable for all research areas and sectors. (Finding 30)
- Interdepartmental projects would be more effectively facilitated by building on existing R&D progress, capacity and complementarity of individual departments, as has been proposed in the new Policy Framework. In order to foster R&D outcomes (expected impacts), the top-down approach proposed for the selection of interdepartmental projects should balance between high profile areas of priority and existing complementary strengths and R&D progress.
- Ongoing efforts to increase collaboration and interaction between GRDI and Genome Canada management are reported to help mitigate duplication of effort and optimize complementarity. (Finding 21)
- GRDI investments are a valuable resource to be leveraged by those carrying out genomics R&D projects in the academic sector, and they position federal genomics expertise and facilities as key resources in a variety of genomics projects. (Finding 26)

- The coordination of genomic research activities and bringing together of individuals/groups from different departments, and from external organizations, with different expertise pools together existing strengths and optimizes resources; this maximizes both the efficiency and cost-effectiveness.

Recommendation 2: Should the Initiative be renewed, a significant proportion of the funding to individual departments should continue in order to build on the research capacity and expertise generated in their respective niche areas.

This continued support will allow the federal government to take full advantage of the demonstrated potential of genomics R&D in supporting departmental mandates and strategic objectives. Research funded through the GRDI is now well positioned to produce more operational impacts as it moves from the proof-of-principle stage into one more translationally oriented.

As per the following findings:

- The allocation of funding to the support of multiple department mandates constitutes the main added value of the horizontal nature of the Initiative. It enabled the federal government to establish genomics R&D capacity and to demonstrate its potential to address issues in several niche areas. (Finding 33)
- Continued support will allow the federal government to tap the demonstrated potential of genomics R&D in supporting departmental mandates and strategic objectives.
- The research funded through GRDI is positioned to begin exhibiting increasingly more operational impacts as it moves from its proof of principle stage into one that is more translationally oriented. (Finding 6)
- Based on projects reviewed, limited examples exist to date of how GRDI-funded research has had direct impacts in one or more of the three strategic areas (health, environment and competitiveness). However, the research is well aligned and positioned to impact these areas in the future. All project review interviewees are unanimous in their belief that such impacts lie not too far ahead for many projects. (Finding 10)
- Research supported by the GRDI—both in terms of project objectives and research results—is in clear alignment with the vision, principles, advantages, and S&T priorities presented in the federal S&T strategy, and it is also required to demonstrate a strong link to individual departmental mandates. (Finding 34)
- The GRDI represents the single most important mechanism in Canada through which mandate-driven R&D results in genomics can be generated. Stakeholders agree that the support of this kind of research is an appropriate and necessary role for the federal government. (Finding 35)

Recommendation 3: Should the Initiative be renewed, review the distribution of funding among participating departments and agencies.

According to results-based management principles, allocations should consider the current and potential level of activity, capacity and performance of mandate-driven genomics R&D conducted in participating departments (including the scientific excellence, progress and potential impact within their respective areas). This will support strategic results-based management and accountability as well as enhanced transparency in the allocation of funds.

As per the following findings:

- The GRDI has enabled federal researchers to participate in and contribute to genomics research in a way that has kept pace with developments in the field. Earlier investments in infrastructure and capacity building have positioned researchers in Phase III to begin applying these resources to more directed research projects. (Finding 1)
- Advancement in genomics science has revealed its potential for application and impact in multiple areas in which participating departments have exhibited distinctive scientific strengths and varying levels of capacity, performance and use of genomics to support their mandate over time.

- GRDI funding allocations to participating departments have remained unchanged since the inception of the Initiative in 1999.
- Preliminary evidence collected in the context of this evaluation suggests that the fixed departmental funding distribution established at the inception of the Initiative may not represent the current level of scientific advancement in genomics and the potential of mandate-driven research conducted across the departments. This evidence suggests that a review of funding allocations provided to departments could contribute to the overall cost-effectiveness of the Initiative. (Finding 27)
- This will support strategic results-based management and accountability as well as transparency in the allocation of funds.

Recommendation 4: Develop and implement a communication strategy to increase the visibility and profile of the Initiative (including the profile of funded genomics R&D, departmental capacity, progress and performance reporting/evaluations), both within and outside of federal departments and agencies.

This will increase awareness and facilitate opportunities for collaboration among stakeholders and other genomics initiatives at the federal, national and international levels. Importantly, this strategy should include specific means to increase levels of communication and exchange between GRDI stakeholders in participating departments (including current and potential GRDI-funded researchers, collaborators and users of R&D results).

As per the following findings:

- Responses from some external interviews suggest that the profile and visibility of the program could be better positioned within the Canadian landscape, particularly with regards to other genomics funding initiatives at the provincial level. (Finding 13)
- Internally to the Federal Government, a lack of awareness of departmental genomics R&D/GRDI activities and capabilities was the main barrier to interdepartmental collaboration.
- Very few of the consulted internal GRDI stakeholders had more than a cursory knowledge of the 2006 evaluation report and its recommendations or of the resulting management response/action plans, and none of the related documents have been widely disseminated to stakeholders in participating departments. (Finding 19)
- More effective channels of communication between senior management of the Initiative and program-level staff is needed. Mechanisms such as online information centres for management protocols, Initiative news and ongoing activities could increase collaborative efforts, as well as the overall transparency and consistency of the management and delivery of the Initiative. (Finding 39)
- Stakeholders have observed an overall lack of awareness about the Initiative and a particular need to better position itself in relation to other genomics funding and R&D initiatives in Canada and abroad.

Recommendation 5: Develop mechanisms that further integrate users of R&D results in all stages of genomics R&D projects' life cycles in order to ensure proper alignment of scientific progress with targeted potential uses and expected impacts (as outlined in the Logic Model).

Efforts should specifically be made to ensure effective interactions at the transfer and adoption phases in order to obtain feedback for continuous improvement and future development. The Initiative should consider the integration of dissemination and transfer plans in project proposals that identify the nature of user(s) involvement and expectations, as well as a knowledge transfer/translation strategy. This will allow the Initiative to increase its focus on the ultimate translation of R&D results.

