Canada Foundation for Innovation

Description of Infrastructure Project and Assessment Against CFI Criteria

Date 03/10/2003 Project number 8910

Descriptive title of infrastructure project (no more than 200 characters):

DNA and Forensic Science Research Centre

Funding program applied to:

Innovation Fund

Language of application:

☒ English ☐ French

Institution (See next page for multi-institution applications)

Trent University

Total cost of infrastructure project and amount requested from the CFI

Note that for each year the CFI request should not exceed 40% of the cumulative cost to that year.

Costs	Year 1	Year 2	Year 3	Year 4	4-year TOTAL
Total project	6 400 905	4 382 681	192 614		$10,976,200
Partner contributions	4 073 435	2 546 580	107 557		$6,727,572
CFI request	$2,327,470	$1,836,101	$85,057		$4,248,628

Designated Project Leader

Name: White, Bradley

Title: Professor

Department: Biology

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Key words: Provide a maximum of ten (10) words that describe the infrastructure project and the research to which it will contribute. Use commas to separate each key word.

DNA Profiling, Geographic Information Systems, Forensic Science, Wildlife Disease, Automation and Robotics, Human Disease, Exercise and Aging, Natural Resources Management, Species at risk.

Research discipline/field code:

Primary: 14400

Secondary: 11700

Area of application code:

Primary: 6.4

Secondary: 4.0

Signature: It is agreed that the general conditions governing the matching provisions and the use of CFI funds as outlined in the Institutional Agreement and the CFI Policy and Program Guide apply to the infrastructure project outlined in this application and are hereby accepted by the institution.

Name _____ Signature _____ Date _____

CEO or President of the Institution (or authorized representative)

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Multi-institutional application. To be completed by **eligible** institutions (other than the institution identified on page 1) that **would share CFI funding** for this project, if approved by the CFI.

The following eligible institutions that will receive CFI funding for this project, agree that the general conditions governing the partner contributions and the use of CFI funds, as outlined in the Institutional Agreement and in the CFI Policy and Program Guide, apply to the project outlined in this application and are hereby accepted by each institution.

Institution:

Name (CEO or President of the institution or authorized representative):

Date:

Signature:

Institution:

Name (CEO or President of the institution or authorized representative):

Date:

Signature:

Institution:

Name (CEO or President of the institution or authorized representative):

Date:

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Institution:

Name (CEO or President of the institution or authorized representative):

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Name (CEO or President of the institution or authorized representative):

Date:

Signature:

Institution:

Name (CEO or President of the institution or authorized representative):

Date:

Signature:

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DNA and Forensic Science Research Centre

Project overview

In language appropriate for a multidisciplinary committee, use this page and up to one additional page to describe the **infrastructure** that will be acquired or developed and indicate where the infrastructure will be located. Indicate briefly why the infrastructure is needed, what research it will enable to be performed and why that research is important.

The DNA and Forensic Science Research Centre will be constructed in the DNA Partnership Building on the campus of Trent University starting in the spring of 2004. The DNA Partnership Building will be the first stage of the Peterborough DNA Cluster Project, which is a community-wide initiative to develop a Regional Centre of Excellence in DNA and Forensic Science. The Peterborough Cluster represents a node in the corridor of Biotechnology Clusters being developed in Ontario and has been funded by Human Resources Development Canada, Industry Canada and the Ontario Biotechnology Cluster Innovation Program (BCIP). The cluster project will be overseen by an Executive Co-ordinator who has just been hired and who will be responsible to the Founding Directorate and Greater Peterborough and Area Economc Development Corporation (GPAEDC). The construction of the DNA Partnership Building will be funded through a combination of private and public sector capital and leasing agreements and will also house research scientists of the Ontario Ministry of Natural Resources (OMNR), police identification units and the private sector partners. This proposal is specifically for the central facilities, which will house the research infrastructure and will comprise about 25% of the building. The research infrastructure will be primarily used by 8 Trent Biology faculty, all of whom have been hired in the past 3 years and 2 OMNR scientists who hold Trent adjunct appointemnts. It will include equipment that has already been obtained with funds from CFI/OIT. The research partners also include Sir Sandford Fleming College, Environment Canada, Department of Fisheries and Oceans, Royal Botanical Gardens, Toronto Metro Zoo and police services. The private sector partners include the GPAEDC, Maxxam Analytics, LabinterLINK, Retisoft, Lakefield Research, Pickseed and the Ontario Fur Managers Federation. This research initiative has developed from the move of the headquarters of the OMNR to Peterborough and increased research activity at Trent University and OMNR in DNA Profiling and Forensic Science. The infrastructure will support research programs in wildlife management, wildlife disease, automated DNA profiling, cancer, molecular physiology, plant biotechnology, forensic science, conservation genetics and biodiversity.

A major focus of the research programs is the development of automated DNA ,RNA and proteomic profiling protocols using robotic platforms. The Centre presently has one CRS robotic platform dedicated to DNA and RNA amplification and a second one is being contributed by Maxxam Analytics and will be dedicated to automated nucleic acid extraction and quantification. DNA and RNA samples are presently analysed using ABI and Pharmacia automated sequencers and profilers and the Centre is in the process of acquiring DNA microarray equipment. The bioinformatics core of the Centre will be a genomics data-base integrated with a Geographic Information System (GIS). Data will be directly submitted from the field using hand held units with both global positioning and bar code reading capability to track samples. The spatially attributed biological, disease and genetic data will be displayed across the web to provide information to wildlife managers.

The research infrastructure will be housed in a number of central laboratories that will form the core of the Centre:

Automation Laboratory: This will support collaborative research with the Applied Computing and Robotics Department of Sir Sandford Fleming College, OMNR and a number of the private

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In language appropriate for a multidisciplinary committee, use this page and up to one additional page to describe the **infrastructure** that will be acquired or developed and indicate where the infrastructure will be located. Indicate briefly why the infrastructure is needed, what research it will enable to be performed and why that research is important.

sector partners. The immediate goal of the research is the development and application of high throughput pre-analytical sample preparation protocols and the automated genotyping and sequencing of the RNA and DNA samples. The research programs using this equipment will include natural resources management projects involving white pine, fishers, wolves, black bears, polar bears, moose, caribou, elk, lake trout, brook trout, muskellunge, and walleye as well as disease programs involving the diagnosis and molecular epidemiology of raccoon rabies, West Nile disease and a variety of parasitic diseases of wild life. It will also support research into autism involving the genotyping of thousands of samples at candidate loci. This facility will also house the automated DNA and tissue banks.

Functional Genomics and Proteomics Laboratory: This facility will support research programs that involve an examination of the effects of psychological stress on the development of breast and prostate cancer in mice, the effects of environmental stressors on genome expression in legume seed development, the effects of global warming, pollutants and other stressors on trees and forest ecosystems and the effects of environmental stress on gene expression in indicator organisms. Components of the genomics and proteomics microarray infrastructure will be integrated with robotic platforms in the automation facility.

Molecular Physiology Laboratory: This facility will house the instrumentation for blood (Fluorecent Activated Cell Sorter) and tissue analysis and support research programs involving human and murine models on aging and the effects of physical stress on genome expression and modulation of immune function. It will also support the wildlife health and virology programs that involve hematological and immunological analyses.

Greenhouse and Phytotron: These facilities will provide controlled environmental conditions for the culturing of transgenic plants and physiological and molecular manipulation of legume (white bean, pea, chickpea, lentil) and tree (white pine, sugar maple) development and study their response to climate warming and pollutants. This research will identify single gene and gene cluster (from microarrays) markers for population-scale studies under field and cropping situations.

Transformation and Tissue Culture Laboratory. This will be used by several programs including the research involving legumes, forestry, cancer and viruses.

Forensic Laboratory: The research programs supported by the infrastructure will include the development of automated forensic analyses and sample tracking and development of markers for animals and plants involved in the illegal trade of animal parts from endangered species.

