EVALUATING RESULTS

Annual Report

2006-2007

Chemical, Biological, Radiological-Nuclear and Explosives Research and Technology Initiative

Defence Research and Development Canada
Recherche et développement pour la défense Canada

Canada

THE **MISSION** OF CRTI IS TO STRENGTHEN CANADA'S PREPAREDNESS, PREVENTION, AND RESPONSE TO CBRN TERRORIST ATTACKS THROUGH SCIENCE AND TECHNOLOGY.

OUR **VISION** IS TO BE RECOGNIZED AS THE CANADIAN AUTHORITY IN CBRN COUNTERTERRORISM KNOWLEDGE, EXPERTISE, AND SCIENCE AND TECHNOLOGY.

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LETTER FROM THE **DIRECTOR GENERAL**

The fiscal year 2006–2007 marked the end of the original five-year mandate of the Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI). Many of the past year's activities concentrated on the program's renewal through a process of reflecting on the experience of the previous four years and planning for its future directions.

CRTI continued in 2006–2007 to support security-focused science and technology (S&T), investing $15 million dollars in new Research and Technology Development (RD), Technology Acceleration (TA), and Technology Demonstration (TD) projects, as well as $1.2 million dollars in technology acquisitions for federal laboratories. These figures bring the total invested by the program in its first mandate to $123 million in S&T projects and $28.7 million in technology acquisitions. The internationally recognized significance of the S&T research that CRTI has supported and technology acquisitions it has funded clearly demonstrates that CRTI has played an essential role in establishing Canada's security S&T capacity.

CRTI will build on its successes as it moves forward with an enhanced and revitalized mandate under the Centre for Security Science (CSS). CSS is a joint initiative between Defence Research and Development Canada (DRDC) and Public Safety Canada. As Director General of CSS, I now oversee CRTI and receive strategic direction from a steering committee and the Program Management Board (PMB).

The framework offered by CSS enables CRTI to coordinate its activities with those of its sister program in the Centre, the Public Security Technical Program (PSTP). Such coordination ensures that the programs can effectively leverage the S&T they support and networks they organize.

Working in partnership with PSTP, CRTI spent much of the year planning its future within CSS. It was within this context and based on stakeholder feedback, that CRTI developed and submitted its request for funding for the next five years to the Treasury Board Secretariat in July 2006. CRTI augmented the Forensics Cluster, added a new Explosives Cluster, and reoriented its focus toward developing Canada's capability to prepare for, respond to, and mitigate the consequences of a wide range of hazards, including criminal activities, accidents, and natural disasters. Based on this renewed mandate, CRTI was awarded funding in November 2006.

As it moves forward, CRTI will also look to further develop networks that are multi-disciplinary and multi-jurisdictional in nature as it reaches out to the academic, industrial, and responder communities at the municipal, provincial, national, and international level. It is also developing long-term strategies for ensuring that the expertise, knowledge, and equipment developed through projects are maintained and enhanced into the future.

In this our fifth annual report, we are pleased to provide you with a review of our successes this year, as well as an overview of our first five years. We would like to extend our thanks to all CRTI's partners and staff members whose efforts have helped us chart our new course for the future.

Dr. Anthony Ashley
Director General
Centre for Security Science

1. INTRODUCTION

The Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI) is a unique, cross-organizational program mandated to strengthen Canada's preparedness for, prevention of, and response to a CBRNE attack through investments in science and technology (S&T). Since its launch in 2002, CRTI partners have been awarded funding for five rounds of projects aimed at closing S&T gaps in knowledge and capabilities, amounting to approximately $160 million of CRTI's $170 million budget. All of these projects are notable for their breadth and quality, and many of them have already made tangible contributions to Canada's national security.

CRTI's emphasis on building and maintaining partnerships has been critical to its success. Led by Defence Research and Development Canada (DRDC), CRTI is comprised of 19 federal government departments and agencies and extends its reach to first responders, provincial governments, and international partners. Work produced with the support of CRTI has gained international recognition within the S&T and security communities and has resulted in significant gains in Canada's CBRN response capabilities. Similar gains are expected with the creation of a new Explosives Cluster.

This annual report charts CRTI's progress, collaborations, and critical factors contributing to its success during its fifth fiscal year, 2006–2007. The structure and content of this report reflect the Results-based Management and Accountability Framework (RMAF), CRTI's blueprint for planning, measuring, evaluating, and reporting on the progress and results of the initiative throughout its life cycle. This report draws on the RMAF's measures and anticipated outputs to chart CRTI's activities during the last year. Corollary information, including financial data, is provided in appendices to this report.

1.1 MANDATE AND KEY ACTIVITIES

CRTI's mandate is to improve Canada's ability to respond to CBRNE incidents by strengthening the coordination and collaboration of capacity, capabilities, and research and technology plans and strategies. It does this by

- creating science clusters of federal laboratories that build S&T capacity to address the highest risk terrorist attack scenarios;
- funding research and technology to build S&T capability in critical areas, particularly those identified with biological, chemical, and radiological attacks;
- providing funds to areas where national S&T capacity is deficient because of obsolete equipment, dated facilities, or inadequate scientific teams; and
- developing and sharing CBRNE S&T expertise and knowledge through symposia, exercises, workshops, and studies.

CRTI manages six key activities:

1. *Creating laboratory clusters* and building an S&T response network for CBRNE events.
2. *Building S&T capability* by funding research to build Canadian science capacity in targeted investment areas.
3. *Accelerating technology to first responders* by channelling funding into technology already under development, thereby facilitating timely adoption of new technologies by first responders.
4. *Funding national S&T capacity* by enhancing federal laboratory equipment and facilities.
5. *Building horizontal capability* by leveraging federal government expertise and non-traditional partners, thereby enhancing S&T capacity of Canada.
6. *Building CBRNE S&T expertise and knowledge* in national and international CBRNE communities.

1.2 CRTI INVESTMENT PRIORITIES

CRTI's investment priorities are determined through an analysis of the risk compared with capability and capacity, and the technology requirements and response gaps of first responders and the laboratory clusters. As of March 31, 2007, CRTI has created and funded 191 projects (including Technology Acquisition projects), 47 of which have been completed, in support of these priorities.

The table below maps the impacts of the projects against CRTI's investment priorities. The impacts are grouped according to CRTI's four original portfolios: Biological, Chemical, Radiological-Nuclear (RN), and Forensic. (The Explosives Cluster, which was created in January 2007 has not funded any projects in fiscal year 2006–2007.) "Pan" projects that cover multiple hazard and target areas, or address broader response dimensions, are sorted by the primary and secondary capability to be provided by the project.

Note: Because the figures in the table below reflect the number of impacts, and not the number of projects, to be achieved by each portfolio, the total number of impacts exceeds the number of projects.

INVESTMENT PRIORITY	PROJECT IMPACTS				TOTAL
	BIOLOGICAL	CHEMICAL	RN	FOR	
Cluster Management and Operations	1		2	1	4
Command, Control, Communications, Coordination, and Information (C^4I) for CBRNE Planning and Response			1	3	4
S&T Training and Equipping First Responders	2	3	2		7
Prevention, Surveillance, and Alert	1		1	2	4
Immediate Consequence Management	3	2	1	2	8
Long-Term Consequence Management	2	1	2	1	6
Criminal Investigation Categories			1	3	4
S&T Dimensions of Risk Assessment		1	2	3	6
Public Confidence and Psychosocial Factors	1		1		2

2. FIVE YEARS OF SUCCESS

The successes of CRTI during its first five-year mandate depended on its ability to recognize and address the challenges it faced. The key success factors discussed in this section contributed to CRTI's ability to address these and other challenges in 2006–2007, the last year of its first mandate.

2.1 BUILDING COMMUNITIES

At the beginning of its mandate, CRTI was primarily focused on building interdisciplinary, cross-jurisdictional laboratory clusters. The laboratory clusters were designed to leverage existing expertise and facilities and build relationships between government, industry, academia, and responders. Much of the program's first year was spent building the initial three clusters: the Biological Cluster, the Chemical Cluster, and the Radiological-Nuclear Cluster. Despite the natural synergies between the various groups involved in these clusters, it was the first time that many of those working in the scientific and operational communities had the chance to meet, let along work together.

The initial three clusters were further solidified in the 2003–2004 fiscal year as the clusters held their first exercises to assess cluster readiness and the potential benefits of new technologies. The clusters had 453 participants coming from 63 different organizations. From 2004 to 2005, the clusters slowly increased the scale of the exercises they hosted as the networks and communities were further solidified. Between 2002 and 2007, CRTI's clusters held a total of 10 exercises. These include the first major exercise, *Exercise As Is*, which was held in Chalk River, Ontario.

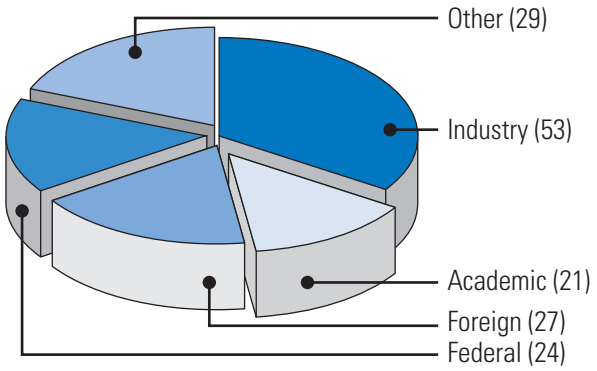
As CRTI matured, new clusters were added to address previously unidentified critical areas. The first of these new clusters, the Forensics Cluster, was added in fiscal year 2004–2005 to make CRTI more operationally focused. The Explosives Cluster was added in the 2006–2007 fiscal year. Today, there are five established clusters, with 85 participating organizations. Members span the scientific, security planning, and response communities.

Recognizing the importance of working with Canada's international partners, CRTI's clusters have recruited affiliate members from high-profile international organizations, such as the United States (US) Centers for Disease Control. Key linkages have also been made with the US Department of Homeland Security (DHS), the Australian National Animal Health Laboratory, and the Research Institute of Hygiene, Toxicology, and Occupational Pathology (Russia), as well as similar government agencies in the United Kingdom and other parts of Europe. These relationships provide the opportunity for knowledge exchange by bringing together the brightest minds to work on solutions critical to Canada's science and technology (S&T) capacity and capability related to CBRNE threats.

TABLE 1: PROJECT PARTNERS BY SECTOR FROM 2002–2007

PARTNERS	NUMBER
Federal	24
Foreign	27
Industry	53
Academic	21
Other	29
TOTAL	154

NUMBER OF PARTNERS



Information sharing is a key component of the CRTI program, both within each cluster and between clusters, and has been a key driver for mobilizing research. With this in mind, CRTI first hosted cluster-specific workshops and then pan-cluster workshops to increase the opportunity for CRTI cluster members to learn from each other. CRTI hosted its first symposium in 2003 to further encourage knowledge sharing. The symposium was well received and has since become an annual event. In addition to promoting knowledge transfer between the groups, the event is also an opportunity to build linkages and further develop the partnerships among cluster members.

2.2 INCREASING CAPACITY

When CRTI was first created in 2002, there was little laboratory capacity to undertake S&T development related to CBRN threats in Canadian science-based departments and agencies. Resulting from CRTI investments, Canadian laboratories now have state-of-the-art infrastructure and equipment, allowing researchers to actively pursue the development of new, leading-edge S&T to boost Canada's capability to respond to a CBRN attack.

One of the ways by which CRTI has supported the development of increased national S&T capacity is through the acquisition of existing technology for science-based departments and agencies. These technologies are used in day-to-day activities and are available in case of a CBRN event. CRTI has invested $28.7 million since 2002, enabling 19 departments and agencies to acquire new technologies. Examples of acquired technologies include a pesticide residue detection system for use in food-monitoring programs by the Canadian Food Inspection Agency (CFIA), on-site decontamination equipment for Environment Canada personnel, and nuclear mobile laboratories that enable response teams to identify the nature and extent of radiological contamination at the incident site.

2.3 CAPABILITY BUILDING

As a result of CRTI's investments in community building and increasing capacity, federal government departments and agencies are actively engaged in research projects that address the needs of Canadian responders. Research projects are carried out with active involvement from these various partners, thus reducing the amount of time it takes to develop a technology from concept to commercialization so that technology is now reaching responders sooner.

CRTI is building greater capability by funding collaborative partnerships between industry, government, and academia through its research and technology development projects. CRTI has funded 38 research development projects since 2002, and 27 technology development projects. This represents $122,965,243.00 of investment. Money has been invested in 154 departments, agencies, and their partners. Examples of research development projects that are now complete include nanodosimeters based on optically stimulated luminescence, a standoff radiation detector, therapeutic antibodies for Ebola and Marburg viruses, and a new surface decontamination foam. Technology development projects that are now complete include an airport radiological surveillance system and portable chemical/biological isolators.

The third means by which CRTI funds capability building is through technology acceleration projects. Technology acceleration projects are designed to move technology out of the laboratory and into the hands of responders. Through the monies invested by CRTI, new technologies have made it through the difficult commercialization process and are now available to and in use by responders across Canada and internationally. For example, the radio frequency (RF) and electronic countermeasures (ECM) compatible, chemical-biological (CB) blast protective helmet has found significant uptake in international defence operations. The information management and decision support system for radiological-nuclear (RN) hazard

preparedness and response (the Accident Reporting and Guidance Operation System [ARGOS] suite) has had both national and international uptake and is presently in development of further technology that will again increase the fidelity and interoperability of the tool.