As per the following findings:

- Effective communication between current and potential collaborators/users of the research results and the scientists involved in the project was identified as a key factor in ensuring that the needs and expectations of all parties are met. (Finding 8)
- A small proportion (13%) of the funds leveraged for GRDI projects (Phase III) were from sources external to the participating department. According to internal stakeholders, external contributions increased in Phase IV and are expected to grow as the potential of genomics is now better demonstrated. (Finding 25)
- Users of R&D were not systematically identified or integrated into the research process. A large portion of collaborators and users of R&D results consulted were engaged in the project only after its completion or were not engaged in the dissemination and transfer of R&D results stage of phase III projects. (Finding 9)
- As the GRDI expected outcomes requires the adoption and applications of genomics R&D results, it is important that the Initiative develop mechanisms to enhance continuity of user involvement in the context of long-term R&D projects.

Recommendation 6: Continue to improve the tracking and reporting of performance, specifically to ensure that reliable information on total departmental investments and expenditures related to GRDI is available and understood.

This would include data for all types of contributions that complement GRDI funding, which are collected and made available for ongoing performance management, reporting and evaluation processes. Participating departments should put in place processes to collect detailed financial profiles of GRDI-supported project/activities, including expenditures. In addition, the GRDI WG should work with participating departments to conduct a scan of the funding landscape for overall departmental genomics R&D activities in order to determine the materiality of the GRDI and the relative importance of genomics in departmental R&D activities. This will inform the review of the distribution of funding among participating departments (Recommendation 3) and could be done prior to each renewal of the Initiative.

As per the following findings:

- Of all of the recommendations from the 2006 evaluation of the GRDI to have since been addressed, the most significant achievement has been the development and implementation of a formal, common performance measurement approach and integrated annual performance reporting. (Finding 18)
- This evaluation mainly relied on funding figures and would have benefited from access to department-level financial data in order to produce a complete picture of the context in which the GRDI operates and determine the materiality of the Initiative (i.e., the relative importance of the GRDI funds to the total funds allocated to genomics R&D in each participating department).
- The 2006 evaluation recommended that departments make improved cost information available for this evaluation, which would allow conclusions to be drawn on the GRDI's cost-effectiveness. Departments have made progress in implementing methods for capturing costs. However, cost data (expenditures) were not readily available across all departments for the evaluation.
- Data on direct or indirect costs for the governance, management and delivery of the Initiative, both by coordinating groups and by department, were not readily available. This has prevented an assessment of the efficiency of the Initiative's current structure and the suggestion of potential alternatives or new approaches for the future of the Initiative.
- The 2006 evaluation also recommended that this evaluation address the issue of leveraging in a way that can

reliably conclude on the issue, and that departments put in place the required systems to meet the specific evaluation requirements in regards to data on leveraging (now outlined in the RMAF).

- According to GRDI Annual Performance Reports (2006-07 to 2008-09), GRDI investments were supplemented by resources from within departments or from other sources at a ratio of 1.5 times the GRDI investments (Finding 23)
- Internal stakeholders consulted during the planning and evaluation phases were critical of the validity of these leveraging data, as a measure of the extent to which GRDI investment has leveraged additional resources for GRDI projects.
- Neither the methods used to capture and report on leveraged resources for the Annual Performance Reports nor the background data on leveraging collected have been disclosed for the evaluation process.
- Detailed background data on leveraging from the annual report were not made available to the evaluation team, preventing the evaluation from addressing the leveraging issue comprehensively.
- Such complete financial profiles, data on leveraging and scan of the funding landscape for overall departmental genomics R&D activities will allow:
 - Reliable cost and effectiveness analysis
 - The estimation of the materiality of the GRDI funds to support the review of the distribution of funding among participating departments and agencies (Recommendation 3)

7.1 Management Response Action Plan

Evaluation Project: Evaluation of the Genomics R&D Initiative (GRDI)

Recommendation	Response	Planned Action(s)	Responsibility	Expected Date of Completion (M/D/Y)	Measure(s) of Achievement
<p>Recommendation 1: Develop opportunities to support specifically interdepartmental genomics R&D projects with shared resources in high profile priority areas.</p> <p>Given the economic context and fixed resources available for research at this time, the support of such integrated projects should be small in scale in order to minimize the reduction of funds for ongoing departmental mandate-driven genomics R&D and to leverage the existing research programs and capacity and advancements of applications. In addition, the selection of high-profile areas of priority for Canada should build on existing complementary strengths, shared departmental priorities and strategic outcomes, and progress made by departments.</p>	Accepted	<p>Phase V of the GRDI will include the launch of pilot interdepartmental projects with shared resources. The GRDI will target about 20% of its funds to these pilot projects.</p> <p>Approaches that encourage interdepartmental projects with shared resources will continue to be supported by the GRDI ADM Coordinating Committee.</p> <p>The selection of high-profile areas to be supported by shared resources will use decision-making criteria related to strategic opportunities and federal science and policy priorities, the unique role and leadership of government scientists, departments capacity and strengths, benefits from an integrated federal genomics R&D approach, and strong potential for collaboration and leverage with Canadian and international research providers.</p>	GRDI ADM Coordinating Committee with support from the Working Group	03/31/2011	Authority and funding provided to implement Phase V of the GRDI reflecting a realignment of 20% of existing resources towards interdepartmental projects along high profile shared priority areas and common goals.

Recommendation	Response	Planned Action(s)	Responsibility	Expected Date of Completion (M/D/Y)	Measure(s) of Achievement
<p>Recommendation 2: Should the Initiative be renewed, a significant proportion of the funding to individual departments should continue in order to build on the research capacity and expertise generated in their respective niche areas.</p> <p>This continued support will allow the federal government to take full advantage of the demonstrated potential of genomics R&D in supporting departmental mandates and strategic objectives. Research funded through the GRDI is now well positioned to produce more operational impacts as it moves from the proof-of-principle stage into one more translationally oriented.</p>	Accepted	<p>While Phase V of the GRDI is being realigned to support interdepartmental projects, 80% of the funds will support individual departmental/agency priorities and mandates through predetermined allocations.</p> <p>In addition, some of the mandated research projects are performed in collaboration or partnership with other government departments/agencies, which aligns with recommendation 1.</p>	GRDI ADM Coordinating Committee with support from the Working Group	03/31/2011	Authority and funding provided to implement Phase V of the GRDI reflecting continued allocation of a significant proportion of funds, (i.e. 80%) to individual departments to support their priorities and core mandates
<p>Recommendation 3: Should the Initiative be renewed, review the distribution of funding among participating departments and agencies.</p> <p>According to results-based management principles,</p>	Accepted	Within the limitations of using the existing GRDI funding level for Phase V of the GRDI, a shared priorities fund will be built from departments on a pro-rata basis of their allocations, meaning that departments receiving the highest share of	GRDI ADM Coordinating Committee with support from the Working Group and NRC Coordination	03/31/2011	Authority and funding provided to implement Phase V of the GRDI reflecting a redistribution of funds among participating