Wildlife Health and Disease Laboratory: The research programs utilizing this laboratory will involve those on fox and raccoon rabies, West Nile virus, rana virus and chronic wasting disease and a number of wildlife parasitic diseases. The laboratory will undertake a comprehensive approach to understanding the epidemiology of emerging wildlife diseases and their implication to animal population ecology, as well as modeling human health and ecological impacts of disease both in Canada and internationally. The infrastucture will include a level 3 bio-containment facility that will also service other research programs including research (continued on p3C)

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Self-assessment

A1 - The Research
Choose the statement that best represents the research

The proposed infrastructure will be used for research that is:

☐ (a) high quality and potentially useful;
☐ (b) competitive at the national level and may lead to innovation;
☒ (c) competitive at the international level and will lead to innovation;
☐ (d) at the leading edge internationally, transformative, and can be expected to have a major impact on innovation.

Using the space below and up to 5 additional pages, address all the following:

- outline the major research and how the infrastructure will be used to enable it;
- explain how the proposed research is innovative and how it is different from similar research being done by other groups regionally, nationally and internationally;
- describe the research opportunity and how the proposed research will capitalise on this opportunity.

The central theme of the research programs that will use the infrastructure in the DNA and Forensic Centre is the application of high throughput DNA, RNA and proteomic profiling to address a range of biological questions in a range of species including humans. A significant component of the research will involve the development of automated pre-analytical sample preparation platforms using robotic arms. Much of the research involving natural resources management and wildlife disease will be in collaboration with scientists from the Ontario Ministry of Natural Resources (OMNR), many of whom will be located in the DNA Partnership Building. Several of the research programs are related to human health and involve collaborations with a number of other institutions. The automation, bioinformatic and geomatic aspects of the research will be carried out in collaboration with Sir Sandford Fleming College and the private sector partners (LabinterLINK and Retisoft). The forensic research will be in collaboration with OMNR Enforcement Branch, Maxxam Analytics and police agencies. The automated profiling platforms produce a high volume of data, which will be directly captured by the Centre's Laboratory Information Management system (AutoLIMS) that will be the heart of the infrastructure. Each of the research programs is linked to the goals of the Peterborough DNA Cluster Project to produce a Center of Excellence in DNA and Forensic Science.
Automation. This research program focuses on the development of protocols and robotic platforms for pre-analytical sample preparation. Our existing CRS robotic platform is integrated with AutoLIMS, which tracks bar-coded samples from field collection through analysis in 96 well plates. AutoLIMS is web-enabled allowing remote data submission and remote data-base querying. The research on automated protocol development is focused on the use of magnetic beads with different functional groups for automation friendly DNA and RNA isolation and post amplification sample cleaning. Samples are presently analysed by automated sequencers and profilers (ABI 377 and Pharmacia MegaBACE), real time pcr (ABI Prism)) and microarrays. The present infrastructure is located in 3 smaller rooms in the Science Complex, a building more than 35 years old. This has presented temperature and air quality challenges to the operation of the equipment and in particular the stability of the lasers in the anlaytical equipment. The research involves linking the work-cells and for this a large single floor space is required. Integration and development of the work cells is being carried out in association with Retisoft, Labinterlink and Maxxam Analytics. We have integrated the CRS platform with Retisoft's Supra and Genera scheduling and integration software. Part of the proposed infrastructure involves developing

integrated systems with plate movers such as the Biobot IV. The Genera and Supra software allow the use of many such arms in one integrated work cell. The broad goal of the automation is the development of low-cost high throughput RNA, DNA and proteomic profiling platforms that can use a broad range of organisms and tissue types for use in a range of molecular diagnostic and forensic facilities. The applications include clinical and medical research, such as the search for genes involved in autism to natural resources population monitoring including the profiling of black bear hairs and fur hides. One aspect of the automation is the development of tissue and DNA Banking infrastructure. The DNA Bank will house samples from species-at-risk and commercially important species such as furbearers, fish, game, and tree and endangered plant species. The banks will be managed in partnership with user groups such as the Ontario Fur Managers Federation, Forest Gene Conservation Association, Environment Canada, Canadian Food Inspection Agency, Royal Botanical Gardens, the Metro Toronto Zoo, North Atlantic Right Whale consortium, OMNR, Natural Resources Canada, Environment Canada, Parks Canada and Canadian Botanical Network. Additional archived material will include isolates of pathogens (eg rabies virus) for cross-referencing against future disease outbreaks as well as samples for gene expression analyses to monitor differences resulting from environmental impacts such as increased pollution or climate change. DNA will be the primary biological material stored although other tissue storage will be coordinated with collaborators. Automated refrigerated storage units (MolBank Biophile) and dry DNA card index systems will be used. Sample tracking through AutoLIMS and bar codes will allow efficient retrieval to provide the timely shipment of material to other facilities.

Conservation and Natural Resources Management. Conservation genetics has emerged as a valuable tool for identifying and monitoring management units of natural resources. As well as mapping the structure and distribution of genetic diversity, genetic tools provide information on historical and contemporary gene flow or connectivity among populations, their status and effective population size. Although it is not feasible to study each species and population in detail, monitoring the status of ecologically sensitive and economically significant species provides valuable indicators of ecosystem health. A large number of ongoing research projects employ DNA profiling of species at risk to help identify conservation and restoration challenges. Projects employing DNA markers to study endangered species in Canada and elsewhere currently include the North Atlantic right whale, St Lawrence Estuary beluga whale, wood poppy, polar bear, Ontario elk, redside dace, deepwater sculpin, margined madtom, cricket frog, wood turtle, Aurora trout, San Clemente loggerhead shrike, Puerto Rican toad, woodland caribou and swift fox. These data are being used to identify remaining genetic resources and units for conservation within species, as well as to provide insights into how best to conserve these irreplaceable evolutionary entities. High-resolution genetic profiles are also being used to address parallel issues in fisheries, forestry and wildlife management. Identifying the geographic structure and diversity of genetic resources within harvested species is essential for their sustainable management in the face of harvest pressures, habitat fragmentation and loss, invading species, climate change and disease stressors. This is particularly important for targeted forestry and fishery species, where centuries of unsustainable resource extraction may have impaired species’ abilities to respond to modern pressures. Currently, DNA profiling is being used to identify populations or stock structure of a number of harvested species, including moose, wolves, coyotes, fishers, black bears, white pine, walleye, yellow perch, lake trout, brook trout, lake sturgeon and

muskellunge. This information is provided to collaborating management agencies such as OMNR, DFO and CWS to enable informed management decisions, providing information that would otherwise not be available; recent examples include management decisions over declining walleye stocks in Lake Ontario and mixed-stock commercial and recreational harvest of walleye in Lake Erie. As well as providing information to help direct or prevent selective harvest on genetically distinct populations, these projects provide valuable baseline data to assess the effects of land use practices on the productivity of populations and habitats, connectivity among habitat patches, and population viability. These data also provide an indirect measure of the adaptive potential of populations, potentially influencing their ability to respond to stressors such as anthropogenic disturbances, disease, climate change or invading species. Coupled with research within the Genomics and Proteomics, Molecular Physiology, and Wildlife Disease Laboratories, this work has the potential to provide unprecendented insights into contemporary evolution, local adaptation, and how organisms interact with their environment. Advances in DNA technology and genomic research have provided new tools and technologies that overcome previous time and cost limitations, making large-scale geographic analyses possible. These projects presently generate DNA profiles from more than 20,000 samples per year, with ever-increasing requests for increased capacity from collaborating agencies and researchers. Although the specific research questions being addressed often vary, all projects involve typing at nuclear, mitochondrial and/or chloroplast loci, and sometimes sex chromosomes. For microsatellite analyses, 10 to 40 loci are typically genotyped per individual profile; sequence analyses typically involve 300 to 1200 bp amplicons. The observed genotypes are stored as genetic layers in the GIS database and are made available through the Ontario Land Information Infrastructure Warehouse. Collaborating agencies such as OMNR, the US Navy, the North Atlantic Right Whale Consortium, Great Lakes Fishery Commission, Department of Fisheries and Oceans, Royal Botanical Gardens, Metro Toronto Zoo, Royal Ontario Museum, and Ontario Fur Harvesters Federation have direct, secure access to the appropriate database and online querying. The proposed automation and research infrastructure will build on existing resources at Trent University's Natural Resources DNA Profiling and Forensics Centre to provide essential information for conservation and resource management. This high-throughput, high resolution GIS-based approach to landscape genetics will significantly enhance Canada's role as a world leader in intraspecific bioinformatics and sustainable resource management.