Many of the other TA projects have provided additional S&T to further advance operational capability in combination with existing technologies. The advanced polymer research for application to personnel protective equipment (PPE) clothing is a good example of successfully developed technology that will be used in equipping responders with improved PPE.

TABLE 2: DISTRIBUTION OF PROJECTS BY CATEGORY FROM 2002–2007

PROJECT CATEGORY	NUMBER
RD	38
TD	27
TA	14
TOTAL	79

NUMBER OF PROJECT CATEGORIES

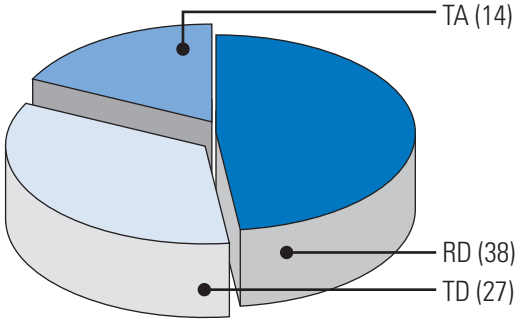


TABLE 3: CRTI INVESTMENT BY LEAD ORGANIZATION FROM 2002–2007

LEAD ORGANIZATION	FUNDING (2002–2007)
Agriculture and Agri-Food	$2,000,000.00
Canadian Food Inspection Agency	$11,193,980.00
Canadian Security Intelligence Service	$1,214,400.00
DRDC Ottawa	$23,005,843.00
DRDC Suffield	$12,486,946.00
Department of Defence	$3,000,010.00
Environment Canada	$9,039,184.00
Health Canada	$23,970,868.00
National Research Council	$8,268,678.00
Public Health Agency of Canada	$22,963,371.00
Public Works and Government Services Canada	$549,988.00
Royal Canadian Mounted Police	$5,271,985.00
TOTAL	$122,965,253.00

2.4 LOOKING AHEAD

While the successes of the last five years have been enormous, there is still much work to be done. There still remain gaps in Canada's capability to prepare for, prevent, respond to, mitigate the effects of, and recover from a CBRNE event. The complexity of the operating environment continues to increase, as does the S&T required to respond effectively. Furthermore, as the partnerships grow, produce success, and garner international attention, so does the recognition of the critical role programs such as CRTI play in leveraging expertise and resources toward a common goal.

3. RENEWAL

IN addition to supporting groundbreaking Canadian research in chemical, biological, radiological, nuclear, and explosives (CBRNE) science and technology (S&T), 2006–2007 was a year of renewal for the CBRNE Research and Technology Initiative (CRTI).

Having completed its first five-year mandate, CRTI began the transition to its second mandate within the business model of the Centre for Security Science (CSS). With a Memorandum of Understanding (MOU) between the Department of National Defence and Public Safety Canada, CSS coordinates the Government of Canada's public security S&T approach.

After extensive consultations with stakeholders about their interests and priorities, CRTI charted its path forward for the next five years. This included plans to expand its scope through the addition of an Explosives Cluster and to place a greater emphasis on more fully engaging innovators at universities, non-governmental organizations, and government institutions with the aim of broadening the CRTI network of knowledge and capabilities. It also included helping to develop the Centre's identity and that of its sister program, the Public Security Technical Program (PSTP).

Critical to this renewal process were the recommendations from CRTI's second Financial Audit, which was completed for the 2004–2005 and 2005–2006 fiscal years. The audit, conducted by an independent consultant, concluded that the financial management practices within CRTI were reliable and that CRTI management, with the cooperation of the participating lead departments, has made progress toward establishing a sound project accountability structure. The audit's recommendations focused on improvements to financial oversight with regard to the information provided for in-kind contributions, policies on year-end roll-over amounts, guidelines on project reporting, and compliance with policies, regulations, and the MOU. Pursuant to the audit, CRTI developed a management action plan to address the issues raised—many of which had already been acted on—which included the new governance model for CSS.

The culmination of these long-term planning efforts was a clear vision of how CRTI can leverage its investment and increase its impact within Canada's public security mandate. It was on this basis that CRTI developed its Treasury Board Secretariat (TBS) submission to secure funding for the next five years. In November 2006, TBS approved CRTI's funding request for the full amount for 2008–2012.

3.1 GOVERNANCE

CRTI's renewal included adjusting to the governance structure of the newly formed CSS within which CRTI was placed. CBRNE is one of four mission areas supported by the Centre. Falling under the Director General of CSS, CRTI is led by a Director who oversees Portfolio Managers responsible for managing investments and related activities in CRTI's five science clusters.

The terms of collaboration between DRDC and Public Safety Canada through CSS require a Steering Committee and a Program Management Board to provide strategic and programmatic oversight of CSS activities. The Steering Committee is responsible for

endorsing CRTI investment priorities, providing strategic policy direction, and overseeing financial activities. It is co-chaired by Assistant Deputy Ministers (ADMs) from the Department of National Defence (DND) and Public Safety Canada with membership at the ADM level from participating departments and agencies.

The Program Management Board, which is co-chaired by the Director General (DG) of CSS and the DG of the Emergency Management Policy Directorate of Public Safety Canada, is made up of Directors or DGs from collaborating departments and agencies. The Program Management Board is responsible for operational and directional oversight of CRTI and makes recommendations to the Steering Committee.

CSS reports to the Program Management Board on the plans and activities of its programs, including CRTI, and makes recommendations. The Program Management Board makes recommendations to the Steering Committee as the final decision-making body.

4. CRTI KEY ACTIVITIES 2006–2007

IN its fifth year, Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI) continued to deliver the capabilities developed throughout its five-year mandate through its six key areas of activity.

4.1 BUILDING LABORATORY CLUSTERS

CRTI's science clusters are unique fora for dialogue and discussion in the federal S&T community, focusing on the joint needs of scientific labs and the operational community with respect to addressing terrorist threats. Through each cluster, representatives from federal departments and laboratories share their ideas, knowledge, experience, and resources, and discuss shared challenges and possible science and technology (S&T) solutions to issues. Such discussions benefit from the knowledge that each member brings to the collective and provides the opportunity for valuable synergies.

4.1.1 OUTPUTS

Implementing the Clusters

Having carried out renewal workshops at the end of the 2005–2006 fiscal year, CRTI's science clusters—Biological, Chemical, Radiological-Nuclear, and Forensics—used the 2006–2007 fiscal year to plan and prepare for future cluster activities during CRTI's second five-year mandate.

The Biological Cluster, for example, developed a five-year business plan, which outlined how the Cluster would meet its short- and long-term objectives. These include, but are not limited to, providing forecasting, monitoring, and advice on dispersion, fate, and effects of the agents and hazards; developing and providing standards and limits for occupational health and safety, response, remediation, and follow-up health monitoring; developing, conducting, and participating in exercises; and building upon and furthering strategic alliances with other like-minded organizations to improve our national capability to respond to biological incidents.

The Chemical Cluster, which achieved major advances in decontamination science and in public health preparedness in the areas of early detection of disease outbreaks through funded projects during the 2006–2007, also developed an implementation plan for the next five years. Their objectives include approving a plan for integrating labs into operational emergency plans; completing two scenario-based exercises incorporating existing emergency plans; developing common procedures for S&T response to events; developing a list of target chemicals and assessing capabilities of the cluster member to deal with them; and developing a protocol for the identification and quantification of true unknown substances.

The Radiological-Nuclear Cluster spent 2006–2007 developing strategies to address gaps in radiological-nuclear S&T preparedness and response. Among the top priorities for the Cluster moving forward is coordinating response to radiological-nuclear (RN) events involving maritime security, mass casualties, and forensic investigations.

The Forensics Cluster, which addresses challenges common to the science clusters and is working to promote interoperability among responder and operational communities, identified a number of strategic areas of impact in 2006–2007. These include expanding the Cluster's membership to include more first responders and safety officers; identifying Canadian CBRNE background levels for remediation, intelligence gathering, and forensic purposes; determining the storage stability of toxins in crime scene exhibits; conducting studies and experiments to define level and duration of CBRNE response capabilities across the response spectrum; and urban planning modeling for CBRNE response.

CRTI also began organizing an Explosives Cluster, which was officially recognized on 1 April 2007. Tapping into a well-established S&T community that was previously engaged under Public Security Technical Program (PSTP), the new Cluster serves to broaden the program's impact in reducing vulnerabilities. Members of CRTI's new Explosives Cluster met twice during the 2006–2007 fiscal year to organize the Cluster and identify critical gaps and the associated priorities in anticipation of program funding. A gap analysis revealed five priority areas for the sixth call for proposals: energetic materials and blast effects; detection; improvised explosive device defeat (IEDD) and post-blast investigation; threat forecasting; and sustainment (e.g., exercises, training). One of the key goals identified by the Cluster is the development of integrated and interoperable solutions to give Canada the capability to effectively respond in the case of attack using explosives combined with CBRN agents, such as a dirty bomb. Members of the new Cluster include representatives from the Royal Canadian Mounted Police (RCMP), Transport Canada, the Canadian Air Transportation Safety Authority (CATSA), Natural Resources Canada (NRCan), Canada Border Services Agency (CBSA), and the Department of National Defence (DND).

Supporting Operational Readiness

Exercises enable the clusters to test their plans and capabilities and train participants in various aspects of CBRNE response. These training opportunities enhance cooperation and knowledge sharing between CRTI partner departments and first responder communities and highlight areas requiring further work and collaboration.

CRTI sponsored the Medical Nuclear Emergency Response Exercise (MEDNEREX), held in Halifax, Nova Scotia in October 2006. The exercise was a multi-jurisdictional, live, mass-casualty exercise involving over 100 participants from 16 organizations at the municipal, provincial, and federal levels, including local emergency medical services. The purpose of the exercise was to test the effectiveness of a medical RN emergency response tool developed by the CRTI Federal Advisory Group in conjunction with International Safety Research (ISR). The scenario involved the theoretical release of radioactive material onboard a nuclear-powered vessel, resulting in 11 contaminated or exposed casualties requiring medical treatment. The Canadian Forces Base (CFB) Halifax Nuclear Emergency Response Team performed initial decontamination and treatment of casualties, who were then taken to the Queen Elizabeth II Hospital. Feedback from the staff participating in the exercise was used to refine the tool and make it better suited for dealing with a mass casualty RN event.

CRTI's science clusters also spent considerable time in 2006–2007 planning for exercises in 2007 and beyond. Bi-Ex West, for example, will be a series of exercises—two tabletop exercises and one field trial—designed to enhance the capability of organizations in the Biological Cluster to respond to biological terrorist events. Planned for spring and fall 2007 in British Columbia, the exercises will provide a unique opportunity for Cluster members to be engaged with partners (e.g., municipal, provincial, and federal agencies) in an integrated response to a simulated terrorist event. Three workshops were held in 2006–2007 to prepare participants.

Providing S&T Advice and Expertise

CRTI Secretariat and cluster members were invited to participate as spokespersons in several CBRNE symposia and information sessions in 2006–2007. Events included a workshop on Forensic Epidemiology hosted by the G8 Bioterrorism Experts Working Group in London, United Kingdom (UK); a workshop in Moscow, Russia devoted to the decontamination and restoration of buildings after a CBRN attack; and a counterterrorism seminar in Tokyo, Japan.

These activities enable CRTI members to increase the outreach of the initiative and participate in the ongoing national and international CBRNE dialogue.

Developing and Managing CBRNE S&T Knowledge

Many of the projects that were initiated in earlier rounds of funding were completed in 2006–2007. To share the results of these projects and the knowledge gained through them with members of the CBRNE community and with the public, CRTI published a series of success stories on the CRTI intranet portal and the CRTI website. CRTI also updated its intranet portal with useful reference materials and project information for first responders and the S&T community.

In 2006–2007, CRTI also worked on compiling a bibliography of citations from both published and unpublished work related to projects funded by CRTI from 2002 to 2007. The bibliography, entitled *Five Years of Knowledge Creation: A Bibliography of CRTI Project Publications*, which will be available in fall 2007, will contain the citations generated from 35 projects, as well as a complete list of CRTI annual reports, conference proceedings, and other articles.

4.1.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

Cluster exercises and plans actively engage Canada's S&T base in CBRNE counterterrorism and are essential to evaluating and improving national preparedness for CBRNE terrorist events. Developing CBRNE counterterrorism expertise and sharing it with the S&T community and first responders in various fora expands the knowledge base on CBRNE countermeasures. Work to implement standards for equipment, establish shared skills and equipment inventories, and develop standard operating procedures contribute to an integrated and interoperable resource base for CBRNE counterterrorism.

4.2 BUILDING S&T CAPABILITY

Research and Technology Development (RD) projects are intended to close existing gaps in capabilities and capacities of the S&T and operational communities to enable an effective response to future CBRNE incidents. CRTI builds S&T capability through collaboration with industry, government, and academia. RD projects require the involvement of at least two federal partners, and are usually completed within three to four years of funding approval. Typically, funding awards are in the $3 million to $10 million range.