Recommendation	Response	Planned Action(s)	Responsibility	Expected Date of Completion (M/D/Y)	Measure(s) of Achievement
allocations should consider the current and potential level of activity, capacity and performance of mandate-driven genomics R&D conducted in participating departments (including the scientific excellence, progress and potential impact within their respective areas). This will support strategic results-based management and accountability as well as transparency in the allocation of funds.		the funds will also contribute the most. These funds will then be redistributed among participating departments to reflect their level of activity in shared priority projects. Recognizing the importance of their regulatory role, the CFIA will have the opportunity to participate in the shared priority projects.	Function		departments relating to shared priority interdepartmental projects in the amount of 20% of total funding.
		When seeking authority to implement the new GRDI framework for 2014 onwards, departments and agencies will be in a position to fully address this recommendation. Departmental business cases will form the key driver for determining the distribution of funding among participating departments to support core mandated research. The business cases already developed will be updated to reflect current priorities, level of activity, capacity and performance, and will be augmented to include consideration of support to genomics expenditures in each	GRDI ADM Coordinating Committee with support from the Working Group	03/31/2014	Authority and funding provided to implement the new GRDI framework reflecting new, rebalanced distribution of funding among participating departments.

Recommendation	Response	Planned Action(s)	Responsibility	Expected Date of Completion (M/D/Y)	Measure(s) of Achievement
		department.			
Recommendation 4: Develop and implement a communication strategy to increase the visibility and profile of the Initiative (including the profile of funded genomics R&D, departmental capacity, progress and performance reporting/evaluations), both within and outside of federal departments and agencies. This will increase awareness and facilitate opportunities for collaboration among stakeholders and other genomics initiatives at the federal, national and international levels. Importantly, this strategy should include specific means to increase levels of communication and exchange between GRDI stakeholders in participating departments (including current and potential GRDI-funded researchers, collaborators and users of R&D results).	Accepted	Communications activities at the corporate GRDI level require dedicated resources. While some activities are currently undertaken (detailed integrated GRDI annual progress reports, the development of a web site for the GRDI), they are currently limited. Phase V of the GRDI proposes that NRC's Coordination Office support the GRDI to manage interdepartmental projects and initiative-level activities, including the development and implementation of a communications strategy for the GRDI. The NRC Coordination Function will work with individual departments/ agencies to encourage them to promote GRDI when opportunities arise.	GRDI ADM Coordinating Committee with support from the Working Group and NRC Coordination Function	03/31/2012	Communications strategy developed for the GRDI.
				03/31/2014	GRDI communications strategy implemented as evidenced by availability of Annual Performance Reports on GRDI web site, as well as other information posted such as profiles of departmental GRDI programs, program-specific success stories, etc. Information is shared with stakeholders.

Recommendation	Response	Planned Action(s)	Responsibility	Expected Date of Completion (M/D/Y)	Measure(s) of Achievement
<p>Recommendation 5: Develop mechanisms that further integrate users of R&D results in all stages of genomics R&D projects' life cycles in order to ensure proper alignment of scientific progress with targeted potential uses and expected impacts (as outlined in the Logic Model).</p> <p>Efforts should specifically be made to ensure effective interactions at the transfer and adoption phases in order to obtain feedback for continuous improvement and future development. The Initiative should consider the integration of dissemination and transfer plans in project proposals that identify the nature of user(s) involvement and expectations, as well as a knowledge transfer/translation strategy. This will allow the Initiative to increase its focus on the ultimate translation of R&D results.</p>	Accepted	<p>Stakeholder engagement is already integrated in the project proposal templates and decision criteria of some GRDI departments. The GRDI Working Group will assess best practices and will develop guiding principles to support the integration of users of R&D results throughout the projects life cycles. This will include the development of dissemination and transfer plans, in the strategic and project planning activities of all participating departments.</p> <p>The communication strategy developed to address Recommendation 4 will also raise users of R&D results awareness of GRDI. This increased awareness should provide for more effective interactions leading to knowledge transfers and translation of R&D results.</p>	GRDI Working Group and NRC Coordination Function	03/31/2011	Guiding principles developed and used to integrate users of R&D results in strategic and project planning activities

Recommendation	Response	Planned Action(s)	Responsibility	Expected Date of Completion (M/D/Y)	Measure(s) of Achievement
Recommendation 6: Continue to improve the tracking and reporting of performance, specifically to ensure that reliable information on total departmental investments and expenditures related to GRDI is available and understood. This would include data for all types of contributions that complement GRDI funding, which are collected and made available for ongoing performance management, reporting and evaluation processes. Participating departments should put in place processes to collect detailed financial profiles of GRDI-supported project/activities, including expenditures. In addition, the GRDI WG should work with participating departments to conduct a scan of the funding landscape for overall departmental genomics R&D activities in order to determine the materiality of the GRDI and the relative importance of genomics in departmental R&D activities. This will inform the review of the distribution of funding among	Partially accepted	A new Performance Measurement Strategy will be developed and implemented for the GRDI that will clearly identify accountabilities and reporting requirements. These requirements will capture leveraging information related to GRDI projects.	GRDI Working Group	03/31/2011	Performance Measurement Strategy developed for the GRDI
				08/31/2012	Performance Measurement Strategy (PMS) implemented. PMS used as guide for development of Annual Performance Report (2011-12) with new performance and financial information provided.
		To the extent possible, these requirements will also capture other genomics-related activities that are not supported by the GRDI, based on existing individual department systems. However, genomics activities are often treated as an embedded tool in many program areas and are thus not identified for tracking or reporting	GRDI Working Group	08/31/2013	An ad-hoc report will be prepared for the ADM Coordinating Committee that will provide, to the extent possible, an indication of the importance of genomics-related