Plant Molecular Physiology. In the past 5 years Canada has emerged as the most competitive exporter in global trade of legumes like chickpea, lentil, white bean and field pea. Yet the growing importance of grain legumes in Canada's agricultural industry is currently limited by the chronic problem of low and variable yields. Understanding the physiological basis and biochemical mechanisms underlying the various stages of reproductive development such as fruit setting and seed filling is essential for economically improving crops and devising strategies for yield improvement and stabilization. To date Dr Neil Emery's laboratory has determined that changes in form (isomerization) of a family of phytohormones, the cytokinins (CK), represent potent regulatory mechanisms for legume fruit set and seed filling. Although a few genes involved in synthesizing and interconverting the CKs are known, most have remained elusive. Yet Dr Emery's laboratory has determined that developing legume seeds are a prolific source for CK synthesis and have documented changes in CK form throughout seed development. It is therefore an excellent system to identify candidate genes or gene clusters (i.e. all those

related to CK metabolism and cell growth and division) for precise control of physiology that limits grain legume production. This will be undertaken by applying divergent growth conditions with the controlled growth environments of the greenhouse and phytotron and exploring gene expression with the microarray facility. Once identified, the high sample throughput capacity of the Automation laboratory will provide the exceptional opportunity of using functional and neutral markers on a population scale either in natural field or cropping situations. This will address ecological and agronomic questions of reproductive effort in populations of cultivated and wild legumes that vary greatly in fruit and seed set. Known CK genes, and any identified from the grain legume experiments could be studied simultaneously on a large population-scale to determine if expression of CK genes, or other as yet unidentified genes, represent selectable molecular mechanisms for local population adaptation to changing reproductive requirements.

Forensic Science. The application of robotic systems to automated DNA profiling of forensic case samples has been limited by the strict requirements of validation. A number of human forensic facilities have implemented automation for national databases but not for case samples. This research program will focus on continuity-of-evidence tracking and validation through the use of strategically positioned control samples from DNA extraction to analysis. The research will involve the development of protocols for the identification of wildlife species based on PCR amplification and DNA microarray analysis. It will take advantage of the wildlife forensic cases that are not subject to the uniform stringency of human forensic facilities. Protocols will be developed for human forensic samples, such as simulated swabs from rape kits in collaboration with accredited human forensic services such as the RCMP and Maxxam Analytics. Part of the research program is directed at establishing sensitive DNA markers for species-at-risk, listed by the Convention on the International Trade of Endangered Species (CITES), that are commonly involved with Environment Canada investigations. These include exotic woods and plants, Asian medicines, tiger bone, penises and black bear galls. In the absence of distinguishing morphological characteristics to identify the species-of-origin, Enforcement Officers in agencies such as Environment Canada and must rely on diagnostic molecular markers in hemoglobins and DNA to provide evidence of a CITES-listed species without the proper authorization. In heavily processed samples such as powdered medicinal animal bone and plant material, wine soaked animal parts, processed material such as hides, and single caviar eggs the probability of success with protein markers are limited due to degradation through processing. Even standard DNA-based diagnostic tests are limited due to low quantity and degradation of the material. As a result DNA profiling for species identification of heavily processed material requires the development of highly sensitive protocols for a wide-range of species commonly involved in trade inclusive of both legal and CITES-listed species. Other cases require the quantification of material that may be mixed into certain products, such as roe and powdered medicines. Furthermore, the need for rapid production of results is high, as the confiscated imported material must be tested in a timely fashion. This project will establish a DNA Bank of type specimen control samples of CITES-listed species as well as associated species involved in the trade, i.e. species not listed under the Convention but common within the trade. Sensitive detection assays will be developed using validated control samples using two platforms: Real-time PCR with an ABI Prism system; and DNA microarrays. These profiling platforms offer specific advantages in different situations: the RT-PCR for high sensitivity, quantification of material and compatibility with automation and microarrays for screening a wide-range of

species simultaneously such as a sturgeon species DNA chip for caviar analysis. Both platforms will utilize species-specific DNA markers in cytochrome b and cytochrome oxidase c genes of the mitochondrial DNA and highly repetitive satellite DNA. The human forensic research will focus on mitochondrial DNA and Y-chromosome profiling. A rapid Y-chromosome profiling assay will provide an initial screen to exclude suspect males from investigations thereby significantly reducing the workload. Research on high-throughput profiling will involve single nucleotide polymorphism (SNPs) using real-time PCR TaqMan and DNA microarrays.

Cancer Research. Cancer is a disease that arises from an interaction among genetic and environmental factors. Generally, cancer is characterized by genetic aberrations, which cause heterogeneous genotypes to be represented within a single tumor. Research examining the etiology of cancer is difficult due to the large number of genes whose expression are altered within a tumor and the many environmental (including physical and psychological) factors that can directly or indirectly influence gene and protein expression possibly leading to carcinogenesis. Currently, there are only a handful of laboratories that are examining the influence of stress or diet on breast and prostate cancer. The infrastructure proposed in this application will allow for the identification and characterization of the many possible interactions among stressor-induced changes in gene and protein expression and relate these changes to cancer risk. Breast and prostate cancers are among the most common tumors affecting women and men, respectively. Both cancers are influenced by the hormonal environment of the body which, in turn, is modified by developmental and environmental factors, including puberty, diet and stress. Although many mechanisms by which environmental risk factors influence disease have been suggested, the etiology of cancer remains unclear. Importantly, only between 5-10% of breast and prostate cancers are heritable, the remainder are due to the collection of somatic mutations within a given tissue (e.g. breast, prostate). Integrating genomic and proteomic data from normal and malignant tissues will help to identify and define the molecular pathways of carcinogenesis, which in turn may help in both prevention and treatment of cancer. Despite decades of research, much of the data from studies examining the possible risk factors (e.g. diet, life-stressors) of cancer development have been confounding or contradictory. Several meta-analysis studies have identified many procedural short-comings (e.g. insufficient study size, inadequate selection of controls, inadequate baseline information, inadequate identification of and adjustment for confounding variables) leading to these inconsistencies. The high throughput DNA microchip technology and proteomic infrastructure proposed in this application will help to identify genes whose expression is altered by, for example, diet and stress. Specifically, the DNA microchip technology proposed in this application will permit large-scale, genome-wide profiling of gene expression patterns (positive and negative) in different tissues (e.g. mammary glands, prostates and hypothalami) of experimental and control (e.g. stressed and non-stressed, or high-fat and low-fat) animals leading to a better understanding of the biological mechanisms involved in the development of breast and prostate cancers. The proteomics infrastructure will allow for a global view of the changes that occur to cause a cell to become cancerous. As a cell’s environment changes, its genome and proteome may also change, adapting to the new environment. Since genotype, mRNA and protein expression may not be completely correlated, the proposed genomics and proteomics core will allow for the examination of the influence of environmental factors on gene and protein expression thus providing a more global and structured view of