4.2.1 OUTPUTS

Completed Projects

Researchers Kick-start Immune Systems to Fight Bioterrorism Pathogens

The most likely method for spreading bioterrorism agents will be through the air or through water systems. Immediate, short-term protection of human and animal airways and intestines against various organisms will be a key emergency response tool for incidents of bioterrorism. This project explored novel approaches to afford animals and humans protection from the effects of exposure to highly virulent infectious agents, such as Ebola virus. The project team developed products and procedures to provide immediate short-term protection against various organisms, while at the same time delivering vaccines that can provide long-term immunity. The researchers studied and identified

several compounds and applications to partially protect animals from diseases induced by various pathogens. They successfully demonstrated that synthetic cytosine-phosphate-guanine oligodeoxynucleotides (CpG ODN) could be used to trigger a protective immune response before vaccines or treatment can be effective and therefore can be used to protect against infection from exposure to biological agents. The four-year project enabled the researchers to study fundamental mechanisms of host defence against serious infectious diseases and provided training for new personnel in scientific and diagnostic work on infectious diseases. Overall, the four participating laboratories have achieved a high level of preparedness to help in fighting bioterrorist attacks.

CRTI 0006RD: Induction of Innate Immunity
Project Lead: Public Health Agency of Canada (PHAC)—National Microbiology Laboratory (NML)
Federal Partner: Canadian Food Inspection Agency (CFIA)—National Centre for Foreign Animal Disease
Academic Partners: University of Saskatchewan—Veterinary Infectious Disease Organization, McMaster University

Major Advances in Responding to and Detecting Biological Radiation Exposure

Rapid assessment and treatment of individuals exposed to radiation during a large-scale radiological emergency will be enhanced by a National Biological Dosimetry Response Plan (NBDRP) developed by researchers for this project. The NBDRP provides a resource for rapid diagnostic techniques for first responders and exposed individuals following an RN event. The development of the plan led to an increase in the number of Canadian laboratories capable of testing for radiation exposure from one to four, and the number of trained staff ready to respond to a large-scale radiological emergency from two to 15. Accuracy of testing at the participating laboratories increased from 68 percent to 88 percent over the course of two exercises designed to test the NBDRP. In addition, the team established the Canadian Cytogenetic Emergency Network with 18 clinical laboratories able to score samples for the dicentric chromosome assay (DCA), thereby further expanding Canada's radiation biodosimetry response capability. The researchers successfully demonstrated several new methods to determine the levels of radiation present in a person's body and identified five new biomarkers that can be measured in human blood to determine radiation exposure. The US Departments of Homeland Security and Health and Human Services have approached the researchers to assist in developing a proposal for a US biological dosimetry network based on the NBDRP model. This project has enhanced Canada's ability to respond to RN events by increasing the national capacity for performing accurate biological dosimetry. Dose estimates for potentially exposed individuals will be available quickly enough to improve the medical community's ability to assist in the management of casualties. The new assays reduce the human resources required and enable sensitive high-throughput dosimetry.

CRTI 0027RD: Biological Dosimetry and Markers of Nuclear and Radiological Exposures
Project Lead: Health Canada—Radiation Protection Bureau
Federal Partners: Defence Research and Development Canada (DRDC) Ottawa, Atomic Energy of Canada Limited (AECL)
Other Partner: McMaster University—Institute of Applied Radiation Sciences

Improved Personal Protective Equipment to Protect First Responders from Biological and Chemical Threats

The purpose of this project was to assess existing personal protective equipment (PPE) for first responders against chemical and biological (CB) threat scenarios, and recommend new standards to ensure that first responders have the necessary guidance to use and select equipment for terrorist response. Project researchers developed scenarios and consulted with the responder community on response activities and protocols. They also developed evaluation methods and models for protective performance of respirators and clothing, and investigated the dermal toxicity of selected chemical warfare agents and toxic industrial chemicals. The researchers have assisted the responder community to make equipment procurement decisions and provided guidance on how to deal with a CBRN event. The team has released a standards guidance document, *Selection and Use of Personal Protective Equipment for the Canadian First Responder to a CBRN Terrorism Event*. The success of this initiative has spurred a new project, CRTI 05-0016 RD, "Development of a Canadian Standard for Protection of First Responders from CBRN Events," that will further advance standards for PPE.

CRTI 0029RD: Protecting the First Responder Against CB Threats
Project Lead: Royal Military College of Canada (RMC)
Federal Partners: RCMP, Health Canada, DND—Director Nuclear Biological Chemical Defence, DRDC
Industry Partner: 3M Canada

Researchers Develop New Technologies for the Surveillance of Biowarfare Agents

The technology to create a lethal biological weapon by introducing a virulence gene into an otherwise innocuous bacterium has existed for over a decade. For this project, the researchers adapted their Bacterial Comparative Genomic Hybridization (BCGH) technology to rapidly identify engineered genes in modified biowarfare organisms. The process involves comparing an engineered biowarfare strain harbouring the novel gene against a related lab reference strain. The final outputs of the project include two-dimensional (2-D) display analysis of the selected organisms and standardized protocol at PHAC's NML and DRDC Suffield, including streamlining of protocols for routine use in diagnostic and forensic laboratories. The adapted BCGH technology will give the NML and DRDC Suffield the capability to rapidly identify virulence genes introduced in engineered biowarfare strains. This will allow for better diagnosis, surveillance, vaccination, and the development of therapeutic measures that can be targeted at the virulence gene or gene product introduced in a bioterrorism attack.

CRTI 0064RD: New Technologies for Surveillance of Biowarfare Agents and Identification of Engineered Virulence Genes
Project Lead: University of British Columbia
Federal Partners: PHAC—NML, DRDC Suffield

Researchers Develop Fast Tests for Bad Bugs

The *Yersinia pestis and Francisella* tularensis bacteria are responsible for causing the plague and rabbit fever respectively, and are considered possible bioterrorism weapons due to their high virulence and ease of spread. Project researchers have developed new, rapid tests that allow these bacteria to be detected in hours rather than days. After procuring bacterial strains and genomic DNA from various collections, the research team generated and analyzed over 900 genetic sequences representing 11 different gene targets that were then used to develop DNA-based assays for the rapid detection of the bacteria using a dried reagent format. Dried reagents offer significant advantages as they simplify assay set-up, reduce the time frame and risk of contamination for the assay, improve reproducibility, and eliminate cold-storage requirements. Two federal laboratories now have the capability to use the new assays to identify *Y. pestis* and *F. tularensi* in different substances, such as nasal mucous and blood, in less than an hour. It is anticipated that the assays will be rolled out to other frontline users, such as provincial public health laboratories. Researchers also hope to use similar methods to develop additional assays for other biothreat agents. The new diagnostic tests greatly enhance Canada's ability to detect the two highly virulent bioterrorist threats and show promise for defense against additional bioweapons.

CRTI 0154RD: Rapid DNA-based Diagnostic Tests for Two Biological Agents
Project Lead: DRDC Suffield
Federal Partner: PHAC—NML
Industry Partner: GenOhm Sciences Inc.
Academic Partner: Université Laval—Infectious Diseases Research Centre

Innovative Tool to Determine Risks of Dirty Bombs

Emergency planning officials are concerned about the potential use of radiological dispersal devices (RDDs), or dirty bombs, as terrorist weapon. Researchers have developed the Probabilistic Risk Assessment (PRA) Tool to allow emergency planning officials to generate systematic analysis of RDDs. The final version of the PRA Tool software provides new capabilities that represent a considerable step forward in RDD risk analysis. One such capability is the ability to conduct intelligent searching of an RDD risk assessment database. This ability allows for a comprehensive study of the feasibility, consequences, and risk of RDD attacks that takes into account the vast range of potential RDDs involving different radioisotopes, activity levels, and dispersion modalities. The risk assessments generated using the PRA Tool will facilitate development of intelligence assessments, bolster criminal and border surveillance, and identify gaps in radioactive materials security. The project team expects that the tool will be adopted by security-mandated agencies to enhance their understanding of the RDD threat and to focus their attentions on the scenarios of greatest concern. The tool will greatly improve the risk assessment process and could be generalized to other hazards.

CRTI 02-0024RD: Probabilistic Risk Assessment Tool for Radiological Dispersal Devices
Project Lead: DRDC Ottawa
Federal Partners: Canadian Nuclear Safety Commission (CNSC), Public Safety Canada, CBSA, Canadian Security Intelligence Service (CSIS)
Industry Partner: SAIC Canada
Other Partner: University of Ontario Institute of Technology

CNPHI Connects Health Officials Across Canada

The Canadian Network for Public Health Intelligence (CNPHI) is a secure, web-based resource that collects and processes surveillance data, disseminates strategic intelligence, and helps public health officials across Canada coordinate their responses to biological threats, including bioterrorism. It is the first tool of its kind that allows federal, provincial, and regional health authorities to share data in a efficient, coordinated, and secure manner. The CNPHI is divided into the Canadian Integrated Outbreak Surveillance Centre (CIOSC) and the Response and Resource Management Centre. The CIOSC includes public health alerts and notifications, as well as surveillance systems for detecting and tracking communicable diseases that pose a threat to public health. The Response and Resource Management Centre provides secure, web-based resources to assist public health officials and other stakeholders in responding to public health emergencies. Overall, CNPHI's data exchange tools and many surveillance modules provide stakeholders with more timely and accurate surveillance information. CNPHI's alert capabilities, intelligence exchange resources, and event management tools enable stakeholders to rapidly exchange secure information, and provide them with web-based resources to help manage and coordinate investigations and responses. CNPHI's knowledge management resources also enable stakeholders to quickly access relevant documents and information. Launched in October 2004, CNPHI is now being used by more than 90 percent of the public health authorities across Canada and is being built into an integrated cross-Canada solution—the Electronic Public Health System. Beyond Canada's borders, the Global Health Security Action Group, World Health Organization (WHO), the US, and Australia have all expressed interest in adopting components of the complete system. Ultimately, CNPHI has allowed Canada's public health stakeholders to be better equipped to detect and respond to infectious disease threats.

CRTI 02-0035RD: Canadian Network for Public Health Intelligence (CNPHI)
Project Lead: PHAC
Federal Partner: CFIA
Academic Partners: University of Guelph
Industry Partner: TDV Global
Other Partners: Canadian Public Health Laboratory Network, TRlabs, Canadian Council of Medical Officers of Health

Knowing Which Way the Wind Blows

During a terrorist attack involving the release of airborne CBRN materials, first responders and decision makers need access to accurate maps of where the material will be deposited and when. Precipitation can have a significant impact on how much contaminated material reaches ground level. Researchers for this project have developed a mathematical model that allows for more accurate prediction, monitoring, and response to an airborne release of CBRN materials. The forecasting model takes into account weather conditions and can be used to determine the geographical areas that are at risk for exposure from the contaminated material, when those areas will be affected, and how much of the contaminated material will reach the ground. Previously, few modeling systems could account for real-time precipitation information and apply it for an accurate assessment of how much of the contaminated material would be removed from the air and deposited on the ground by rain or snow. The model is running operationally at Environment Canada's Canadian Meteorological Centre (CMC) and is available for access by Health Canada's Accident Reporting and Guidance Operational System (ARGOS).

CRTI 02-0041RD: Real-Time Determination of Area of Influence of CBRN Releases
Project Lead: Health Canada
Federal Partner: Environment Canada, AECL
Academic Partner: McGill University, York University

Project Team Constructs Revolutionary Detector to Support Radiation Forensics

Materials that are radioactive or have been exposed to radioactive radiation produce light when exposed to blue, green, or infrared light. The amount of light can then be used to determine how long the radioactive material has been present, as well as how much radioactive material is present. Canadian researchers have constructed a portable radiation detector based on this process, known as optically stimulated luminescence (OSL). The OSL detector will assist investigators in identifying past storage locations of illicit radioactive material. The technique can detect the exposure to radiation of a wide range of materials, including cement, concrete, drywall, and ceramic tile. Bubble Technology Industries developed a laboratory prototype and a field-portable prototype OSL detector. The OSL device has potential applications in the forensics, intelligence, and military communities, as well as for other responders to radiological events. With new funding, Bubble Technology Industries will continue commercializing a portable OSL detector with applications in forensics, arms control verification, and retrospective accident dosimetry.

CRTI 02-0045RD: Forensic Optically Stimulated Luminescence
Project Lead: DRDC Ottawa
Federal Partners: Public Safety Canada, RCMP
Industry Partner: Bubble Technology Industries

Addressing the Psychosocial Effects of CBRN Terrorism

Psychological and social impacts represent CBRN terrorism's most prominent consequences. Researchers under this project have developed a training program and a tool to help emergency planners integrate psychosocial considerations into their plans. The researchers developed the Psychosocial Risk Assessment and Management (P-RAM) framework to address the management of psychosocial impacts, the communication of associated risks, and the implementation of interventions. The researchers integrated existing research, consulted with responders and planning officials, and obtained public input through surveys and focus groups. A national responder network that grew out of the consultations remains in place. Feedback from tests of the initial training program led to a shorter, three-day version of it. PRiMer, the web-based Psychosocial Risk Manager for Emergency Response, is in the demonstration phase and includes a user-friendly interface, categorization of data, and incorporation of data on psychosocial effects manifested during past events. The training program will assist agencies and responders to integrate evidence-based psychosocial considerations in their preparedness and response planning for CBRN-terrorism events. The team has obtained additional CRTI funding to extend the development of the P-RAM framework as more research data becomes available.