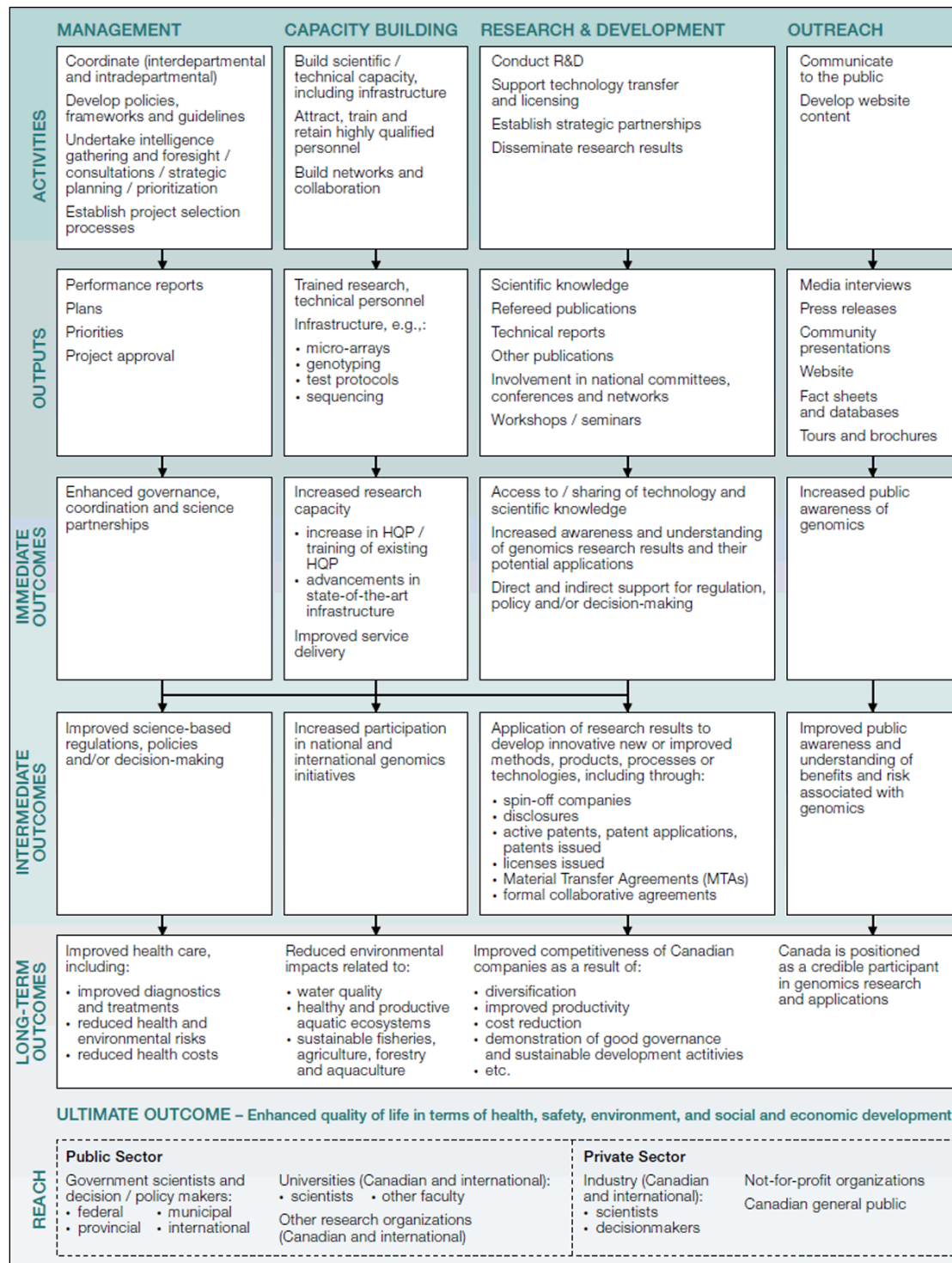
Recommendation	Response	Planned Action(s)	Responsibility	Expected Date of Completion (M/D/Y)	Measure(s) of Achievement
participating departments (Recommendation 3) and could be done prior to each renewal of the Initiative.		purposes. Detailed financial profiles of non-GRDI genomics activities are thus expected to be difficult to obtain. Moreover, this information falls outside the scope of GRDI management and performance measurement activities.			activities in departments relative to their total R&D activities.

Appendix A – Abbreviations

AAFC	Agriculture and Agri-Food Canada
A-base	Funding for ongoing activities received annually to operate (includes salary, benefits and operating)
ADM	Assistant Deputy Minister
APR	Annual Performance Report
CFIA	Canadian Food Inspection Agency
CIHR	Canadian Institutes of Health Research
EC	Environment Canada
DFO	Fisheries and Oceans Canada
GHI	Genomics and Health Initiatives
GRDI	Genomics Research and Development (R&D) Initiative
HC	Health Canada
HQP	Highly Qualified Personnel
IEWG	GRDI Interdepartmental Evaluation Working Group
NCE	National Centres of Excellence
NRC	National Research Council Canada
NRC-GHI	NRC Genomics and Health Initiative
NRC-SDB	NRC Strategy and Development Branch
NRC-SDB-PPM	NRC-SDB Planning and Performance Management
NRCan	National Resources Canada
NRCan-CFS	NRCan Canadian Forest Service
NSERC	Natural Sciences and Engineering Research Council of Canada
PAA	Program Activity Architecture
PHAC	Public Health Agency of Canada
R&D	Research and Development
RMAF	Results-based Management and Accountability Framework
S&T	Science and Technology
TBS	Treasury Board of Canada Secretariat
WG	GRDI Interdepartmental Working Group
WoS	Web of Science

Appendix B – GRDI Logic Model

Figure 5 GRDI logic model



Source: GRDI Annual Performance Report 2008-2009 (from the GRDI RMAF 2006-2007)

Appendix C – Detailed Evaluation Approach and Methods

This section describes the overall evaluation approach (Section C.1) and provides, in addition to the information provided in the Sections 1.4 and 1.5, details on the data collection and analytical methods used in the present evaluation (Section C.2).

C.1 Overall Approach and Design

Planning phase (prior to the evaluation study): The approach for this evaluation was developed by Science-Metrix during the GRDI planning phase, through a collaborative process with NRC-SDB-PPM and the IEWG. The planning phase spanned over a period of two months, from February to March 2010.

The planning phase involved interviews with IEWG members (11 program staff and 5 evaluation staff from the seven participating departments/agency), two interviews with external stakeholders and a review of available documents and data/information. The interviews were designed to gather information and views on: the GRDI's context and activities, methodological options for the evaluation, associated challenges, and evaluation reporting needs. The development of the evaluation framework and associated level of effort were also guided by a risk assessment.