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cellular functioning within dynamic biological and cellular environments. Moreover, comparisons between gene and protein expression in mouse and human tissue are possible and thus allow the identification of strengths and weaknesses of hypotheses in both models.
Molecular Physiology of Aging . This research will investigate the impact of physical stress on genome expression and modulation of immune function in the young and old using human and mice models. The immune system becomes depressed as people age and elderly individuals are more prone to developing infections, autoimmune disorders and certain cancers. However, the mechanisms for some of these age-related decrements in immune function are not known. Exercise is a controlled, quantifiable stressor that can be used to examine how the body adapts to physical stress and how the aging process may be altered. Much of the research to date has focused on exercise-induced changes at the systemic and cellular levels. For example, it has been shown that acute exercise induces similar cellular changes in both the young and old and that physical conditioning can enhance NK cell activity and T-cell proliferation. Moreover, regular moderate exercise has been shown to decrease susceptibility to infection and incidence of certain cancers. However, to date there has been minimal research at the molecular level. Alterations in gene expression, protein synthesis as well as apoptosis and changes in levels of circulating cytokines may all play a role in contributing towards the age-related changes in immune function that are observed in the elderly. Regular exercise may act at a biochemical and molecular level to induce physiological changes that alter the aging process and associated age-related disorders. This will be investigated using the infrastructure provided to study gene expression of key regulatory factors in many blood and tissue samples. The Fluorescent Activated Cell Sorter will enable us to identify different cell populations and to study intracellular processes. The Immulite machine will allow us to investigate biochemical parameters. Together with the other hematological and immunological analytical equipment, this will give us a comprehensive view of mechanisms occurring at the sub-cellular level and provide information on the cascade of reactions underlying immune system responses to physical stress and aging. Through this research we will be able to establish exercise guidelines for the elderly with the goals of improving levels of physical fitness, immune function and the delay of age-related immune disorders.
Clinical Genetics and Autism Spectrum Disorders. Autism Spectrum Disorders result from an interaction of multiple loci and the environment. The automation facility will be used by the Autism Spectrum Disorders-Canadian American Research Consortium (ASD-CARC) headed by Dr Holden at Queen’s and funded by CIHR. This project will involve genotyping microsatellite and SNP markers for over 40,000 samples at 50-500 loci. It will require the sample tracking and data management and serve as a model for genotyping and applying genetic data to complex disorders. Dr White is part of a 6 year CHIR funded training grant aimed at exposing graduate students to the range of disciplies involved in autism research.
Wildlife Health and Disease. There exists growing recognition that infectious and non-infectious diseases of wildlife play an important role in today’s society. Viral diseases can have profound effects on both human and wildlife populations. The proposed infrastructure will create a unique integrated research facility that will conduct research into disease by combining field and laboratory approaches. This has proved successful (continued on 4G)

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A2 - The Researchers

1) List the researchers who will **use** the infrastructure. Add one (1) additional page if required. This list may include researchers from non-eligible organizations.
2) Provide a CV module for the principal researchers, i.e. the main users essential to the justification of the project (the CFI will accept up to 10 CV modules).
3) For New Opportunities applications, include **only** the CVs of new researchers.

Reseacher (name and title)	Affiliation (department or faculty & organization)
Principal users:	
Brenner, Ingrid Assistant Professor	Nursing and Biology Trent University
Brunetti, Craig Assistant Professor	Biology Trent University
Emery, Neil Assistant Professor	Biology Trent University
Kerr, Leslie Assistant Professor	Biology/Psychology Trent University
Murray, Dennis Associate Professor	Biology Trent University
Rosatte, Rick Research Scientist	Wildlife Research & Development Government of Ontario
White, Bradley Professor	Biology Trent University
Wilson, Chris Adjunct Professor	Ont. Min. Nat. Res. - Biology Trent University
Wilson, Paul Assistant Professor	Biology Trent University
Yee, Janet Assistant Professor	Biology and Chemistry Trent University
Other Users:	
Berrill, Michael Professor	Biology Trent University
Bowman. Jeff Adjunct Professor, Research Scientist	WEGS Trent and OMNR
Davies, Chris Adjunct Professor, Section Manager	WEGS Trent and OMNR
Fleming, Jim Mr	Robotics and Applied Computing Sir Sanford Fleming College
Galbraith, David Coordinator	CBCN Royal Botanical Gardens

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A2 - The Researchers

1) List the researchers who will **use** the infrastructure. Add one (1) additional page if required. This list may include researchers from non-eligible organizations.
2) Provide a CV module for the principal researchers, i.e. the main users essential to the justification of the project (the CFI will accept up to 10 CV modules).

Reseacher (name and title)	Affiliation (department or faculty & organization)
Holden, Jeanette Professor	Psychiatry and Physiology Queen's University
Kapron, Carolyn Professor and Chair	Biology Trent University
Metcalfe, Chris Prfessor and Dean of Grad Studies	Environmental Resource Studies Trent University
Nol, Erica Professor	Biology Trent University
Nsengiyumva, Dominique Dr	Geographical Information Systems Sir Sandford Fleming College
Obbard, Martyn Adjunct Professor, Research Scientist	WEGS Trent and OMNR
Patterson, Brent Adjunct Professor, Research Scientsist	WEGS Trent and OMNR
Pond, Bruce Adjunct Professor, Research Scientist	WEGS Trent University and OMNR
Quinn, Jim Associate Professor	Biology McMaster University
Rafferty, Steven Associate professor	Chemistry Trent University
Rapley, William Director	Research Toronto Metro Zoo
Spasov, Peter Mr	Robotics and Applied Computing Sir Sanford Fleming College
Sutcliffe, Jim Professor	Biology Trent University

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Self-assessment

A2 - The Researchers

Choose the statement that best describes the principal research users.

The researchers who will be the **main users** of the infrastructure:

☐ (a) have the skills and expertise to accomplish the proposed research;

☐ (b) are recognized for their accomplishments, or are new researchers who are promising in the proposed research field(s);

☒ (c) are acknowledged leaders, or have demonstrated potential for leadership in the proposed field(s);

☐ (d) are international pioneers in the proposed research field(s), or have the potential for major breakthrough(s) in the proposed field(s).

Using the space below and up to 1 additional page, describe how each researcher will use the infrastructure to contribute to the proposed research. If major new users are to be recruited, describe the recruitment plan.

Dr Bradley White – was recruited to the Department of Biology at Trent University in 2001 as a Canada Research Chair in Conservation Genetics and Biodiversity to develop the collaboration with the Ontario Ministry of Natural Resources (OMNR) on the application of DNA Profiling to natural resource management, wildlife disease, conservation and wildlife forensics. He developed the Natural Resources DNA Profiling and Forensic Centre (NRDPFC) and acquired much of the existing infrastructure for the Centre through CFI, OIT and ODRA funding. He has been involved with DNA Profiling for over 20 years and started the second DNA Diagnostic Laboratory in Canada. He is involved with a number of projects that involve high throughput DNA profiling and DNA/tissue banking. He is Principal Investigator of the project to assess the mechanisms leading to the spread of raccoon rabies. This project will use the biocontainment and autopsy facilities and automation infrastructure. The data will be managed in the GIS AutoLIMS data base. Dr White is also involved in a number of projects involving endangered species that require extensive DNA typing and DNA banking. Trent holds the DNA samples of 75% of the 300 remaining North Atlantic right whales and critical samples of the San Clemente shrike. He is collaborating with Dr Holden at Queen's on an International project to identify genes involved with autism. This project will use the high throughput infrastructure for DNA extraction from buccal swabs and single nucleotide polymorphism analysis of candidate genes.

Dr Rick Rosatte – is a senior scientist with the Ontario Ministry of Natural Resources (OMNR) and came to the campus of Trent University when OMNR moved its headquarters to Peterborough in 1997. He has extensive research experience on raccoons and rabies. He is involved with research on the re-introduction of elk to Ontario and the spread of raccoon rabies. He will use the automated DNA profiling and banking infrastructure and the biocontainment facilities as well as the animal tracking infrastructure of the Wildlife Disease laboratory. He is presently collaborating with a number of scientists to develop a research program into the spread of West Nile Disease, which will use the real time pcr infrastructure.