CRTI 02-0080RD: Psychosocial Risk Assessment and Management Tools to Enhance Response to CBRN Attacks and Threats in Canada
Project Lead: University of Ottawa—Institute of Population Health
Federal Partners: PHAC, CFIA

Outputs of RD Projects in Progress 2006–2007

The following descriptions provide highlights of the outputs achieved in ongoing RD projects in 2006–2007.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 0072RD: Nanodosimeters Based on Optically Stimulated Luminescence	• DRDC Ottawa • Health Canada • Bubble Technology	To create a dosimeter, based on OSL, that is suitable for the long-term monitoring of radioactive contamination.	The researchers developed two prototypes, one field-ready and the other for lab testing. The dosimeters are intended for unsupervised long-term monitoring of areas contaminated with radioactive material. They could also be used to monitor cargo containers in transit for illicit radiological material. The project has produced a custom photodetector with unique characteristics that will allow the dosimeter to be adapted to chip-level design. A suite of minidosimeters was completed in March 2006, but testing of them was extended until September 2007.
CRTI 0091RD: Development of Recombinant Monoclonal Antibodies for Treatment and Detection of Bioterrorism Agents	• PHAC • DRDC Suffield • CFIA	To develop monoclonal antibody-based detection, diagnostic, and treatment tools for bioterrorism agents.	The project team produced recombinant anti-anthrax antibody fragments as well as recombinant single-chain antibody fragments recognizing two different encephalitis viruses. The team linked these antibody fragments to a variety of detection tags, and determined that those linked to alkaline phosphatase tags outperformed the others in viral antigen detection.
CRTI 02-0066RD: Development of Simulation Programs to Prepare Against and Manage Bioterrorism of Animal Diseases	• CFIA • Environment Canada • University of Guelph • Colorado State University • US Department of Agriculture • Ontario Ministry of Agriculture and Food	To develop a computer simulation program and atmospheric dispersion model to predict the extent and direction of the spread of highly contagious diseases of livestock.	The first official version of the North American Animal Disease Spread Model (NAADSM) was released by the project team in 2005. The team collaborated with Australian and New Zealand government epidemiologists to compare the NAADSM with their simulation models, resulting in improvements to all three. NAADSM has been used to simulate an outbreak of avian influenza in Georgia and is being used to develop scenarios of avian influenza outbreak in Canada.
CRTI 02-0069RD: Molecular Epidemiology of Biothreat Agents	• PHAC • DRDC Suffield	To increase the capacity of laboratories to trace the source of a bioterrorism or natural outbreak using a new molecular method for subtyping three of the most prominent biothreat bacterial species.	The project team developed multi-locus variable-number tandem repeat analysis (MLVA) for subtyping *Bacillus anthracis, Francisella tularensis*, and *Yersinia pestis*. The technique was optimized to increase sensitivity while keeping the steps manageable. To differentiate *B. anthracis* isolates that have the same MLVA type, the team developed a molecular typing method called single-nucleotide repeat analysis. The genotyping data is stored in a database located and maintained at PHAC's NML and a secure access link is being created to allow data exchange between partners.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 02-0093RD: An Advanced Emergency Response System for CBRN Hazard Prediction and Assessment for the Urban Environment	• Environment Canada • DRDC Suffield • Health Canada • AECL • J.D. Wilson and Associates • Waterloo CFD Engineering Consulting	To design a modelling system to forecast dispersion of CBRN materials, particularly in urban areas.	The project team has successfully validated the modelling system predictions against data collected from a field experiment that was conducted in Oklahoma City in 2003, providing an initial demonstration that the developed modelling system can correctly reproduce the many features of wind flow and dispersion of material in an urban environment. A prototype of the Global Environmental Multiscale (GEM) cascade is running experimentally over Vancouver, BC, and Montreal, QC, and has been fully transferred to Environment Canada's CMC. The modelling system is being applied to the planning of CBRN counterterrorism measures for the 2010 Vancouver Olympics.
CRTI 03-0005RD: Sensor Technology for the Rapid Detection and Identification of Pathogens used as Bioweapons	• National Research Council (NRC) • PHAC • DRDC Suffield • Becton • Dickinson and Company • Université Laval • Centre hospitalier universitaire de Québec	To develop a novel technology based on luminescent polymeric transducers that will lead to a rapid and sensitive detection system for the identification of biological pathogens.	The project team developed a process using a polymeric transducer that rapidly detects *Bacillus anthracis* without polymerase chain reaction (PCR). The selection of optimal capture and detection probes for *B. anthracis* was also achieved, while work on magnetic probes continues. The team has filed a patent for a new fluorescent probe architecture that could increase the sensitivity of detection even further.
CRTI 03-009RD: Caring About Health Care Workers as First Responders: Enhancing Capacity for Gender-based Support Mechanisms in Emergency Preparedness Planning	• DND • University of Ottawa • Canadian Women's Health Network • Canadian Federation of Nurses' Unions • University of Ottawa—School of Nursing • University of Toronto—School of Nursing • Health Systems Strategies • Victorian Order of Nurses • GPI Atlantic • Ontario Ministry of Community Safety and Correctional Services • BC Centre of Excellence in Women's Health	To mitigate the impact of future CBRN contagion threats by recommending support mechanisms for health care workers as first responders and using lessons learned from the SARS outbreak about the psychosocial impact and need to balance work performance and family responsibilities.	Data collection and analysis are complete. The project team found gaps in organizational and social support for frontline health care workers. Focus group and survey responses showed that health care workers lack confidence in systemic response capacity and feel unprepared to respond to large-scale infectious diseases outbreaks. Indications that health care workers may not respond during a highly contagious outbreak is of particular concern. Coordinated efforts are needed to develop policies and procedures to address these concerns.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 03-0018RD: Experimental Characterization of Risk for Radiological Dispersal Devices	• DRDC Ottawa • DRDC Valcartier • Health Canada • Environment Canada • RMC • Carleton University • University of Ontario Institute of Technology • University of British Columbia	To address gaps in the knowledge of risk for both explosive and non-explosive dispersal of radiological material.	The project team carried out further indoor and outdoor tests to characterize the explosive dispersal of radiological material from RDDs. The non-explosive dispersal of radiological material is being tested at the University of Ontario Institute of Technology, where the team is also performing spray nozzle modeling to predict large-scale dispersal. Researchers are also analyzing other aspects of RDD-generated aerosols to assess their health effects.
CRTI 03-0060RD: Protective Markers for Anthrax Serodiagnosis	• DRDC Suffield • PHAC • University of British Columbia • Cangene Corporation	To develop validated serum screening assays that can aid in better diagnosing individuals exposed to anthrax and to identify proteins that can be used in a new anthrax vaccine.	Using recombinant proteins from the University of British Columbia and serum from DRDC Suffield, Cangene researchers developed and validated separate assays to support anthrax vaccine trials in mice, to detect and measure anthrax antibodies in persons given the anthrax vaccine or exposed to anthrax, and to measure antibodies that functionally prevent anthrax lethal toxin activity. These assays will be transferred to the PHAC's NML for future experimental and clinical use. The researchers also identified protein candidates for a new anthrax vaccine and developed a model to test these candidates.
CRTI 04-0004RD: Canadian Animal Health Surveillance Network	• CFIA • PHAC • TDV Global Incorporated • Government of British Columbia • Government of Alberta • Government of Saskatchewan • Prairie Diagnostic Services • University of Saskatchewan, Government of Manitoba • University of Guelph • Government of Québec • University of Montréal • Government of New Brunswick • Government of Newfoundland and Labrador • University of Prince Edward Island • Government of Nova Scotia	To establish an animal health diagnostic network that will provide real-time surveillance data from Canadian and US laboratories to enhance national and cross boarder intelligence-gathering capacity to detect animal disease threats.	The project team continues negotiating a Memorandum of Understanding (MOU), expanding the diagnostic capabilities of the provincial, federal, and university laboratories to assist in diagnosing specific foreign animal diseases and developing the system design. The surveillance team has been working with the CNPHI to facilitate the exchange of animal and public health intelligence through a secure web-based system. Fifty percent of the network labs are now interconnected with CNPHI. In addition, the project Steering Committee is reviewing a draft CD featuring a project overview to aid as a communication tool.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 04-0018RD: Development of Standards for Chemical and Biological Decontamination of Buildings and Structures Affected by Terrorism	• Environment Canada • PHAC • DRDC Suffield • SAIC Canada • US Environmental Protection Agency • University of Ottawa • University of Leeds • Russian Institute of Hygiene • Toxicology and Occupational Pathology	To establish cleanup standards, using data from exposure experiments, for decontaminating buildings after a chemical or biological attack.	The project team has completed an extensive literature search, an interim draft report, and an in-depth analysis of existing clearance levels. Formulae from various sources were used to calculate preliminary clearance criteria and experiments have begun. Experiments include tests of transfer rates from surface-to-surface, surface-to-air, and surface-to-sampling device. Plans are underway to test chemical agent clearance levels using animal models and other laboratory manipulation in Canada and Russia.
CRTI 04-0022RD: Rapid Separation and Identification of Chemical and Biological Warfare Agents in Food and Consumer Matrices using FAIMS-MS Technology	• NRC • CFIA • DRDC Suffield • Thermo Fisher Scientific	To develop a fast and conclusive method for identifying chemical and biological warfare agents using high-field asymmetric waveform ion mobility spectrometry (FAIMS) mass spectrometry (MS).	The project researchers focused on developing flow injection-atmospheric pressure ionization (API) combined with FAIMS-based methods for the separation and identification of chemical warfare agents. The researchers evaluated three API methods with varied results depending on the substance used. Overall, detection limits were comparable to those obtained with conventional methods, but with significantly reduced analysis time and less complex sample preparation.
CRTI 04-0029RD: Development of an Electronic Neutron Dosimeter	• DRDC Ottawa • CNSC • DND • Bubble Technology Industries	To develop an electronic neutron dosimeter (END) that meets the needs of first responders for accurately measuring the radiation dose during a radiological contamination event.	Recent advances in scintillator and electronics technology allowed the team to develop a new pulse shape discrimination (PSD) circuit. This circuit produces a system capable of meeting the stringent operational requirements for a personal END. The prototype was successfully tested at the DRDC Ottawa Van de Graaff accelerator.
CRTI 04-0045RD: Development of Collections, Reference/DNA Databases, and Detection Systems to Counter Bioterrorism Against Agriculture and Forestry	• Agriculture and Agri-Food Canada (AAFC) • CFIA • NRCan • Canadian Forest Service	To create a DNA database, an online database, and a sample collection of fungal plant pathogens that are possible risks as bioterrorism agents against Canadian crops and forests.	The project team has developed a 90,000-record Canadian plant-pathogen database, as well as a three-gene test for *Phytophthora ramorum* (sudden oak death). An international blind trial showed the test to be the most accurate test available. The test and the database are being used by the CFIA. Collection of high-risk pathogens and their specimens is nearly complete. Researchers continue to work on identifying unique regions in the pathogens' DNA to aid in identification.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 04-0052RD: On-site Composting for Biocontainment and Safe Disposal of Infectious Animal Carcasses and Manure in the Event of a Bioterrorism Attack	• CFIA • AAFC • Alberta Agriculture • Food, and Rural Development • Iowa State University—Agriculture and Biosystems Engineering	To develop composting methods that can be used on farms or other sites for biocontainment of livestock carcasses infected with pathogens and their manure.	Experiments were conducted to test the impact of different variables on the efficacy of composting for biocontainment. Variables include the type of animal carcass, the type of material surrounding the carcass, the type of virus or bacterium, the depth of the compost pile, and the length of composting time. Researchers found that pathogens were killed fastest in an environment with higher composting temperatures. Moisture and oxygen levels are also important. Future fieldwork will test passive ventilation-system design as well as operating strategies to improve airflow control and composting performance.
CRTI 04-0127RD: Canadian Health Integrated Response Platform	• Health Canada • PHAC, Environment Canada • Prolog Development Centre • DBX Geomatics	To integrate two current decision-support platforms into one comprehensive platform that will enable better surveillance, monitoring, alerting, and response during emergencies.	The project in its early stages demonstrated its usefulness in an emergency situation. The Canadian Health Integrated Response Platform (CHIRP) was successfully used during the polonium-210 event in London, England, in 2006. Health Canada distributed focused alerts to the public health community through the CNPHI system using the CHIRP framework. The alerts were received and viewed by more than 400 health care professionals.
CRTI 05-0014RD: Experimental and Theoretical Development of a Resuspension Database to Assist Decision Makers during RDD Events	• DRDC Ottawa • Environment Canada • University of Ontario Institute of Technology • Defence Science and Technology Laboratories • Wehrwissenschaftliches Institut für Schutztechnologien • DGA—Centre d'études du Bouchet	To develop an understanding of the process by which deposited radioactive particles re-enter the atmosphere.	The main threat from a radiological terrorist event is the human ingestion or inhalation of radioactive particles that re-enter the atmosphere through the process of resuspension. Project researchers in four North Atlantic Treaty Organization (NATO) countries are examining the process and the natural and man-made variables that influence it. The project will allow radiological experts to better predict, prepare for, and mitigate the outcomes of a radiological event, and provide guidance to field personnel on protective procedures and operational constraints for work in contaminated environments.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 05-0016RD: Development of a Canadian Standard for Protection of First Responders from CBRN Events	• Public Works and Government Services Canada (PWGSC) • Public Safety Canada, Transport Canada • RMC • NRC • RCMP • Canadian Professional Police Association • Canadian Healthcare Association • Canadian Public Health Association • Canadian Association of Fire Chiefs • Canadian Standards Association • Canadian Council of Health Services Accreditation • International Association of Fire Fighters • Paramedic Association of Canada • Canadian General Standards Board	To establish a Canadian standard for personal protective equipment used by first responders to CBRN incidents.	A committee of stakeholders from government, public health and safety organizations, first responders, manufacturers, and research organizations was established in early 2007. The committee has familiarized itself with the work undertaken as part of CRTI 0029RD, which is the basis for the new standard. The committee has begun discussions on the structure of the standard, terminology to be used, and the development of a lexicon. The committee will prepare working drafts for public review, revise the drafts, develop consensus on the standard, and publish it in English and French. It will then promote the standard to encourage its adoption.
CRTI 05-0043RD: Economic Impact of Radiological Terrorist Events	• DRDC Ottawa • CNSC • CSIS • AECL • Battelle Memorial Institute	To conduct a study that provides quantitative data on the economic consequences of a RDD event. Such data will improve the effectiveness of RN emergency response plans by generating tangible data for a more accurate evaluation of risk in RDD events.	A representative set of radiological terrorism scenarios were chosen by the project team to be used in the study. The team is focusing on evaluating different isotopes and isotope activity, various Canadian geographical locations, active versus passive sources of radiation, and meteorological conditions. Computer programs are being used to predict event chronology for active devices, while dose-rate isocontours are being developed for passive devices. To evaluate the economic impact of an RDD event, efforts have begun to incorporate additional factors in the patterns, including unit cleanup cost factors, population density, and lost economic activity.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 05-0069RD: Development of PEGylated Granulocyte-Macrophage Colony Stimulating Factor for Acute Radiation Syndrome	• Health Canada • DRDC Suffield • Cangene Corp.	To develop and evaluate a final formulation of granulocyte-macrophage colony-stimulating factor modified with polyethylene glycol (PEG-GM-CSF) for treatment of neutropenia resulting from acute radiation syndrome (ARS).	Weekly doses of PEG-GM-CSF have been proven to prevent severe neutropenia in irradiated monkeys. The project team is finalizing production parameters for PEG-GM-CSF to be able to prepare batches to support larger animal studies and to transfer production to a good manufacturing practice (GMP) facility, thereby enabling production for treatment of humans. Studies are underway to determine the optimal dosing regimen. A stockpile of PEG-GM-CSF may be a valuable asset among the therapies available for treatment of ARS in a nuclear terrorism event.
CRTI 05-0078RD: Development of Live Replicating Viruses as Vaccines and Therapies for Viral Haemorrhagic Fever Viruses	• PHAC • Health Canada • Impfstoffwerk Dessau-Tornau GmbH • United States Army Medical Research Institute for Infectious Diseases	To develop attenuated recombinant vaccine vectors based on vesicular stomatitis virus (VSV) as prophylactic and therapeutic vaccines that can be produced for use in the event of a bioterrorist attack with Ebola or Marburg viruses.	The Ebola and Marburg viruses are often fatal and there is no preventive vaccine or post-exposure treatment. Researchers will develop stocks of a vaccine based on VSV and determine its immune correlates for the protection of rodents and primates. The project team will generate data that will be required for the future licensing of the vaccine. The vaccines tested for this project are currently the most effective treatments. Data suggests that these vaccine candidates are safe and efficacious in relevant animal models.
CRTI 05-0121RD: Evidence-based Risk Assessment of Improvised Chemical and Biological Weapons	• Public Safety Canada • DRDC Suffield • DND • RCMP	To assess information available to the public on chemical and biological weapons (CBWs) technologies, review classified data on terrorist interest in CBWs, and identify scenarios where there are knowledge gaps about terrorist interest in CBWs.	The project team members will construct, test, and characterize the technologies in question. They will address the technical gaps or inaccuracies in the information; the level of expertise needed to overcome these gaps and execute the technology; threats to the safety of those implementing the technology; the availability of materiel; the yield, toxicity, and stability of the product; the efficacy of dissemination; the potential for scale-up; signatures of activity; and potential targets and impact. The study will identify significant terrorist threats and contribute to the development of technologies for their prevention and management.