The results of the planning process were presented to the IEWG for feedback. The proposed planning, evaluation approach and design resulting from the planning phase were approved by the IEWG.

Evaluation study: The approach used for this evaluation study had four planned phases (Figure 6). The data gathering phase (Phase I; not shown in Figure 6) entailed the preparatory work conducted by NRC-SDB-PPM and the IEWG to collect specific administrative data and R&D project-level information needed for the design and implementation of the multiple embedded project reviews and the impact survey of stakeholders, as well as the identification of potential key informants.

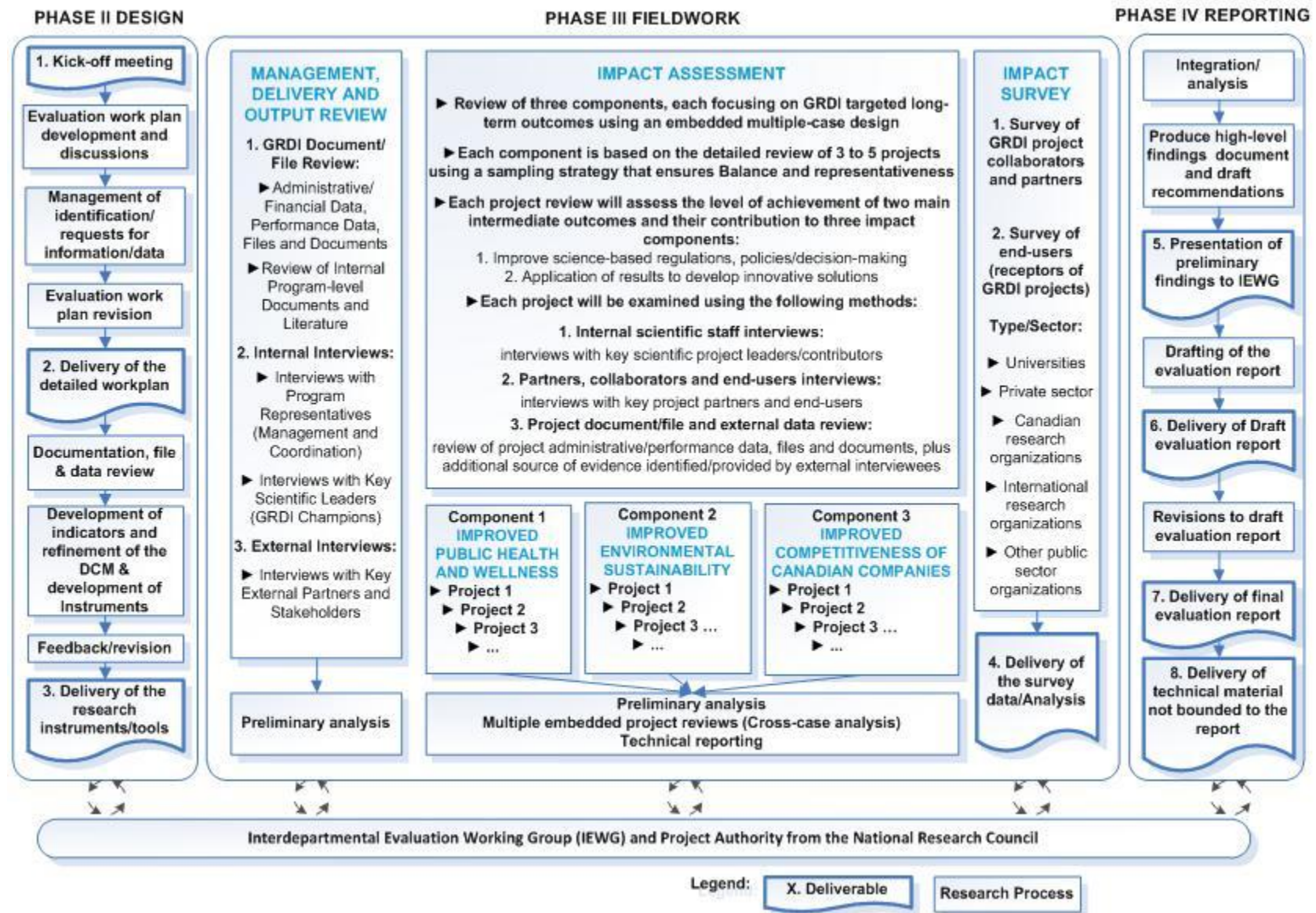
The design phase (Phase II) included: the refinement of the evaluation work plan and framework, (including an articulation of ethical practices, and detailed communication and risk management plans), the development of evaluation tools, the final selection of project reviews and interviewees, and the validation of the list of potential web survey respondents. Additional relevant documents and data were also collected during this phase. Approval of the final evaluation framework and tools initiated Phase III – the implementation of the evaluation protocol (e.g., fieldwork) and technical reporting. Analysis, integration and reporting of evaluation findings constituted the last phase of the study (Phase IV).

The evaluation study was conducted by a mixed team of evaluators from Science-Metrix and NRC-SDB-PPM. The evaluation study spanned over seven months, from July 2010 to January 2011.

This evaluation used multiple indicators and lines of evidence to address the five core evaluation issues and 15 evaluation questions (Table 2):

- document/file/literature review (including review and analysis of administrative data and external literature)
- interviews of internal and external stakeholders (a total of 57 interviews)
- web surveys (a total of 117 respondents)
- reviews of R&D projects supported by the GRDI (a total of 15 projects)

Figure 6 Evaluation approach overview: phases, processes and deliverables



C.2 Data Collection Methods

Method 1: Management, delivery and output review

Two data collection methods were used as part of the management, delivery and output review:

1. Document/file/literature review: The review of documents, secondary literature, files, and data included:

- GRDI administrative documents, files and data, including information provided by GRDI-participating departments
- GRDI governance-related documentation, including the terms of reference and policy documents, and GRDI WG and IEWG meeting minutes
- GRDI performance data/reports, reviews and past GRDI evaluations, and other documented R&D outputs
- Departmental performance data and reports, including available case studies
- Bibliometric assessment of the scientific output of federal scientists supported by the GRDI
- Canadian and international literature on genomics R&D and biotechnology sectors
- Data on all R&D projects supported by the GRDI during Phase 3 (description, financial profile, information internal participants, collaborators and users of R&D results)

2. Stakeholder interviews: A total of 15 telephone-based interviews were conducted with internal stakeholders involved in the management/coordination of GRDI and genomics R&D and with external stakeholders who were knowledgeable about genomics R&D in the Canadian/international context and about genomics R&D in GRDI-participating federal departments. The distribution of the 15 interviews by position type and organization is shown in Table 15.