Dr Dennis Murray – was recruited to the Departments of Biology and Environmental Resource Studies in 2002 as a Canada Research Chair. He has extensive experience in wildlife management, population modeling, wildlife re-introductions and wildlife disease. He will head the Wildlife Disease Laboratory that includes the biocontainment and wildlife tracking infrastructure. He will use the automated DNA profiling facilities for pathogen identification and tracking and for genotyping elk and deer to assess chronic wasting

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disease susceptibility.
Dr Chris Wilson was hired as a research scientist with the fish genetics and stock assessment unit of OMNR in 1999. He is an adjunct professor at Trent University and the OMNR fish genetics facilities are on campus. He will use the automated DNA isolation and profiling infrastructure and the DNA banking facilities and the Autolims data base for monitoring fish biodiversity in Ontario.
Dr Paul Wilson was recruited in 2001 as an Assistant Professor and Research Scientist in the NRDPFC. His research programs will extensively use the Forensic Science Laboratory and the automated DNA extraction and profiling facilities. The research involves the detection and screening for the SNPs using the DNA microarray infrastructure.
Dr Neil Emery – was recruited as an Assistant Professor in 2000. His research program will use the Greenhouse and Phytotrons in combination with resources of the Functional Genomics, Geographical Information System and Automation Laboratories for research programs that integrate controlled growth laboratory conditions and field and cropping situations. He will also use the transformation and cell culturing laboratory to develop transgenic plants. The controlled growth conditions will reveal gene expression critical for stabilizing fruit development in crops and to give insight into response to warming, uv exposure and pollutants like CO2 and ozone in pine seedlings. These data will be linked with high-throughput DNA and RNA profiling information.
Dr Ingrid Brenner – was hired as an Assistant Professor in Biology and Nursing in 2002. She will use the infrastructure of the Molecular Physiology Laboratory to study the effects of exercise on aging. Her research will rely heavily on the blood analytical instrumentation together with the Proteomics and Genomics infrastructure for gene expression studies.
Dr Janet Yee – was hired jointly by the Departments of Chemistry and Biology in 2001 as an Assistant Professor in the Biochemistry Program at Trent University. Dr. Yee is a leader in applying molecular tools to study gene regulation in the protozoan pathogen, Giardia lamblia. She has also established collaborations with leading researchers in the field such as: with Dr. Miklos Muller at Rockefeller University in New York on histone gene expression; with Dr. Staffan Svard at the Karolinksa Institute in Sweden on membrane transporter genes; and with Dr. Andrew McArthur at the Marine Biological Laboratories at Woods Hole on the cell-cycle dependent gene expression in Giardia. She will be using the infrastructure of the Genomics and Proteomics Laboratory as well as the containment facilities in the Wildlife Disease laboratory.
Dr Leslie Kerr – was hired as an Assistant Professor in Biology and Psychology and will use the Infrastructure of the Genomics and Proteomics Laboratory and the Transformation and Cell Culture Laboratory for her research on the effects of stress on breast and prostate cancer. She will be examining the changes in gene expression using mouse genome DNA microarrays.
Dr Craig Brunetti – - was recruited to the Department of Biology at Trent University in 2003. His research focuses on the molecular virology of human and wildlife viruses. He will use the Genomics and Proteomics infrastructure to identify how these viruses cause disease by identifying viral genes that function to disarm the host immune system particularly in new or emerging diseases in the poxvirus and iridovirus families. The biocontainment facilities of the Wildlife Disease Laboratory will be used to culture various virus strains and to generate recombinant viruses including viral deletion mutants to assess the role of particular viral genes during virus replication.

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Self-assessment

B1 - Need for the infrastructure

Choose the statement that best represents the proposed infrastructure

The proposed infrastructure is essential for the proposed research and:

☐ (a) enhances institutional research capacity;

☐ (b) establishes a unique institutional research capability;

☐ (c) establishes a unique regional or national research capability;

☒ (d) establishes an internationally competitive research capability which would not exist otherwise.

Using the space below and up to 2 additional pages, address all of the following:

- the appropriateness of the infrastructure project for the proposed research;
- the project's potential impact on building institutional, regional or national capacity for innovation;
- the availability and accessibility of similar infrastructure within the institution, the region, the country or internationally, as well as issues of complementarity, duplication and sharing;
- how the infrastructure project helps build capacity in the institution's strategic research priority areas, including efforts to attract and retain highly qualified researchers in these areas. Describe the means the institution proposes to take to support these priority areas (e.g. institutional resources to capitalize on the infrastructure, creation of new academic staff positions, research chairs, etc.).

Several converging events have led to the need for the research infrastructure outlined in this proposal. During the past 3 years Trent University has recruited 8 of the primary infrastructure users. This recruitment has been based on Trent University's Institutional Research Plan that identifies DNA and Forensic science as priority research areas. The translocation of the headquarters of the OMNR to Peterborough and the move of many of the research scientists to campus has further stimulated the collaborations that have produced the critical mass of research activity in these areas. The Canada Research Chair program was used to recruit two of the Trent faculty members and the CFI and OIT programs have allowed the acquisition of some of the required infrastructure through the Innovation, CRC and New Opportunities Funds. This equipment is presently housed in rooms in the Science Complex that were built in 1966. The space, environmental control and air handling capability of the physical plant is not adequate for the needs of the additional faculty and the rapid expansion of existing research programs. The identification by the Greater Peterborough Area Corporation (GPAEDC) of DNA and Forensic Science as the focus for future economic development for the region has created the opportunity to construct a "DNA Partnership Building" to house the private and public sector partners on the campus of Trent University. The "Peterborough DNA Cluster Project" has received funding from Human Resources Development Canada and Industry Canada, the Ontario Biotechnology Cluster Innovation Program and a private sector group (the Peterborough Partnership Group) dedicated to furthering the Peterborough economy. Trent University has donated 5 acres of land and O.P. McCarthy and Associates have developed a business plan and floor plans to house the partners that include OMNR, OPP Identification Services, Peterborough and Lindsay Police Services, Trent University and Sir Sandford Fleming College and a number of companies. The funding of the building will be through a combination of private and public sector capital and leasing agreements. The OMNR is proposing to move about 29 more research personnel and its library from the Peterborough headquarters to campus. It is also planning on moving the infrastructure of the rabies research unit and the fish genetics and stock assessment unit to the new building. The infrastructure will be used

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to support and extend the research collaborations that have been developed by the public and private sector partners.
Automation Laboratory: This is required as a critical integrative part of the infrastructure. It will be used both as a high throughput analytical facility as well as an automation research and development area. It is designed as an “open concept” floor plan to allow the existing large robotic platforms to be integrated together in partnership with the Sir Sanford Fleming College faculty and private sector partners that have contributed some of the infrastructure. Maxxam Analytics will be providing one CRS robotic platform and a Zymark Twister platform that will be integrated for new applications and with new workstations through a collaboration between Sir Sandford Fleming College and Retisoft. LabinterLINK has provided two autoamated specimen sorters that have footprints of approximately 2x2 metres, which will be integrated with the analytical instruments and automated storage banks. This area will have critical environmental and air quality controls. The research will also utilise smaller less expensive robotic arms to develop the modules suitable for forensic and DNA diagnostic facilities. We do not know of any research automation facility in North America that is dedicated to the range of DNA and RNA profiling applications being undertaken at the Centre. This high throughput facility will have a major impact on emerging areas that will use profiling to track meat (Maple Leaf Foods) and assess the presence of genetically Modified Foods
Forensic Science Laboratory. This facility is required to provide the clean environment and controlled sample flow for forensic science research. It will provide a much needed capability for forensic research in Canada. While its focus is on wildlife forensic research it will partner with the RCMP, Centre for Forensic Science and private companies such as Maxxam Analytics to develop automated protocols and design forensically-informative arrays for different species (human and non-human) and DNA markers such as short tandem repeats (STRs), single nucleotide polymorphisms (SNPs), mitochondrial DNA (mtDNA) and the Y-chromosome. Infrastructure in this project will also support the development of protocols for increased sensitivity that will be applicable to both forensic and wildlife studies. RT-PCR and MALDI-TOF systems will be used to analyse the small amounts of DNA in forensic specimens. These developments will also be applied to wildlife studies by examining fecal material as a non-invasive and cost-effective method of mark-recapture analysis and assessing the movement of animals. Microarray technology will be utilized to establish forensic chips for specific applications using a combination of DNA markers that can be used for specific species, e.g. an ungulate chip for moose, deer, caribou, elk and bovine and a caviar chip for sturgeon roe identification, with expansion into human mtDNA and Y-chromosome diagnostic arrays.
Greenhouse and Phytotron. These are required to conduct the collaborative research programs with OMNR forestry scientists and to take advantages of research opportunities with private sector partners such as Pickseed and public sector partners such as the Royal Botanical Gardens and the Forest Gene Conservation Association. The present greenhouse facilities on campus have shading problems as well as temperature control issues that only allow a single growth season to be attained. The proposed infrastructure is needed to allow us, not only to understand how a tree or crop may respond to a stress, but also how those processes are manifested in nature or agriculture. Eventually it should lead to innovative forestry management and directed breeding of superior crop cultivars. Similar plant growth facilities and plant molecular