4.2.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

Participation in ongoing RD projects has enhanced the expertise and knowledge of CBRN S&T performers and, upon their completion, will contribute to their capabilities. The prototypes, techniques, assays, tools, and technologies developed under RD projects in 2006–2007 are important milestones and, in some cases, have already contributed to the national response capacity.

4.3 ACCELERATING TECHNOLOGY TO FIRST RESPONDERS

Technology Acceleration (TA) projects contribute to the commercialization of and transition to use by first responders and other operational authorities of technologies that address key capacity gaps. TA projects involve first responders, industry, and government and are usually completed within six months to two years of funding approval. The guidance for these projects suggests they be funded to levels between $1 million and $10 million.

Introduced in 2004–2005, the Technology Demonstration (TD) project category enables S&T partners to demonstrate the utility and impact of new technologies to first responders in an operational setting. TD projects afford a "leave-behind" opportunity to transfer knowledge, technology or capacity quickly to specific end-user communities. The advances in S&T resulting from the direct participation and interface with the end-user community are intended to improve the integration and interoperability of the collective response capacity. TD projects will typically span three to four years.

4.3.1 OUTPUTS

Completed Projects

Rapid Analysis for Carbon-14 Radiological Contamination

Carbon-14 is a naturally occurring radioactive isotope that emits only low levels of radiation, but its half-life of 5,730 years allows it to accumulate in the environment, and its ability to enter the food chain can lead to absorption by humans. These properties make the accidental or deliberate release of carbon-14 a serious public safety risk. If a carbon-14 release did occur, rapid measurement of contamination levels at agricultural sites and in samples related to human health would be critical. Project researchers have developed a system to provide fast, sensitive, and high-capacity analysis of organic samples for carbon-14 contamination. The system could be used to determine initial contamination, as well as monitor clean up efforts. The team modified the existing IsoTrace mass spectrometry system, integrated software controls for automated analysis, and established procedures for sample analysis and the identification of materials for collection in a radiological-nuclear event. The equipment developed for this project and the training in its use provides Canada with the capability to respond expeditiously to events in which carbon-14 is dispersed in the environment, thus minimizing the impact of the dispersion.

CRTI 0052TA: Rapid Carbon-14 Analysis by Accelerator Mass Spectrometry
Project Lead: University of Toronto—IsoTrace Laboratory
Federal Partners: Health Canada—Radiation Protection Bureau, Fisheries and Oceans Canada—Atlantic Environmental Radioactivity Unit
Industry Partner: High Voltage Engineering Europa B.V.

A System for Practical, Cost-Effective Radiation Surveillance

Researchers for this project developed an integrated surveillance system that could be mounted in patrol vehicles to provide sensitive, real-time detection of gamma radiation. A telecommunications component transmits data to a central server that transforms the data into a meaningful graphic format overlaid on maps that can be used by emergency management field operations. The radiation sensors are controlled by the mobile detection unit and the system supports both person-carried and static sensors. The system provides the earliest possible detection and assessment of illicit radiation sources and practical incident management data for first responder and community safety. It operates in the background and generates alerts by comparing real-time radiation data with alert criteria defined by system users. A key element is its ability to generate a location-based model of normal radiation levels across the community. Comparing new measurements against this model provides sensitive detection of distant, weak, or shielded radiological sources. The system provides continuous, autonomous, cost-effective, and practical radiological threat identification. It contributes to a national and international common operating picture and will catalyze the development of a new concept of operations and standard operating procedures among cooperating incident response agencies. The RCMP deployed the system for its pilot in the National Capital Region (NCR) and it provided technology for the Ottawa International Airport Radiological Security System developed under another CRTI project (CRTI 03-0018TD).

CRTI 0105TA: Mobile, Real-Time Radiation Surveillance Network
Project Lead: McFadden Technologies Ltd.
Federal Partners: Health Canada—Radiation Protection Bureau, RCMP, NRCan
Industry Partners: Mobile Detect Inc., Pixon LLC.
Other Partner: DND

A New Antidote Delivery System to Treat Nerve Agent Exposure

HI-6 is an effective nerve agent antidote (NAA), but there are no reliable sources for it and the existing injection system is cumbersome. Researchers collaborated under this project to address these shortcomings. They first developed a new formulation of HI-6. Initial efforts to produce a more soluble formula were successful, but production costs remain high. As an interim measure, the team identified an off-shore source of HI-6 dichloride for conversion to the more soluble formula. The team has also identified production methods and potential suppliers for other drug components. The UK Ministry of Defence has found a prospective manufacturer for a new three-in-one auto-injector. This injector does not meet Canadian requirements, but plans for one that does are in place. Studies for the development of an intravenous formulation of HI-6 for use in clinical settings were to be conducted in late 2007. The UK Ministry of Defence is continuing development of the NAA system and additional funding will allow continued Canadian participation.

CRTI 0131TA: HI-6 Nerve Agent Antidote System
Project Lead: DRDC Ottawa
Federal Partners: PHAC, Public Safety Canada
Industry Partner: UGM Engineering Ltd
Other Partners: UK Ministry of Defence, Netherlands Ministry of Defence

New Radiation Alert System Keeps Canada Safe

Sodium iodide (NaI) radiation detection systems are used by various law-enforcement and security agencies in Canada to detect radiation. These NaI detection systems include fixed-point monitoring network systems, mobile detection systems, and NaI detectors used to screen personnel and materials. Researchers for this project have developed software to enhance the range of industrial isotopes and illicit radioactive materials that can be detected rapidly and on site. The software includes an expanded library of isotopes and has increased sensitivity, allowing for the identification of even small amounts of radiation in materials previously thought free of radiation. This system will assist in the interdiction of the illicit movement of nuclear materials through airports, into harbours, across borders, and out of nuclear facilities. Rapid, accurate characterizations among natural, medical, industrial, and special nuclear material are provided so that security personnel have the necessary information to formulate a course of action. This software has been deployed by CBSA for two years and is currently being used at a CBSA pilot project monitoring ports for illicit radiological-nuclear material within incoming cargo containers.

CRTI 02-0057TA: Canadian Radiation Alert and Expert System for Critical Infrastructure Monitoring
Project Lead: Health Canada
Federal Partner: CBSA
Industry Partners: Ontario Power Generation, SAIC Exploranium

Early CBRN Attack Detection Now Possible

The Early CBRN Attack Detection by Computerized Medical Record Surveillance (ECADS) is a Real-time Outbreak Detection and Surveillance (RODS) syndromic surveillance system. Syndromic surveillance systems are designed to detect time- and geography-dependent abnormal disease occurrences. The ECADS software system processes medical data in real time and generates alerts for public health or anti-terrorism first responders. The project also developed a plan to integrate the ECADS system within other Canadian medical systems. A trial of the ECADS system using data from the *Escherichia coli* contamination in 2000 of the water supply in Walkteron, Ontario, demonstrated that monitoring patients presenting to area emergency rooms could have provided important information regarding the Walkerton outbreak. In December 2005, the ECADS system was successfully installed in the Grey Bruce Public Health Unit in Owen Sound, Ontario. The system was used to issue several alerts to area emergency departments, including a gastrointestinal alert that was confirmed by Health Canada's over-the-counter sales surveillance system.

CRTI 03-0013TD: Early CBRN Attack Detection by Computerized Medical Record Surveillance
Project Lead: NRC—Institute for Marine Biosciences
Federal Partners: NRC—Institute for Information Technology, PHAC
Industry Partner: AMITA Corporation
Other Partners: University of Ottawa Heart Institute, Michigan State University, National Food and Toxicology Center, Carnegie Mellon University—School of Computer Science—Auton Laboratory, Performance Support Services Inc., CAM Emergency Preparedness, e-Privacy Systems Inc., Grey Bruce Public Health Unit, Grey Bruce Health Services, South Bruce Grey Health Centre, Hanover and District Hospital

New Gamma Ray Probes Advance Detecting Direction and Type of Radiation

This project resulted in two radiation detectors: a directional gamma ray probe (DGRP) for use in high-level radiation fields, and a sensitive directional gamma ray probe (SDGRP) for use in low-level radiation fields. The ability to indicate the direction of the radioactive source is a feature not currently available in commercial detectors. The project team tested the detectors in laboratory and field trials, which resulted in refinements to the software and replacement of some defective components. Results from the field trials showed that, on average, the DGRP and SDGRP reduced the time to find radioactive sources compared to another commercially available detector. In addition, the DGRP and SDGRP were better at identifying isotopes. The increased sensitivity of the detectors will lead to better remediation decisions and will reduce the amount of time responders spend in the field exposed to radiation.