Table 15 Distribution of stakeholder interviews by position and organization

	AAFC	DFO	EC	HC	NRC	NRCan	Industry	University	Research Funding Organization
Management					3	1	2		3
Scientists/researchers	1	1	1	1				2	

Internal interviewees provided qualitative information on the perceptions and opinions of individuals who have a significant role in the governance, design and delivery of the GRDI. Data collected during these interviews helped to address specific questions related to all of the main evaluation issues, most particularly those relating to Efficiency and Economy.

Potential external interviewees were identified in collaboration with the Project Authority and members of the IEWG. It should be noted that these interviewees exclude the additional departmental staff and stakeholder interviews conducted as part of the project reviews (see Method 2).

External interviewees provided valuable insight into the genomics R&D environment in Canada and abroad, as well as on the efficiency of the design and delivery of the GRDI in the Canadian context. The selection criteria included an understanding of the genomics R&D in Canada and abroad and knowledge of the GRDI so that external interviewees could provide an informed view on alternative design or delivery mechanisms. However, to assure neutrality and objectivity, the external interviewees selected had experienced limited direct involvement with funded R&D

activities as a partner/collaborator; note that the R&D partners/collaborators and direct beneficiaries were consulted using a web survey questionnaire (see Method 3). Thus, importantly, these stakeholders provided an external, non-vested interest view on the GRDI.

Method 2: Impact assessment, using multiple embedded project/program reviews

In keeping with the evaluation's focus on performance, the project reviews examined the success of the GRDI by assessing the extent to which the three targeted intermediate outcomes (as presented in the logic model, Figure 5) have been achieved. Furthermore, the evaluation strived to capture the contribution of intermediate achievements to longer-term outcomes, even if, given the level of maturity and nature of research projects under review, only early benefits or changes are likely to have occurred at the time of the evaluation fieldwork. Given the limited time and resources available for the evaluation, an impact assessment using multiple, embedded project reviews⁸⁰ was designed to focus on the first and third intermediate outcomes:

- **R&D Outcome A:** Improve science-based regulations, policies and/or decision making; and
- **R&D Outcome B:** Apply results to develop innovative new or improved methods, products, processes or technologies.

This assessment indicated how the achievement of these two main intermediate outcomes contributed to the GRDI's targeted longer-term outcomes, namely improved health care (component 1), reduced environmental impacts (component 2) and improved competitiveness of Canadian companies (component 3). Using an embedded approach, the assessment helped to determine the level of uptake of new or improved science-based regulations, policies and decision-making, as well as R&D applications, and thus identify which changes and benefits occurred as a result in each of the components (Figure 7):

- **Component 1:** Improved health care (including diagnostics and treatments; reduced health and environmental risks; and reduced health costs);
- **Component 2:** Reduced environmental impacts (related to water quality; healthy and productive aquatic ecosystems; sustainable fisheries, agriculture, forestry and aquaculture);
- **Component 3:** Improved competitiveness of Canadian companies (as a result of diversification, improved productivity, cost reduction, demonstration of good governance and sustainable development activities, etc.).

Figure 7 Illustration of the embedded project review approach

R&D Outcome	Impact Component		
	1. Improved health care	2. Reduced environmental impacts	3. Improved competitiveness of Canadian companies
A. Improve science-based regulations, policies and/or decision-making	●	●	●
B. Apply results to develop innovative new or improved methods, products, process or technologies	●	●	●

⁸⁰ See i) Yin R. K. *Case Study Research – Design and Methods*. Sage Publications, Thousand Oaks: London, Third Edition, 2003, and ii) Scholz R.W. and Tietje O. *Embedded Case Methods – Integrating quantitative and qualitative knowledge*. Sage Publications, Thousand Oaks: London, Third Edition, 2002.

Selection of genomics R&D projects/activities: To validate the preliminary selection of projects (including back-up projects), Science-Metrix consulted with the Project Authority and members of the IEWG. Project/activity-level data were collected and used to develop and refine this method and, importantly, to select R&D projects for detailed review. A total of 15 genomics R&D projects were selected and distributed using the following approach:

- **Step 1.** Exclusion of projects where the GRDI represents less than 40%⁸¹ of the total project costs
- **Step 2.** Determination of the number of projects by main criteria to obtain a distribution that is as much as possible representative of the total number of GRDI-funded projects:
 - ✓ Criteria 1. Links with previous phases
 - ✓ Criteria 2. R&D outcome (2 categories)
 - ✓ Criteria 3. Impact component (3 categories)
 - ✓ Criteria 4. Total project costs (Under \$249,000; \$250,000 to \$999,999; and \$1M and over)
 - ✓ Criteria 5. Distribution of projects across participating departments/agencies (the final selection of projects needed to match with the relative importance of the GRDI funding allocated to participating departments/agencies in Phase 3)
- **Step 3.** Semi-random selection of project to obtain desired criteria-based selection (criteria were transformed into logic constraints that were then evaluated against samples of 15 projects).

The final distribution of the 15 projects selected using this approach is shown in Table 16.

Table 16 Distribution of the 15 R&D projects reviewed for the impact assessment

Project ID	Criteria 1 Links with previous phase	Criteria 2 Outcome type	Criteria 3 Impact component	Criteria 4 Total Project Cost	Criteria 5 Dept'l Distribution
1	No	B	3	Under \$249,000	AAFC
2	No	B	1/3	Under \$249,000	AAFC
3	No	B	1/3	Under \$249,000	AAFC
4	Yes	B	2	\$250,000 to \$999,999	DFO
5	No	A/B	2/3	\$250,000 to \$999,999	DFO
6	No	A	2	Under \$249,000	EC
7	Yes	A/B	2	\$250,000 to \$999,999	EC
8	Yes	A	1	Over \$1 Million	HC
9	Yes	A/B	1/2	Over \$1 Million	HC
10	Yes	B	2/3	Over \$1 Million	NRC
11	Yes	B	1/3	Over \$1 Million	NRC
12	Yes	B	1,3	Over \$1 Million	NRC
13	Yes	B	2	\$250,000 to \$999,999	NRCan
14	No	A, B	2	\$250,000 to \$999,999	NRCan
15	Yes	B	1	Over \$1 Million	PHAC

⁸¹ After the first round of selection, this threshold was reduced to 25-30% to account for the contribution of the GRDI funding to the total project value in specific departments.