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physiology laboratories certainly exist at other universities, but they do not benefit from the integration and synergy, with automation and GIS/Bioinformatics, Genomics and Proteomics that is being developed in the DNA and Forensic Science Research Centre.
Wildlife Disease laboratory. This infrastructure is needed to integrate the field research into diseases like rabies, chronic wasting disease and West Nile virus with the laboratory research of molecular diagnostics and molecular tracking. Development of predictive and mechanistic wildlife disease models requires that model parameters be estimated precisely and rigorously through intensive field efforts. Only recently, through the advent of Global Positioning System (GPS) technology and telemetry, has it become possible to monitor precisely the movements and potential contact rates with conspecifics of free-ranging animals at the level required to effectively parameterize disease models. VHF telemetry, while offering less spatial resolution than GPS telemetry, remains effective for determining survival rates and cause of death in animals. Portable ultrasound technology, and state-of-the-art hematological and immunological units, provide sophisticated tools for determining live animal condition and status. The autopsy and biocontainment facilities are required to handle the carcasses and prepare samples for analysis. They will also be used for research programs involving pathogens such as giardia. Collectively, these components will enable research into the mechanics of wildlife disease that far exceeds current capabilities in Canada. The laboratory would build a strong capacity for wildlife disease research in Canada. The core of wildlife ecologists, spatial ecologists, geneticists, microbiologists, and physiologists would form a multi-faceted team able to address a variety of disease issues in a range of research contexts. As Canada lacks a single centre specializing in all the many facets of wildlife disease, the Centre based on a University–Government partnership will serve to optimize research progress in the realm of wildlife disease at a national scale. These facilities will also be used for the research program on the waterborne parasite, Giardia lamblia. This program will initially contain a basic research unit to study gene regulation in Giardia, and specifically, to establish a database containing both gene expression and protein expression profiles for each stage of the parasite’s cell cycle. Collaborations with Maxxam Analytics are focused on developing more sensitive, and automated methodologies for the detection and quantification of Giardia contamination in, food watersheds and municipal water supplies.
Genomics and Proteomics laboratory. This infrastructure is required to service a number of the research programs ranging from cancer, gene expression and environmental stress and impacts of genotoxins. And molecular ecology. It is this range that of applications that sets it a part from other similar facilites that are dedicated to single clinical, environmental or developmental research programs. The juxtaposition of the automation laboratory also provides for high sample analytical throughput. For example there are few universities in Canada with the research-orientation and technological capabilities in place to examine the range of biological mechanisms involved in cancer development or progression. With the development of the Centre and through collaboration with the strong community-based breast cancer screening and support programs of the Peterborough Women's Health Network (supported by the Peterborough Region Health Centre), there is an opportunity to create a nationally, if not internationally, recognized research program. The goal of the research is to use the proposed resources of the infrastructure to determine the function and plasticity of gene products by allowing for the examination of, for example, (continued on p7D)

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Self-assessment

B2 - Training, through research, of Highly Qualified Personnel (HQP)

Choose the statement that best represents the infrastructure project.

The infrastructure project will support the training of HQP, through research, by imparting:

☐ (a) the basic skills and expertise required to undertake research activities or other endeavours;

☐ (b) an appropriate set of skills and expertise needed in areas of importance to Canada;

☒ (c) a broad range of high-level skills and expertise in areas of critical importance to Canada;

☐ (d) an exceptional set of high-level skills and expertise that are considered as "world class" in areas of critical importance to Canada.

Using the space below and up to 1 additional page, address all of the following

- how the proposed infrastructure will create a stimulating and enriched training environment for HQP;
- current HQP training at the institution(s) and future plans for HQP training to be carried out with the proposed infrastructure. Include the current number and level (undergraduate and graduate students, postdoctoral fellows, technicians, technologists other trainees/students) of HQP trained as well as the number and level of HQP to be trained as a result of the proposed infrastructure.

The research programs in the DNA and Forensic Science Centre will provide a diverse training environment as a result of the juxtaposition of the private and public sector partners involved with the Peterborough DNA Cluster Project. Some of this potential has already been realised with joint projects involving the OMNR, Sir Sandford Fleming College and Trent University. College and University students have been working in teams on the same research projects and have developed communication and team building skills in addition to the specific knowledge and skills related to the research programs. As a result of this and the involvement of private sector partners, students have found appropriate employment opportunities. One project on automated DNA extraction using magnetic beads that was undertaken last year illustrates the interactions and training potential with the partnerships. A Trent graduate student led the research project. He was supported by an NSERC Industrial Scholarship, which was sponsored by Maxxam Analytics. He worked with a team of Sir Sanford Fleming students who were in the final year of an applied computing and robotics program. They were integrating a CRS robotic system using software from Retisoft and worked closely with the company personnel. A second project involved a team of Fleming students developing an e-commerce component for the Wildlife Forensic DNA Laboratory web-site. They worked closely with a NRDPFC IT technician and the Wild-Life DNA forensic technician. This site now allows the OMNR Conservation Officers across Ontario to directly order forensic sample kits on the web from the laboratory while minimizing transaction costs by using “Pay Pal”. An internship was provided to the NRDPFC by Natural Resources Canada (NRCan) for a software developer in designing handheld PCs for field data collection A group of 4th year computing students at Trent worked with a Fleming faculty member and a number of graduate students in the NRDPFC to transfer the AutoLIMS data base to a Microsoft SQL platform. The proposed automation laboratory will promote these research partnerships further and expand the training and research opportunities. The presence of the forensic science research programs at Trent has led to the initiation of a summer Forensic Science Camp for High School students funded by the NSERC Promoscience program and the initiation of a joint Honours Forensic Science degree with Sir Sandford Fleming College. While not directly related to research projects these programs will provide high school and undergraduate students with early exposure to forensic science. These programs also have

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Advisory Committees made up of practitioners from the RCMP, OPP, Centre for Forensic Science, local police forces and the OMNR Enforcement branch. These contacts have lead to employment opportunities and a number of graduate students and technicians have been hired by the Centre for Forensic Science and the RCMP. An Ontario Premier's Excellence Award (PREA) has been submitted by Dr. Wilson in collaboration with Environment Canada's Enforcement Section for a PDF position to design high throughout automated detection systems and forensically-informative arrays for cases involved in the illegal trade of endangered species.