CRTI 03-0017TA: Development of a Directional Gamma Ray Probe
Project Lead: DRDC Ottawa
Federal Partners: CNSC, DND—Joint Nuclear, Biological and Chemical Defence Company (JNBCD Co.), RCMP
Industry Partner: Bubble Technology Industries
Other Partner: US Coast Guard

Radiological Surveillance System Enhances Airport Security

Air transportation is a particularly sensitive radiological-terror target because of the number of travellers, the role of air transportation in the economy, and the vulnerabilities associated with a public space. Using technology developed in another project (CRTI 0105TA: Mobile, Real-Time Radiation Surveillance Network), the project team set out to deploy a radiological surveillance system in the Ottawa International Airport that would fully integrate with the routine operations of airport passenger and luggage systems, pre-existing airport security operations, and airport incident response procedures. The project ended in March 2007 with the handover of the surveillance system to the Ottawa International Airport Authority, following the successful deployment of the system at this location. Consisting of sensors that transmit data from covert static and mobile locations to a central server and database, the system provides sensitive, real-time, cost-effective detection of gamma radiation. The system is the first 24-hour, seven-day-a-week radiological surveillance system to fully integrate with airport operations and procedures. The technology is also being used in the intelligent traffic system of the city of Colorado Springs, Colorado.

CRTI 03-0018TD: Airport Radiological Surveillance System
Project Lead: Health Canada—Radiation Protection Bureau
Federal Partner: Transport Canada
Industry Partner: McFadden Technologies, Mobile Detect Inc.
Other Partners: Ottawa Police Service, Ottawa International Airport Authority

New Knowledge Base Permits Safe Recovery, Transport, and Analysis of Radiological-Nuclear Evidence

A Canadian team of experts has made significant progress in enabling forensic specialists to safely recover and analyze evidence following an radiological-nuclear terrorist event, even when there is widespread radiological contamination on the site. The team established protocols, developed laboratory analysis methods, and linked expert responders and forensic identification specialists to foster information sharing in the field. The team organized field and laboratory exercises to test protocols and identify gaps. An exercise was held in December 2006, during which investigators removed radiological samples from a crime scene in the form of swipes and powdered material. The samples were then switched with laboratory-prepared samples of known isotopes and activity before being transported to radiological-nuclear laboratories for analysis. Researchers compiled the final results into a report, which concluded that all participating laboratories correctly identified the isotopes and provided an activity estimate within one order of magnitude of the actual activity. Moreover, the field portion of the exercise sparked significant international interest, leading to agreements for future collaboration.

CRTI 04-0030TD: Nuclear Forensic Response Capabilities and Interoperability
Project Lead: DRDC Ottawa
Federal Partners: CNSC, Health Canada, Public Safety Canada, RCMP
Other Partner: SAIC Canada

Project Team Develops State-of-the-Art Helmet

Med-Eng Systems researchers, in collaboration with the RCMP's Explosives Disposal and Technology Section and DRDC Suffield, developed and evaluated a new chemical and biological (CB) blast protective helmet that is compatible with radio frequency (RF) and electronic countermeasures (ECM). The helmet will enable first responders to work and communicate in an area where a jamming device is emitting an RF field, without worrying about inadvertently activating an improvised explosive device. Researchers used the technology that emerged under the CRTI project Chemical and Biological Blast Protective Helmet (CRTI 0161TA) as the mechanical platform for RF-shielded electronics. The designers improved the helmet, incorporating two interchangeable visors to protect against different threats. In addition, Med-Eng researchers reduced the weight of the helmet to increase user comfort. The helmet underwent extensive testing to determine its compatibility with ECM-jamming, its ability to stop CB agent penetration, and its functionality in a wide range of conditions. The helmet performed well in the tests, and in the fall of 2006, the RCMP's Explosive Disposal and Technology Section received an advanced functional prototype, along with related training from Med-Eng.

CRTI 04-0082TA: Radio Frequency and Electronic Countermeasures-Compatible CB-Blast Protective Helmet
Project Lead: RCMP—Explosives Disposal and Technology Section
Federal Partners: DRDC Suffield
Industry Partner: Med-Eng Systems

Outputs of Projects in Progress 2006–2007

The following descriptions provide highlights of the outputs achieved in ongoing TA and TD projects in 2006–2007.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 02-0057TA: Canadian Radiation Alert/ Expert System for Critical Infrastructure Monitoring	• Health Canada • CBSA • Ontario Power Generation • SAIC Exploranium	To develop software for use in a wide range of existing NaI detector systems, enabling better identification of isotopes and more sensitive alarming capabilities, with the final objective of full spectral identification.	The project team developed the software and the CBSA is using it in their pilot project monitoring ports for illicit RN material within incoming cargo containers. Recently, the project team developed two significant software advances—a spectral library creation and testing browser tool, and an automatic data-processing service—leading toward the final objective. The new software is simpler, more accurate, and sufficiently reliable to make advanced decisions in real time.
CRTI 02-0091TA: *Clostridium botulinum* Type A Genomic DNA Microarray	• Health Canada • NRC • UK Institute of Food Research	To develop highly discriminating typing methods for strains of *Clostridium botulinum*—a bacterium that produces the botulinum neurotoxin—by analyzing its genetic and physiological makeup.	The researchers sequenced the DNA of the *C. botulinum* genome of strain Hall A and constructed a genomic microarray. They used microarray typing to identify unknown strains of Group I *C. botulinum*. They found that PCR analysis of flagellin and neurotoxin genes can be combined to improve typing. The researchers found that flagellin from various strains of *C. botulinum* showed a variety of post-translational modifications. They could identify the ions associated with these modifications in a mixed-protein sample, a discovery that shows promise as a method of *C. botulinum* typing, independent of DNA analysis.
CRTI 03-0019TD: Real-time Biosurveillance and Response Readiness Using an Interconnected, Electronic Information Infrastructure	• PHAC • IBM Canada • Winnipeg Regional Health Authority	To integrate health data from many points of care, including emergency rooms, telehealth labs, and over-the-counter (OTC) drug sales, in order to contribute to the detection and characterization of, and response to bioterrorism and other disease events.	Early detection can contribute to the prevention and mitigation of disease events. The Canadian Early Warning System (CEWS), launched in Winnipeg in 2006, is the only syndromic surveillance system in Canada to offer a web-based, multi-data feed platform for access to real-time data sources. The integration of many data sources and interoperability between public healthcare workers at all jurisdictional levels allows for a collective detection and response capacity. Initial evaluation of CEWS revealed a lack of standards and contextual information, a high false-positive rate, and information overload. Further evaluation will be performed.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 03-0021TD: Assay Development and Production Team for the Identification of Bioterrorism Agents	• PHAC • CFIA • DRDC Suffield	To form a core diagnostic group, called the Assay Development and Production Team (ADAPT), who will develop, produce, and distribute tests for the detection of bioterrorist agents.	ADAPT upgraded the hybridoma facility at DRDC Suffield and established a laboratory for hybridoma and monoclonal antibodies (mAb) development. The team is comparing its new mAbs with antibodies acquired from the US Department of Defense (DOD), and is applying these antibodies to a rapid field-portable electro¬chemiluminscence (ECL) assay. DRDC Suffield has developed ECL assays for *Bacillus anthracis* protective antigen and several other biothreat agents. Compared to standard diagnostic tests, ECL is faster, easier, more sensitive, and can be used in the field. This research also strengthens ties with international collaborators.
CRTI 03-0025TA: Defender™ Nuclear Detection Web	• Health Canada • CBSA • Canadian Police Research Centre (CPRC) • DRDC Ottawa, • Transport Canada • Bubble Technology Industries • xwave • Raytheon Company	To develop an ultra-sensitive, low-cost nuclear detection web for the rapid and accurate detection of RN materials.	Bubble Technology Industries' Defender™ neutron detector provides immediate detection and measurement of neutrons. For this project, the developers are equipping the Defender™ with instrumentation for automatic readout, global positioning, alarms, and wireless communication, and the data will be uploaded to a network for access via the Internet. The project scope was expanded to include participation in the Canada-US Cargo Security Project (CUSCSP). The low-cost system will be able to detect illicit RN materials before weapon assembly takes place. Defender™ detectors have been tested, improved, and are undergoing further tests. The participating federal agencies will retain the instrumented detectors for ongoing use.
CRTI 04-0019TD: Field Demonstration of Advanced CBRN Decontamination Technologies	• Environment Canada • DRDC Suffield • DRDC Ottawa • PHAC • Allen-Vanguard Corporation • SAIC Canada • US Environmental Protection Agency	To demonstrate and analyze building decontamination technologies for chemical, biological, and radiological counterterrorism.	The team held chemical and biological trials using buildings at DRDC Suffield. Surrogate chemical agents were decontaminated with the surface decontamination foam (SDF) and two bacterial species were decontaminated using vaporous hydrogen peroxide (VHP). The team found that concentrations of the contaminant and type of surface material influenced the results. SDF was 40 to 100 percent effective in decontaminating building materials. VHP worked well on non-porous materials, but not on porous materials.
CRTI 04-0047TD: CBRN Incident Database	• RCMP • CSIS • CFIA • DRDC Ottawa • CNSC • NRCan • AMITA Corporation • Carleton University • Singapore Armed Forces • Australian Federal Police	To develop and demonstrate a hazardous materials incident database to enable data exchange between national and international agencies.	The project team has completed software development for the CBRN Incident Database (CID) and is deploying it to a restricted user base for testing. The scope of CID has been broadened to include explosives. CID has generated international interest among police and defence agencies. CID will be converted to Spanish and plans are underway to implement CID on a server at the International Criminal Police Organization (INTERPOL). DND officials are determining if a militarized version of CID can be made interoperable with the civilian version.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 05-0006TA: Optically Stimulated Luminescent Radiation Sensor for Long-Dwell Detection in Transit Applications	• DRDC Ottawa • CBSA • Transport Canada • DRDC Atlantic • Bubble Technology Industries	To develop a radiation sensor based on OSL that can be installed inside a cargo container to detect the presence of low levels of radiation during shipment, increasing Canada's capacity to thwart RN attacks.	Bubble Technology Industries has advanced the OSL sensor that was part of a prototype radiation detector developed during a previous CRTI project. Bubble Technology Industries found that the new sensor functioned well during temperature fluctuations and in high magnetic fields. Based on feedback from CBSA and Transport Canada, Bubble Technology Industries designed a rugged mechanical concept for the sensor enclosure so that it can withstand conditions within cargo containers.
CRTI 05-0058TD: Unified Interoperability Solution Set to Support CONOPS Framework Development: Municipal-Provincial-Federal Collaboration to CBRNE Response	• DRDC Ottawa • Environment Canada • DRDC Suffield • DND • RCMP • CAE Professional Services (Canada) • EmerGeo Solutions • Justice Institute of British Columbia • Vancouver Police Service • Vancouver Fire and Rescue Services • British Columbia Ambulance Service	To produce a capability analysis methodology, based on simulation and consideration of scenarios, which can be used to evaluate response capabilities to all hazard types.	The team used information from subject-matter experts (SMEs) to design an interoperability framework and concept of operations (CONOPS) for municipal-provincial-federal interoperability in a CBRN response. The project's response partners will validate the CONOPS. The team has acquired two-dimensional (2-D) and three-dimensional (3-D) data from the City of Vancouver and is integrating the data into the geographic information system (GIS)-based Common Operating Picture Environment (COPE). COPE will be used in demonstrations at the end of the project. Environment Canada is developing atmospheric models in conjunction with DRDC Suffield.
CRTI 05-0090TA: Adaptation of Recently Developed DNA Microarrays to NanoChip Microarray Technology for Detection of Agroterrorism Agents	• CFIA • Nanogen	To improve detection and typing of the viruses for foot-and-mouth disease (FMD) and avian influenza (AI) by adapting DNA slide microarray technology to the more portable NanoChip platform that can be easily used by first responders.	The project team has made substantial progress in assay design and layout for the NanoChip platform. The capture probe down format has proven effective for detecting FMD virus serotypes and AI hemagglutinin subtypes, and appears more suitable than the alternative amplicon down format. Project researchers have optimized the capture probes for the NanoChip platform and as a response to the expanding database of AI sequences. Their work on selecting capture probes for use in the NanoChip is ongoing. The researchers have incorporated reporter probes in the assay to replace the direct labeling of the amplicons, thereby streamlining the assay.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 05-0092TA: Integrated Personal Cooling for Chemical and Biological Protective Undergarments	• RCMP • RMC • DRDC Suffield • Med-Eng Systems • University of Ottawa	To develop an undergarment for first responders that will integrate chemical protection and cooling into one layer, resulting in decreased staging time, increased mobility, reduced heat stress, and easier decontamination.	Researchers at Med-Eng Systems made swatches of chemical protective undergarments from materials by three different manufacturers, combining them with different moisture management layers, and using two methods to affix cooling tubes. Following tests, the researchers are using the layers from the best performing swatches to make prototype garments, which will undergo further testing.
CRTI 05-0106TA: Development of Field-ready Nucleic Acid Detection Techniques for Category 1 and 2 Biological Agents	• PHAC • DRDC Suffield • Cepheid Incorporated	To develop real-time assays to detect the nucleic acid of a broader range of Category 1 and 2 biological weapon threats such as Ebola and Lassa viruses.	The project team identified real-time probe sets for the chosen biological agents and converted them to optimize their functionality with Cepheid's automated, real-time PCR systems, Smartcycler and GeneXpert. The team evaluated the first trial conversions and determined that the assays detected Ebola and Marburg viruses with equally high sensitivity. The remaining probe sets are being converted to the probe format, while Cepheid continues to upgrade its systems.
CRTI 05-0108TD: National Nuclear Emergency Laboratory Network and Interoperability	• Health Canada • DRDC Ottawa • RMC • Department of Fisheries and Oceans • Ontario Ministry of Labour • BC Centre for Disease Control • Trent University	To develop a framework for a national laboratory network for RN emergency preparedness, including laboratory protocols, an information technology (IT) solution for lab results networking, and gamma-ray spectra interoperability.	Based on the outcomes of a workshop on RN scenarios and on requirements for laboratory analysis, the project partners repackaged the lab protocols to be developed and reorganized planned exercises. The project team consolidated procedures in use at participating labs. To develop a networking solution, the researchers are finalizing the formats for standard protocols, data, and reports to be used by participating labs. Health Canada and the Ontario Ministry of Labour are developing gamma spectra interoperability.
CRTI 05-0122TD: CBRN Crime Scene Modeller	• RCMP • CPRC • DRDC Ottawa • MDA Space Missions • Toronto Police Services • Vancouver Police Department • York University	To develop a multi-sensor, 3-D modelling system for collecting evidence at crime scenes contaminated with CBRN agents with minimum exposure to first responders.	The project team developed the architecture and CONOPS for the CBRN Crime Scene Modeller (C2SM). The C2SM uses stereo cameras to record images and create 3-D models of the scene, while other sensors provide CBRN-specific information. A prototype C2SM, which the team has interfaced with a computer, includes an embedded computer and a screen with an input device. A remote operator can access the unit computer through a wireless link to assist the unit operator. The prototype is being tested.