The project selection was designed to be transparent and objective. Recommendations for adding to or removing projects from the preliminary selection were carefully considered, debated and documented. The goal was not to select and review known success stories, but rather to review a representative sample of projects to determine the strengths and weaknesses of funded genomics R&D. As R&D is not a linear process and involves a certain level of uncertainty and risk, Science-Metrix strongly believes that the review of less successful projects (in terms of outputs or impacts) provided an invaluable and more balanced perspective to the multiple project reviews, and to the evaluation findings more generally.

Data collection and analytical method: Data collection for the project reviews case consisted of a review of project files/documents and a total of 52 interviews with principal investigators and co-investigators (17) and with project collaborators and users of R&D results (25). Principal investigators were contacted first i) to confirm their participation, ii) to identify collaborators and users of R&D results for interviews and iii) to obtain project files, data and documentation. Telephone interviews were then conducted separately with principal investigators and with collaborators and/or users of R&D results. All data were integrated and analyzed per project, after which a cross-project analysis was performed to provide evidence both on project delivery and on the level of impact for each main R&D outcome and impact components (as illustrated in Figure 7).

Method 3: Impact survey of end-users and research partners

While the project reviews provided detailed evidence on achievements and impacts for a selection of 15 genomics R&D projects, the survey of collaborators and end-users provided additional evidence on a wider range of changes and benefits that relate to GRDI's expected outcomes. This web survey, which provided a rich source of external feedback for most genomics R&D projects (Phase 3) performed in collaboration with GRDI-supported scientists from each department, was intended to compensate for the limited external consultation during the 2006 evaluation.

To increase the survey's participation rate, the NRC sent advance notification letters by e-mail to potential survey respondents. This process was useful to validate e-mail addresses and identify potential changes (i.e., e-mail address changes) in the target survey population. All potential respondents with valid emails were contacted through electronic invitations and provided with a unique identifier required to log in to the survey using a secure access. This identifier was also used to send reminders to non-respondents after the initial invitation. As a number potential respondents acted as a collaborator or user for more than one project, this unique identifier was also used to seed the survey with relevant project titles: respondents were invited to select one project from a drop-down list and refer to the selected project in their answers.

A generic questionnaire—applicable to all departments, types of projects and organizations—was designed, pre-tested and administered. The survey was launched on August 25, 2010 and closed on September 15, 2010. Two reminders were sent to non-respondents at weekly intervals. The average completion time for the web survey was 34 minutes. The sample distribution is presented in Table 17.

Table 17 Web survey sample disposition

Sample Disposition	#
Number of e-mails obtained/collected (a)*	295
Number of bounced e-mails/e-mails removed (b)**	17
Number of valid e-mails (c)	278
Number of bounced e-mails/unreached potential respondents (d)***	2
Valid survey population (N): Number of potential survey respondents (e=c-d)	276
Completed (f)****	117
Valid response rate (f / d) †	42.4%
Margin of error‡	6.91%

Notes: * Integrated list of e-mails collected by individual departments/agencies; ** E-mails removed mainly because recipient's e-mail address was not found in the recipient's e-mail system during the notification electronic process. Additional unreachable e-mail addresses. **** Some respondents started answering the survey without completing it. Only those who answered more than 75% of the questions were kept in the sample (n=1). † Valid response rate = Number of completed surveys, divided by the total valid sample population (N), which excludes unreachable potential respondents during notification and the first invitation processes. ‡ Calculated for a response distribution of 50% (i.e., 50% yes/50% no); 95% confidence level (19 times out of 20).

Appendix D – Summary of Findings

Finding 1	The GRDI has enabled federal researchers to participate in and contribute to genomics research in a way that has kept pace with developments in the field. Earlier investments in infrastructure and capacity building have positioned researchers in Phase III to begin applying these resources to more directed research projects.....	26
Finding 2	GRDI-funded researchers have made significant contributions to the development and advancement of fundamental genomics research. These advances have led to new and improved applications of this research towards more translational and commercially-oriented projects. Initial impacts are beginning to be seen on the regulatory and policy side, but remain fairly limited.....	27
Finding 3	Direct application of GRDI research results is limited by several factors. First, most applications remain at the proof of concept stage and are only now reaching a point where translational impacts are possible. Second, timelines for implementation (particularly in the regulatory domain) can be very long.	28
Finding 4	Based on projects reviewed, GRDI-funded research is too early in its development to have resulted in a large number of operational changes or benefits. However, some examples do exist that demonstrate the progression of GRDI research to the point where it could be translated and applied at the regulatory level.....	30
Finding 5	Results from GRDI-funded projects have been disseminated and used by other researchers both within and outside of the federal government in the advancement of their own projects and objectives. Examples of this include protocols, experimental processes/tools and scientific findings.....	30
Finding 6	The research funded through GRDI is positioned to begin exhibiting increasingly more operational impacts as it moves from its proof of principle stage into one that is more translationally oriented.	30
Finding 7	Collaborators and users of the R&D results generated from GRDI funded projects are very satisfied with how the projects have addressed and satisfied their needs. The overall structure and objectives of the program were credited with fostering a strong alignment between the scientific and organizational needs of the two groups.....	31
Finding 8	Effective communication between current and potential collaborators, users of the R&D results and the scientists involved in the project was identified as a key factor in ensuring that the needs and expectations of all parties are met.....	32
Finding 9	Users of R&D were not systematically identified or integrated into the research process. A large portion of collaborators and users of R&D results consulted were engaged in the project only after its completion or were not engaged in the dissemination and transfer of R&D results stage of phase III projects.	33
Finding 10	Based on projects reviewed, limited examples exist to date of how GRDI-funded research has had direct impacts in one or more of the three strategic areas (health, environment and competitiveness). However, the research is well aligned and positioned to impact these areas in the future. All project review interviewees are unanimous in their belief that such impacts lie not too far ahead for many projects.....	34
Finding 11	GRDI-funded research has targeted areas identified as being strategic for Canada and, as such, has positioned genomics researchers to make contributions in these areas in the upcoming years.	34
Finding 12	All lines of evidence show that GRDI-funded researchers are recognized as leaders in their field and important contributors to the national and international knowledge base. Researchers are regular participants in national and international conferences, serve on advisory committees, sit as invited members on international regulatory boards/committees and are routinely invited to present the results of their findings to other organizations.	35
Finding 13	Responses from some external interviews suggest that the profile and visibility of the program could be enhanced within the Canadian landscape, particularly with regards to other genomics funding initiatives at the provincial level.....	35