Together Sir Sandford Fleming College, Trent University and OMNR provide Peterborough with one of the highest concentrations of wildlife biologists in Canada. Capitalizing on this resource, the infrastructure will help create a stimulating environment for training of students in integrated laboratory and field research programs. The OMNR rabies research and development unit is a recognized world leader in the field of research into the epidemiology and control of wildlife rabies. This expertise and the proposed infrastructure are not available anywhere in Canada and thus will provide a unique environment for wildlife disease research. The close relationship of OMNR and Trent University allows graduate students to be supervised by OMNR and Trent scientists and to obtain intern positions. An OMNR intern is presently managing the NSERC funded raccoon rabies project and the four PhD students involved in the program are jointly supervised by OMNR, Trent and Canada Food Inspection Agency (CFIA) scientists. Many of the research programs involve spatial analysis and the close partnership with faculty on the Lindsay campus of Sir Sandford Fleming College, OMNR and the Queen's GIS laboratory provide an exceptionally high level of training in geomatics. The integration of genetic data with GIS allows students to develop research programs in the emerging field of landscape genetics and to interact with mangers and policy makers in OMNR, Environment Canada, Department of Fisheries and Oceans and the Canadian Wildlife Service involved in wildlife conservation and management.

The infrastructure in the DNA Partnership Building will be shared by graduate students working on a range of research projects that involve DNA profiling in human and wildlife disease as well physiology and ecology. This exposure to diversity will create students with flexibility to move into a broad array of fields. The infrastructure will also support research programs on stress and cancer and aging and exercise and promote linkages to the emerging health programs at Trent. The creation of a new graduate program in the Biosciences and Health Studies at Trent is currently underway and upon its implementation will train students with a unique blend of skills and experience. This program will include one year course MSc degrees in areas such as forensic science.

This year the primary users of the infrastructure supervised 25 graduate students, 12 honours students and 6 Fleming students. Six technicians are working in the group with one post-doctoral fellow. Four co-op students also were trained in the NRDPFC. The secondary users of the infrastructure supervised another 20 graduate students and 10 honours students. With the increased infrastructure and the physical proximity of the private and public sector partners a doubling of training at all levels is expected in the next three years. The DNA Partnership Building will promote the public/private sector collaborations and increase access to grant programs like the Industrial NSERC Scholarships. Two graduate students are presently being recruited with NSERC Industrial scholarships sponsored by Irving Oil and the Ontario Fur Managers Federation.

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Self-assessment

B3 - Research Collaborations and Partnerships

Choose the statement that best represents the infrastructure project.

The proposed research infrastructure will create or strengthen:

☐ (a) collaborations among researchers (e.g. collaboration on funded projects, co-authorship);

☐ (b) collaborations among researchers from different disciplines, institutions, sectors or countries;

☒ (c) partnerships (e.g. formal signed agreements) among research institutions in the same sector or from different sectors;

☐ (d) international partnerships among research institutions or among sectors.

Using the space below and up to 1 additional page, address all of the following aspects:

- what collaborations or partnerships already exist;
- what collaborations or partnerships are planned;
- what steps have been taken or will be taken to create or strengthen collaborations or partnerships;
- how the infrastructure is essential to the collaborations or partnerships.

The Peterborough DNA Cluster Project and the DNA Partnership Building have their origins in the strong partnerships among the major Public Institutions in Peterborough, Trent University, Sir Sandford Fleming College and the Ontario Ministry of Natural Resources. The private sector component of the partnership has been led by the Greater Peterborough Area Economic Development Corporation (GPAEDC) and includes the Peterborough Partnership Group, LabinterLINK, Lakefield Research, Pickseed Ltd, Maxxam Analytics, Retisoft, Stolt Sea Farms Inc., and the Ontario Fur Managers Federation. GPAEDC identified DNA and Forensic Science as the areas to develop a regional Centre of Excellence and have received funding from Human Resources Development Canada, Industry Canada and the Ontario Biotechnology Cluster Innovation Program (BCIP). An executive coordinator has been hired by the Founding Directorate for the overall management of the Peterborough DNA Cluster Project, which is estimated at about $37 million, and he will be responsible for coordinating the process to construct the DNA Partnership Building on the campus of Trent University beginning in Spring 2004. Trent has provided the 5 acres for the construction of this building. The research infrastructure will occupy approximately one quarter of this building. The other occupants of the DNA Partnership Building will be the OMNR, police identification services and a number of the private sector partners.

A number of formal agreements already link the public sector partners. On the educational front, these include the Nursing program and the new Honours Forensic Science degree program given jointly by Trent and Sir Sandford Fleming College. The Natural Resources DNA Profiling and Forensic Center (NRDPFC) and the Watershed Sciences Center represent formal research partnerships between Trent and OMNR. Many OMNR scientists hold academic appointments at Trent and supervise Trent graduate students. There are numerous joint projects between Trent and the OMNR on wolves, black bears, polar bears, moose, elk, caribou, fishers, white-pine, wood poppies and a number of fish species. The OMNR Enforcement section collaborates on a number of forensic research projects. The major research program on assessing the spread of raccoon rabies not only involves Trent and the OMNR but also Sir Sanford Fleming College, McMaster University, Queen’s University, Cornell University, the Centre for Disease Control in Atlanta and the Canadian Food

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Inspection Agency. There are also on-going research collaborations that involve Trent, Sir Sandford Fleming College and some of the private sector partners such as Maxxam Analytics, LabInterLINK, and Retisoft. Close links have been established between Trent and PerkinElmer and the NRDPFC is a reference Centre for AmershamPharmacia instrumentation.

There are numerous and extensive national and international research collaborations at the individual project level. These include significant major international activities on programs to understand the reproductive problems of the highly endangered North Atlantic right whale that involve the New England Aquarium in Boston, Woods Hole Oceanographic Institute, University of Rhode Island, Centre for Coastal Studies, Department of Fisheries and Oceans, Memorial University of Newfoundland and Dalhousie University. There is a collaboration with the US Navy to study the genetic status of the San Clemente shrike. There are collaborations with the US Fish and Wildlife Service on the relationship of the red wolf in the US and the eastern wolves in Canada. An aspect of the wildlife forensic research involves a partnership with Environment Canada for the enforcement of the Trade in Endangered Species and this has included research into caviar and waterfowl. The NRDPFC participated in a 2-year study with the Natural Resource Institute, Greenwich, UK to identify specific cattle within the blood meals of tsetse flies to provide recommendations on which cattle to immunize against sleeping sickness. Forensic research has also involved collaborations with New York Humane Society, International Marine Mammal Association and a number of other provincial agencies.

Dr Emery collaborates with CLIMA at the University of Western Australia, Perth, Australia on the hormonal regulation of seed development in legumes. Dr. Emery is also collaborating with the Prof. Laurent Leport (Equipe Osmoadaptation et Métabolisme de Stress, Interactions Cellulaires et Moléculaires, Université de Rennes 1, Rennes France) within his cellular and molecular program that investigates salt stress and senescence of salt adapted coastal plants. Population level functional genomics at Trent University would be of great interest to these collaborators who have excellent molecular and ecological infrastructure but no access to equivalent automation and GIS facilities. Collaborations are being developed with the private sector and other government agencies. These include (1) Pickseed Ltd. for the development of new forage legume cultivars and the protection of intellectual property rights for forage legume and turfgrass cultivars by DNA profiling (2) French government (Institut National de la Recherche Agronomique: INRA) to aid in their study of the invasive spread of Ambrosia artemisiifolia (common ragweed) and its relationship with natural Canadian populations (3) the Central Ontario Viticulture Association (COVA) to help develop cold and freeze-thaw tolerant wine grapes for a new market central Ontario.