PROJECT	LEAD AND PARTNERS	OBJECTIVE	KEY OUTPUTS
CRTI 05-0123TD: All-hazards Sample Receiving and Storage Capability	• DRDC Suffield • PHAC • Public Safety Canada • RCMP • DRDC Ottawa • Metro Toronto Police • Ontario Provincial Police • Toronto Emergency Management Services • Centre for Forensic Sciences	To deliver the capability for an all-hazards sample-receiving facility by developing standard operating procedures (SOPs), procuring specialized equipment, building a prototype facility, and demonstrating the completed facility at the Counter Terrorism Technology Centre (CTTC) at DRDC Suffield.	The project team is acquiring knowledge to enable Canada to establish facilities to receive, triage, sample, store, and direct hazardous samples to laboratories. DRDC Suffield is collaborating with the US Army's Forensic Analytical Center's Mobile Laboratory and Kits Team, and is initiating collaboration with the UK's National Network of Laboratories. The team will gain knowledge from these collaborators who already have all-hazard sample receiving and storage facilities.

4.3.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

The development of ECADS is the culmination of a unique collaboration among project partners and has greatly increased Canada's response capabilities. Work to develop other surveillance systems, containment systems, assays, prototypes, and other technologies in ongoing TA and TD projects contributes to Canadian S&T performers' knowledge of CBRN countermeasures. The knowledge, technology, and capacity developed in these ongoing projects will be transferred to first responders upon their completion.

4.4 BUILDING NATIONAL S&T CAPACITY

CRTI supports the development of national S&T capacity through the acquisition of existing technology for use primarily by science-based departments and agencies.

Technology acquisitions are intended to establish or enhance the infrastructure and equipment of the laboratory clusters, and thereby address gaps in Canada's ability to respond to CBRN threats. These acquisitions should typically be made in the year in which they are funded and be "off-the-shelf" purchases of existing technology. Priority is given to those submissions that address the most critical gaps in capacity that are consistent with cluster objectives, roles, and responsibilities.

4.4.1 OUTPUTS

In 2006–2007, facilities were provided with funding to purchase acquisitions aimed at addressing identified gaps. In many cases, other organizations also gain access to the CRTI-funded acquisition, extending its reach and benefit. A total of $2.6 million was awarded for acquisitions in 2006–2007.

Technology Acquisition projects that were completed and began contributing to the federal laboratory response capacity in 2006–2007 are as follows:

- Biological Agent Detection Systems for CBSA Evaluation (BIO025AP)
- BIOLOG Microstation Microbial Identification System (BIO026AP)
- Acquisition of the Pathalert Detection System for the Rapid High Throughput Detection of *Bacillus Anthracis* And *Yersinia Pestis* Aas Potential Foodborne Bioterrorist Agents (BIO027AP)
- Upgrade of Bioaerosol Testing Facilities (BIO028AP)
- Vaporized Hydrogen Peroxide Decontamination Equipment (BIO030AP)
- Surveillance of Foreign Animal Disease in the Field using Air Sampling Coupled With Rapid Identification using DNA Technology (BIO032AP)
- Air Sampling Equipment, most notably Summa Canisters, is a Primary Tool Used at Spills and Other Responses (CHEM032AP)
- Repairs to AED System to Provide Elemental And Empirical Formulae Analysis of Unknown or Unusual Chemical Contaminants (CHEM033AP)
- A System for the Sampling and Analysis of Unknown Gaseous Samples using Summa Canister Technology (CHEM034AP)
- Gas Chromatogram (GC) Equipped with Dual Flame Photometric Detectors (FPD) Specific to Phosphorus (P) and Sulfur (S) and a Mass Selective Detector (MSD) (CHEM035AP)
- Air Sampling Equipment for Hazardous Materials (CHEM036AP)
- Dissemination Equipment for Chemical Protection Test Facility (CHEM037AP)
- Gas Chromatography Mass Spectrometer System with Micro conductivity Detector for Toxic Gas Analysis (CHEM039AP)
- Portable Air Sampling Equipment for First Responders – Personal Pumps (CHEM040AP)
- Portable Air Sampling Equipment for First Responders – Nox Monitors (CHEM041AP)
- Portable Air Sampling Equipment for First Responders – Ultrafine Particle Monitors (CHEM042AP)
- Benchtop Flow Cytometer (CHEM043AP)
- Equipment and Forensic Identification Protocols for the On-Site Identification of Biological Materials "et al" (FOR003AP)
- Multi-Sample Molecular Identification of Biological Agents (FOR005AP)
- Multiplexing Capability for Biological Screening of Samples (FOR006AP)
- Ancillary Equipment for the Mobile Nuclear Labs (RN017AP)
- Mobile Lab Truck Upgrades (RN018AP)
- Upgraded High Bandwidth Internet Communications Link for the FNEP Emergency Response Network (ARGOS and CHIRP Systems) (RN019AP)
- RN Exercise Control Team Deployable High Bandwidth Satellite Communication System (RN020AP)
- Phase 1 Rollout of Ruggedization of Fixed Point Surveillance Network (RN021AP)
- Phase 2 Fixed Point Surveillance Network Upgrade (RN022AP)

- Portable Cell - Counter for Identification of Irradiated Individuals (RN023AP)
- Twin-Port Glove Box for Analysis of Nuclear Forensic Samples (RN025AP)
- Acquisition of Extended Range HPGE Detector (RN027AP)
- Proof-of-Concept for Data Logging, Telemetry, and Populating a Laboratory Information System (LIMS) with High Volume Air Sampler Data (RN028AP)
- Automation of Plutonium Measurements (RN029AP)
- Distant Early Warning Assessment of Radioactivity (DEWAR) (RN031AP)

4.4.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

The purchase of storage equipment, analysis tools, and other products enhanced federal laboratory capabilities in 2006–2007. Given the dual-use functions of some of this equipment, staff will have an opportunity to hone their knowledge and skills prior before applying it as a CBRN countermeasure.

4.5 BUILDING HORIZONTAL CAPABILITY

"Building Horizontal Capability" refers to the ability of CRTI to encourage and nurture partnerships that leverage capability and capacity. As the field of CBRNE counterterrorism is international and multidisciplinary, strong partnerships to bridge geographical borders and complementary areas of expertise are critical.

4.5.1 OUTPUTS

National and International Collaboration

The success of the CRTI's model depends on leveraging the knowledge, facilities, and expertise of its 19 partner departments and agencies in the Government of Canada, and among federal, provincial, and municipal levels of government, private sector industry, academia, and responder and operational communities, both in Canada and abroad.

CRTI has also established significant new cooperation with the UK's Nuclear Threat Reduction organizations and the Health Protection Agency's Emergency Response Division. International workshops such as those outlined in subsection 4.1.1. have also provided excellent opportunities for new partnerships.

4.5.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

CRTI's strengthened partnerships with the US, as well as new relationships forged with other provincial, national, and UK partners enabled CRTI to share and receive new knowledge for CBRNE countermeasures in 2006–2007. In the near-term, CRTI's reach both within Canada and abroad will be significantly strengthened and expanded with the new CSS goverance structure, resources, and alignment with PSTP.

4.6 BUILDING CBRNE EXPERTISE AND KNOWLEDGE

CRTI builds CBRNE expertise and knowledge within the operational community and among national and international CBRNE partners through symposia and other knowledge management activities and products.

4.6.1 OUTPUTS

CRTI Summer Symposium

Held in Gatineau, Quebec, on 12–15 June, 2006, the fourth annual CRTI Summer Symposium provided an opportunity for CRTI and the broader CBRNE community to learn about the progress of the projects from the first four rounds of funding and share CBRNE knowledge with other experts in the field. The three-day scientific conference was followed by a two-day workshop and demonstration for first responders.

During the scientific conference, the 270 attendees learned of the results of several completed projects funded by CRTI through oral and poster presentations. These updates on new contributions to Canada's CBRNE preparedness were complemented by keynote speeches from representatives from several research institutions, as well as a distinguished former Canadian politician.

Participants were treated to a presentation by key note speaker Prof. Wesley Wark, from the Munk Institute at the University of Toronto, who spoke on the potential motivations for the use of WMD (weapons of mass destruction) or "super" terrorism. A special highlight for the crowd was when guest speaker Mr. Preston Manning shared his approach on how to communicate the value of science programs to decision-makers.

The Symposium wrapped up on the third day with presentations on applying scientific results to first responder guidelines. Dr. Steve Musolino from Brookhaven National Labs in the U.S. shared the podium with Dr. Lorne Erhardt of DRDC Ottawa to present their research with the first responder community.

Other CBRNE Community Outreach Events

CRTI also sponsored a CBRNE forensic workshop in August 2006 entitled "From Crime Scene to Courtroom" at the joint Canadian Identification Society and Canadian Society of Forensic Science conference at the University of Windsor. The objective of the workshop was to explore the current state of Canadian CBRNE preparedness from the perspective of a criminal investigation.

4.6.2 ALIGNMENT WITH INTERMEDIATE OUTCOMES

Participating in national and international workshops and events (as previously mentioned in subsection 4.1.1) enables CRTI to strengthen existing partnerships, such as those with the US, the UK, and Russia as well as develop new ones, such as those with Japan and the Netherlands. As CRTI broadens its network, it raises its profile and expands its knowledge base. The summer symposium is a critical forum for knowledge sharing and for identifying the operational needs of first responders for CBRNE countermeasures, and will continue to play a central role in determining CRTI's priorities.

5. OUTLOOK

AS part of its renewal for its second five-year mandate, Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI) has shifted its focus from building and strengthening the security capacity of Canada's science and technology (S&T) to broadly developing Canada's capability to prepare for, respond to, and mitigate the consequences of a wide-range of hazards. CRTI has defined the new approach, identified its impact on operations, and will integrate more capability-based planning into its activities and governance. This reorientation recognizes that by leveraging S&T, CRTI can help build capability in other areas that threaten the safety and security of Canadians, including criminal activities, accidents, and natural disasters.

In the coming year, CRTI will augment the new Explosives Cluster, and continue to develop its partnership with the Public Safety Technical Program (PSTP) under the Centre for Security Science (CSS). The Call for Proposals issued in 2007 will reflect this change of focus, with proponents being asked to address specific, identified knowledge and capability gaps, as well as the need to take a systems approach to S&T development.

CRTI's renewal marks a maturation of the program that is reflected in CRTI's outreach activities. Building on the success CRTI found by helping build horizontal networks across federal departments, the program is now committed to building even more diverse networks by reaching out to academia, industry, and the responder and receiver communities, as well as building more international partnerships. As these enhanced, multi-jurisdictional and multi-disciplinary networks are built, they will allow the S&T generated by CRTI and CSS as a whole to inform policies, response systems and standards, and operational plans to further develop our national capability for all-hazards response.

Protecting the safety and security of Canadians requires a flexible, dynamic approach to meet the changing nature of the threats the nation faces. To remain static would be to become ineffective in meeting this challenge. CRTI continues to evolve to ensure that the accomplishments of its partners continue to meet the challenge.