Finding 14	Bibliometric analyses show that GRDI-funded researchers outperform their Canadian counterparts in terms of scientific impact, both within and outside of the federal sector.	36
Finding 15	According to recent bibliometric analyses, the funding provided through the GRDI had a positive effect on the intramural research capacity of the federal government in genomics, which is the core objective of the GRDI.	37
Finding 16	Both quantitative and qualitative data show that the funding provided by the Initiative is responsible for the positioning of federal genomics researchers as credible contributors to the field at the national and international levels.	38
Finding 17	The majority of the recommendations from the 2006 evaluation of the GRDI have been considered through the development of a new Policy Framework to be proposed for the next renewal of the GRDI and therefore have not impacted the delivery and performance of the Initiative to date.	40
Finding 18	Of all of the recommendations from the 2006 evaluation of the GRDI to have since been addressed, the most significant achievement has been the development and implementation of a formal, common performance measurement approach and integrated annual performance reporting.	41
Finding 19	Very few of the consulted internal GRDI stakeholders had more than a cursory knowledge of the 2006 evaluation report and its recommendations or of the resulting management response/action plans, and none of the related documents have been widely disseminated to stakeholders in participating departments.	42
Finding 20	The competitive process used by participating departments to select GRDI-funded R&D projects, which is reliant on a combination of peer-review (internal and external to the federal government) and senior management decisions, is the main mechanism for managing and limiting any duplication of effort.	43
Finding 21	Ongoing efforts to increase collaboration and interaction between GRDI and Genome Canada management are reported to help mitigate duplication of effort and optimize complementarity.	45
Finding 22	Stakeholders are largely satisfied with GRDI management processes and believe that efforts to increase program efficiency have been successful. Factors inhibiting the efficiency of the Initiative varied by department (no initiative-wide guidelines pertain to the use of funds). Some examples included: the inability to use GRDI funds for salary support, lack of communication between program management and departmental staff, and uncertainty associated with continuity of program funding.	49
Finding 23	According to GRDI Annual Performance Reports (2006-07 to 2008-09), GRDI investments were supplemented by resources from within departments or from other sources at a ratio of 1.5 times the GRDI investments.	50
Finding 24	Internal contributions that complemented the GRDI funds corresponded to an average of one-third of the total project value (Phase III). A number of projects relied greatly on GRDI investments to support genomics R&D projects designated as part of the Initiative.	51
Finding 25	A small proportion (16%) of the funds leveraged for GRDI projects (Phase III) were from sources external to the participating department. According to internal stakeholders, external contributions increased in Phase IV and are expected to grow as the potential of genomics is now better demonstrated.	51
Finding 26	GRDI investments are a valuable resource to be leveraged by those carrying out genomics R&D projects in the academic sector, and they position federal genomics expertise and facilities as key resources in a variety of genomics projects. Leveraging data would be more useful if there were consistent understanding and approaches for collecting leverage information across participating departments and agencies.	52
Finding 27	Preliminary evidence collected in the context of this evaluation suggests that the fixed departmental funding distribution established at the inception of the Initiative may not represent the current level of scientific advancement in genomics and the potential of mandate-driven research conducted across the departments. This evidence suggests that a review of funding allocations provided to departments could contribute to the overall cost-effectiveness of the Initiative.	53

Finding 28	The level of interdepartmental collaboration in projects supported by the GRDI in Phase III was fairly low. In these cases, scientists had a relationship with the collaborators before applying for GRDI funding. However, it has been recognized that the GRDI provided the mechanism to undertake an interdepartmental project or to facilitate interdepartmental collaborations.	55
Finding 29	There are mixed views as to the cost-effectiveness of the horizontal nature of the Initiative. It is recognized that in some research areas, true interdepartmental efforts would probably enhance resource use efficiency and research returns. However, some are concerned that moving towards a more horizontal delivery approach will further limit the resources available from the GRDI for some departments.	55
Finding 30	The interdepartmental delivery of projects is not perceived to be suitable for all research areas and sectors.	56
Finding 31	The cost-effectiveness of R&D projects is perceived to be high by a large proportion of collaborators and users of R&D results involved in Phase III projects.	57
Finding 32	The value generated by genomics R&D projects relative to the GRDI investment is significant.	58
Finding 33	The provision of funding to the support of multiple department mandates constitutes the main added value of the horizontal nature of the Initiative. It enabled the federal government to establish genomics R&D capacity and to demonstrate its potential to address issues in niche areas.	58
Finding 34	Research supported by the GRDI—both in terms of project objectives and research results—is in clear alignment with the vision, principles, advantages, and S&T priorities presented in the federal S&T strategy, and it is also required to demonstrate a strong link to individual departmental mandates.	61
Finding 35	The GRDI represents the single most important mechanism in Canada through which mandate-driven R&D results in genomics can be generated. Key informants agree that this sort of Initiative is an appropriate and necessary role for the federal government.	63
Finding 36	Although the last decade has seen many significant changes to the context in which the GRDI operates, none of these have diminished the relevance of the Initiative, and key informants strongly agree on the continued need for the program.	65
Finding 37	The current, horizontally managed structure of the Initiative has enabled the creation of a core capacity (both human and technological) in many areas of applied genomics. The success of this Initiative is evident in the current and predicted impacts of GRDI-funded research.	66
Finding 38	The unique horizontal management and departmental delivery structure of the Initiative is positioned to provide the required mechanisms for supporting both departmentally-mandated research and multi-disciplinary, interdepartmental research projects.	67
Finding 39	More effective channels of communication between senior management of the Initiative and program-level staff are needed. Mechanisms such as online information centres for management protocols, Initiative news and ongoing activities could increase collaborative efforts, as well as the overall transparency and consistency of the management and delivery of the Initiative.	67
Finding 40	The new Policy Framework proposed by the WG and the ADM Coordinating Committee—as it is currently written—will require the Initiative to continue to be managed horizontally and delivered within select federal departments.	67