Dr Murray currently collaborates with colleagues from Indiana State University, Simon Fraser University, University of Idaho, University of Central Florida, Utah State University, U.S. Fish and Wildlife Service, and U.S. Forest Service. Most of these collaborations are leftover from his term at University of Idaho and currently involve data analysis, theoretical modeling, and population viability analysis for a variety of species and systems. He now is establishing more extensive Canadian collaborations through work with OMNR, Ducks Unlimited, Delta Waterfowl, and McGill University. The Wildlife Health and Disease Laboratory will foster collaborations with the Canadian Cooperative Wildlife Health Centre (CCWHC), Guelph University, University of Saskatchewanthe Centres for Disease Control, Health Canada, (continued on p9C)

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Self-assessment

C - Potential benefits of the research to Canada

Choose the statement that best represents the infrastructure project.

The proposed infrastructure will support research that has the potential to:

☐ (a) contribute indirectly to economic activities (e.g. economic growth, cost savings, job creation) **or** contribute indirectly to the improvement of society, quality of life, health, or the environment;

☐ (b) improve economic activities (e.g. economic growth, cost savings, job creation) **or** improve society, the quality of life, health, or the environment;

☒ (c) contribute to increased economic activity in strong or emerging areas of the Canadian economy **or** yield a major benefit in terms of society, quality of life, health, or the environment;

☐ (d) contribute significantly to increased economic activity; help Canadian industry increase its global competitiveness and create new economic ventures; **or** lead to dramatic sustained improvements to society, quality of life, health, or the environment.

Using the space below and up to 1 additional page

- identify potential users of the research results; including partnerships with industry, health providers, etc.
- describe expected benefits, how these will be realised and the timeframe over which they are expected;
- where appropriate, provide plans for the development of clusters and for technology transfer, other forms of commercialisation or transfer of know-how, as well as contributions to policies and practices.

The key linking feature of the research programs and the infrastructure is the development and application of flexible robotic high throughput DNA, RNA and proteomic profiling protocols and platforms. Automation played a critical role in the rapid success of the human and other genome projects. The infrastructure in this proposal will place Canada at the forefront of research and development in the application of the information obtained from the genome projects to health, forensics, agriculture, forestry, environment and wildlife management and disease. These applications will depend on the identification and tracking of the genetic variation of individual organisms using rapid and inexpensive tests. These procedures must be automated and include effective sample tracking (especially for clinical, food and forensic applications) linked to automated data capture and analysis. These are the characteristics of the laboratory information system, AutoLIMS, that is a central development and integrating component of the infrastructure. The recent experiences with emerging diseases such as West Nile virus, Severe Acute Respiratory Syndrome (SARS), chronic wasting disease and mad cow disease emphasises the need for developing a flexible rapid testing capability in Canadian laboratories. The tests should be developed hand in hand with automation rather than automating previously developed manual testing protocols. This makes the co-location of the partners and the infrastructure in the proposal unique and why it will have such a broad impact across Canada. The research and development will be carried out in partnership with automation companies like LabinterLINK and Retisoft and the technology will be transferred to analytical laboratories like Maxxam Analytics and Lakefield Research. Companies like Maple Leaf Foods are using DNA tracking as a means of quality assurance of food from farm to table. This strategy becomes even more important when situations like mad cow disease suddenly impact the Canadian beef industry and this empahasises the intimate relationship of human and livestock health with wildlife health Given the small economic margins of the food industry this approach can only be cost effective using automation.

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The DNA and Forensic Science Centre will be located in the DNA Partnership Building on the campus of Trent University and will be an integral part of the Peterborough DNA Cluster Project. The project is being co-ordinated by an executive co-ordinator and led by the Founding Directorate, which is composed of Peterborough community leaders and an Advisory Committee of business and technical experts. The project has received funding from Industry Canada, Human Resources Development Canada and the Ontario Biotechnology Cluster Innovation Program. An Executive Coordinator will be responsible for the commercialization opportunities that flow from the research in conjunction with the Greater Peterborough and Area Economic Development Corporation and Trent's Industrial Liaison Office. The close partnership with the policy makers in the Ontario Ministry of Natural Resources ensures the information from the natural resources research programs is effectively transferred to the users. Canada is rapidly reaching a crossroad in its ability to manage and conserve wildlife populations and its capacity to effectively control or mitigate disease transmission from wild animals to humans and livestock. The infrastructure and innovative research proposed will provide a wide array of management agencies with useful information across the web (Department of Fisheries and Oceans, Environment Canada, Canadian Wildlife Service , Parks Canada). In the case of zoonotic diseases, legislators and health providers will gain insight from research results displayed in GIS format into the possible prevention and control of wildlife disease spread to humans.

Research into DNA forensics is limited in Canada and world-wide. The capacity of large service laboratories like the Centre for Forensic Science in Toronto is taken up by case processing leaving minimal resources for research and development. The infrastructure and partnerships with the police and wildlife enforcement agencies in the DNA and Forensic Science Research Centre will provide the capacity for forensic research as DNA profiling moves to single nucleotide polymorphism analysis and the use of smaller amounts of ever more degraded samples. The automated technologies will be transferred to the private (Maxxam Analytics) and public forensic service providers (RCMP and the Centre for Forensic Science) following validation.

The plant molecular physiology research will benefit the Canadian forage and grain legume industry. Pickseed Ltd. is Canada's largest supplier of forage legume seed with its company headquarters nearby in Lindsay Ontario. They have expressed strong support for the proposal. And the short term benefits to Pickseed would include the development of DNA profiling for protection of intellectual property rights over the cultivars they develop. Another example is Pulse Canada, a national legume industry association, which has a mandate to find ways to optimize growth and efficiency of Canadian pulses to add value for Canadian farmers and secure Canada as a global pulse supplier. This matches our research goals to improve chronically low and variable legume yields. It will be achieved through marker or physiology based selection to direct breeding programs or genetic engineering for hormonal modifications. The geo-spatial genetic profiling of white pine will help national and provincial governments develop and implement forest biodiversity monitoring programs and indicators toward sustainable forest management. This also impact on white pine conservation and forensic protection of remaining old-growth stock. Experiments in white pine molecular physiology may eventually lead to the ability to predict long-term population response to the spread of disease, like blister-rust, and climate change.

The Molecular Physiology Laboratory will be dedicated (continued on p10C)

Canada
Foundation
for Innovation

SUGGESTED REVIEWERS 1-3

Date: 03/10/2003 Project number: 8910

Title of project: DNA and Forensic Science Research Centre

Institution: Trent University

Designated Project Leader White, Bradley

Complete this module for all applications to the CFI. Identify six (6) reviewers appropriate for the application. **Reviewers must not** be current or recent (within the last 6 years) collaborators, departmental colleagues, students or supervisor(s).

Provide a complete mailing address, telephone number, fax number, **current e-mail address**, and the areas of expertise of potential reviewers. Suggested reviewers may be Canadian or international and should be able to evaluate the application in the language in which it is written.

The CFI reserves the right to make its own selection of reviewers.

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Canada
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SUGGESTED REVIEWERS 4-6

Date: 03/10/2003 Project number: 8910

Title of project: DNA and Forensic Science Research Centre

Institution: Trent University

Designated Project Leader: White, Bradley

Reviewers must not be curent or recent (within the last 6 years): collaborators or departmental colleagues, students or supervisors. Provide a complete mailing address, telephone number, fax number, **current e-mail address**, and the areas of expertise of potential reviewers. Suggested reviewers may be Canadian or international and should be able to evaluate the application in the language in which it is written.

The CFI reserves the right to make its own selection of reviewers.

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Subject: CFI Proposal
From: "Brad White" <Brad.White@nrdpfc.ca>
Date: Thu, 14 Oct 2004 17:21:14 -0400
To: <undisclosed recipient@trentu.ca>

Hi <undisclosed recipient@trentu.ca>:
We received $3.6 million from CFI and $3.6 million from OIT as well as over 1 million in matching funds from MNR and private sector partners. A major thrust of the research is the conservation of the natural resources of Ontario. Our biased view is that our greatest natural resource is the DNA across the landscape in the form of the genetic variation in the many species that have evolved over the past 1-2 billion years. I hope this helps.

Brad

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