ANNEX A: **LIST OF ACRONYMS AND INITIALISMS**

2-D: two-dimensional

3-D: three-dimensional

AAFC: Agriculture and Agri-Food Canada

ADAPT: Assay Development and Production Team

ADM: Assistant Deputy Minister

AECL: Atomic Energy of Canada Limited

AED: atomic emission spectrometry

AI: avian influenza

API: atmospheric pressure ionization

ARGOS: Accident Reporting and Guidance Operation System

ARS: acute radiation syndrome

BC: British Columbia

BCGH: Bacterial Comparative Genomic Hybridization

C2SM: CBRN Crime Scene Modeller

C^4I: Command, Control, Communications, Coordination, and Information

CATSA: Canadian Air Transportation Safety Authority

CB: chemical and biological

CBRN: chemical, biological, radiological, and nuclear

CBRNE: chemical, biological, radiological, nuclear, and explosives

CBSA: Canada Border Services Agency

CBW: chemical and biological weapon

CEPR: Centre for Emergency Preparedness and Response

CEWS: Canadian Early Warning System

CFB: Canadian Forces Base

CFIA: Canadian Food Inspection Agency

CHIRP: Canadian Health Integrated Response Platform

CID: CBRN Incident Database

CIOSC: Canadian Integrated Outbreak Surveillance Centre

CIP: Critical Infrastructure Protection

CMC: Canadian Meteorological Centree

CNPHI: Canadian Network for Public Health Intelligence

CNSC: Canadian Nuclear Safety Commission

CONOPS: concept of operations

COPE: Common Operating Picture Environment

CpG ODN: cytosine-phosphate-guanine oligodeoxynucleotides

CRTI: CBRNE Research and Technology Initiative

CSIS: Canadian Security Intelligence Service

CSS: Centre for Security Science

CTTP: Counter Terrorism Technology Centre

CUSCSP: Canada-US Cargo Security Project

DGRP: directional gamma ray probe

DHS: Department of Homeland Security (US)

DNBCD: Directorate of Nuclear, Biological and Chemical Defence

DND: Department of National Defence

DOD: Department of Defense

DOE: Department of Energy (US)

DRDC: Defence Research and Development Canada

ECADS: Early CBRN Attack Detection by Computerized Medical Record Surveillance

ECL: electro¬chemiluminscence

ECM: electronic countermeasures

END: electronic neutron dosimeter

EOC: Emergency Operations Centre

FAIMS: high-field asymmetric waveform ion mobility spectrometry

FMD: foot-and-mouth disease

FNEP: Federal Nuclear Emergency Plan

FPD: flame photometric detectors

GC: gas chromatogram

GEM: Global Environmental Multiscale

GIS: geographic information system

GMP: good manufacturing practice

IED: Improvised Explosive Device

INTERPOL: International Criminal Police Organization

ISR: International Safety Research

IT: information technology

JNBCD Co: Joint Nuclear, Biological and Chemical Defence Company

LIMS: Laboratory Information Management Syteam

LSJML: Laboratoire de sciences judiciaires et de médecine légale

mAb: monoclonal antibodies

MEDNEREX: Medical Nuclear Emergency Response Exercise

MLVA: multi-locus variable-number tandem repeat analysis

MOU: Memorandum of Understanding

MS: mass spectrometry

MSD: mass selective detector

NAA: nerve agent antidote

NAADSM: North American Animal Disease Spread Model

NaI: sodium iodide

NATO: North Atlantic Treaty Organization

NBC: nuclear, biological, and chemical

NBDRP: National Biological Dosimetry Response Plan

NCFAD: National Centre for Foreign Animal Disease

NCR: National Capital Region

NML: National Microbiology Laboratory

NRC: National Research Council

NRCan: Natural Resources Canada

OSL: optically stimulated luminescence

OTC: over-the-counter

PCR: polymerase chain reaction

PEG-GM-CSF: granulocyte-macrophage colony-stimulating factor modified with polyethylene glycol

PHAC: Public Health Agency of Canada

PMB: Program Management Board

PPE: personal protective equipment

PRA: Probabilistic Risk Assessment

P-RAM: Psychosocial Risk Assessment and Management

PSD: pulse shape discrimination

PSTP: Public Security Technical Program

PWGSC: Public Works and Government Services Canada

RCMP: Royal Canadian Mounted Police

RD: Research and Technology Development

RDD: radiological dispersal device

RF: radio frequency

RMAF: Results-based Management and Accountability Framework

RMC: Royal Military College of Canada

RN: Radiological-Nuclear

RODS: Real-time Outbreak Detection and Surveillance

S&T: science and technology

SDF: surface decontamination foam

SDGRP: sensitive directional gamma ray probe

SME: subject-matter expert

SOP: standard operating procedure

TA: Technology Acceleration

TBS: Treasury Board of Canada Secretariat

TD: Technology Demonstration

UK: United Kingdom

US: United States

VHP: vaporous hydrogen peroxide

VSV: vesicular stomatitis virus

WHO: World Health Organization

WMD: weapon of mass destruction

DISTRIBUTION OF FUNDS BY PROJECT

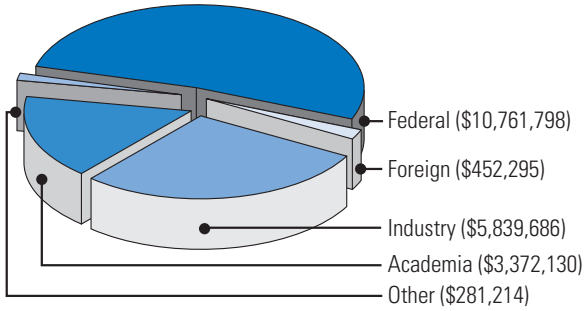
PROJECT	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	CRTI FUNDING
CRTI 0004TA	50,000	–	–	–	–	–	–				50,000
CRTI 0006RD	52,500	457,500	400,000	289,500	–	–	–				1,199,500
CRTI 0011TA	200,000	600,000	–	–	–	–	–				800,000
CRTI 0019TA	361,600	1,535,000	729,000	–	–	–	–				2,625,600
CRTI 0027RD	142,600	1,250,500	916,300	743,400	607,200	–	–				3,660,000
CRTI 0029RD	198,460	1,094,410	871,340	583,670	252,130	–	–				3,000,010
CRTI 0052TA	95,826	22,706	349,943	39,750		–	–				708,225
CRTI 0060TA	–	1,082,985	84,693	–	–	–	–				1,167,678
CRTI 0064RD	130,070	733,747	571,576	600,315	437,042	–	–				2,472,750
CRTI 0072RD	34,100	228,100	319,100	245,800	–	–	–				827,100
CRTI 0080TA	142,000	353,000	–	–	–	–	–				495,000
CRTI 0085TA	58,950	656,000	485,050	–	–	–	–				1,200,000
CRTI 0087RD	178,592	1,660,995	786,713	–	–	–	–				2,626,300
CRTI 0091RD	148,487	702,610	757,674	528,970	176,722	–	–				2,314,463
CRTI 0100TA	–	1,170,296	1,557,333	–	–	–	–				2,727,629
CRTI 0105TA	247,220	655,333	534,277	338,222	–	–	–				1,775,052
CRTI 0120RD	107,479	1,047,575	497,446	–	–	–	–				1,652,500
CRTI 0131TA	400,000	1,800,000	1,700,000	1,100,000	–	–	–				5,000,000
CRTI 0133RD	673,100	364,700	254,700	174,900	–	–	–				1,467,400
CRTI 0154RD	182,210	718,149	731,749	808,939	558,380	–	–				2,999,427
CRTI 0161TA	443,145	695,655	21,200	–	–	–	–				1,160,000
CRTI 0196TA	695,400	1,401,200	1,229,100	1,101,500	–	–	–				4,427,200
CRTI 0203RD	213,400	912,800	195,400	–	–	–	–				1,321,600
CRTI 0204RD	163,100	259,700	136,600	–	–	–	–				559,400
CRTI 02–0007TA	–	637,167	835,167	267,566	–	–	–				1,739,900
CRTI 02–0021RD	–	500,000	500,000	–	–	–	–				1,000,000
CRTI 02–0024RD	–	378,700	612,200	420,300	–	–	–				1,411,200
CRTI 02–0035RD	–	1,160,071	1,258,365	1,281,226		–	–				3,699,662
CRTI 02–0041RD	–	455,500	560,500	550,500	449,500	–	–				2,016,000
CRTI 02–0041TA	–	349,330	606,000	179,700	–	–	–				1,135,030
CRTI 02–0043TA	–	448,624	921,766	591,372	–	–	–				1,961,762
CRTI 02–0045RD	–	339,330	460,820	565,900	–	–	–				1,366,050
CRTI 02–0053TA	–	683,027	799,737	–	–	–	–				1,482,764

PROJECT	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	CRTI FUNDING
CRTI 02–0057TA	–	240,000	220,000	190,000	–	–	–				650,000
CRTI 02–0066RD	–	384,843	599,500	194,500	312,938	–	–				1,491,781
CRTI 02–0067RD	–	526,316	763,269	710,411	–	–	–				1,999,996
CRTI 02–0069RD	–	856,035	398,929	301,600	304,272	–	–				1,860,836
CRTI 02–0080RD	–	339,565	655,665	610,565	594,065	–	–				2,199,860
CRTI 02–0091TA	–	91,723	100,000	100,000	100,000	–	–				391,723
CRTI 02–0093RD	–	541,000	961,000	1,157,000	826,000	–	–				3,485,000
CRTI 02–0093TA	–	583,275	427,446	159,779	–	–	–				1,170,500
CRTI 03–0005RD			352,222	716,685	747,778	383,315					2,200,000
CRTI 03–0009RD			160,208	347,820	332,120	259,852					1,100,000
CRTI 03–0013TD			466,478	1,046,582	286,940						1,800,000
CRTI 03–0017TA			200,000	180,000							380,000
CRTI 03–0018RD			732,300	796,900	715,700	174,900					2,419,800
CRTI 03–0018TD			1,236,400	463,400	201,500						1,901,300
CRTI 03–0019TD			780,000	847,000	173,000						1,800,000
CRTI 03–0021TD			354,129	631,728	637,502	376,641					2,000,000
CRTI 03–0023TD			78,000	476,300							554,300
CRTI 03–0025TA			782,638	737,363							1,520,000
CRTI 03–0060RD			232,771	344,327	351,752	81,007					1,009,857
CRTI 04–0004RD				431,000	881,000	781,000	307,000				2,400,000
CRTI 04–0018RD				538,915	771,451	716,641	682,993				2,710,000
CRTI 04–0019TD				385,492	458,696						844,188
CRTI 04–0022RD				146,500	168,500	133,500					448,500
CRTI 04–0029RD				275,000	397,000	265,000	20,000				957,000
CRTI 04–0030TD				172,500	194,100						366,600
CRTI 04–0045RD				439,000	757,000	581,000	223,000				2,000,000
CRTI 04–0047TD				394,092	903,317	107,497					1,404,906
CRTI 04–0052RD				272,115	728,417	668,605	330,863				2,000,000
CRTI 04–0082TA				222,348	177,652						400,000
CRTI 04–0112TD				256,000	189,500						445,500
CRTI 04–0127RD				98,940	801,059	703,059	362,680				1,965,738
CRTI 05–0006TA					392,400	294,200					686,600
CRTI 05–0014RD						91,195	245,830	191,510	64,665		593,200
CRTI 05–0016RD					139,576	167,826	242,576				549,978

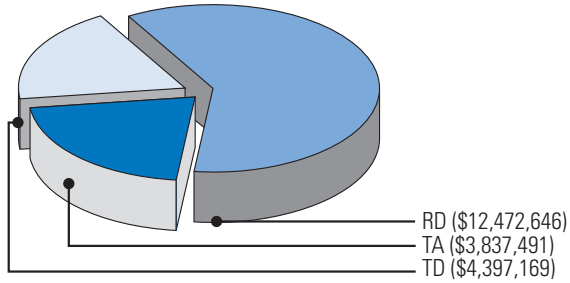
PROJECT	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011	2011–2012	CRTI FUNDING
CRTI 05–0043RD				10,000	113,000	113,000					236,000
CRTI 05–0053TA					417,000	365,000	218,000				1,000,000
CRTI 05–0058TD					380,045	498,016	621,939				1,500,000
CRTI 05–0069RD					516,858	862,377	534,120	86,645			2,000,000
CRTI 05–0078RD					58,854	485,350	583,546	579,891	257,776	44,581	2,009,998
CRTI 05–0090TA					263,500	392,500	219,000				875,000
CRTI 05–0092TA					75,000	185,000					260,000
CRTI 05–0106TA					235,084	391,409	153,507				780,000
CRTI 05–0108TD					346,500	285,500	353,000				985,000
CRTI 05–0121RD					5,000	408,550	203,550	43,000			660,100
CRTI 05–0122TD							269,060	791,677	540,591		1,601,328
CRTI 05–0123TD				20,000	102,000	302,000	876,400				1,300,400

ANNEX C: **FINANCIAL OVERVIEW 2006–2007**

DISTRIBUTION OF FUNDS BY SECTOR



DISTRIBUTION OF FUNDS BY PROJECT CATEGORY



FUNDING TO FEDERAL GOVERNMENT PARTNERS 2006–2007

DEPARTMENT/AGENCY	2006–2007 PORTION
Agriculture and Agri-Food Canada	$ 757,000
Environment Canada	$ 2,025,588
Health Canada	$ 3,606,440
Royal Canadian Mounted Police	$ 1,283,470
National Research Council of Canada	$ 1,236,531
Canada Security Intelligence Service	$ 43,935
Canadian Food Inspection Agency	$ 2,400,681
Public Health Agency of Canada	$ 3,563,221
Department of National Defence	$ 376,995
Public Works Government Services Canada	$ 65,576
DRDC Ottawa	$ 4,368,700
DRDC Suffield	$ 979,168
Total	**$ 20,707,305**