Developing an Animal Health Science Agenda for the National Animal Health Strategy (NAHS)

Application of Strategic Foresight to the Development of Vision, Goals, Objectives and Actions

Version 1.0

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TDV Global Inc.

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1.0 Background

1.1 Strategic Foresight for an Animal Health Science Agenda

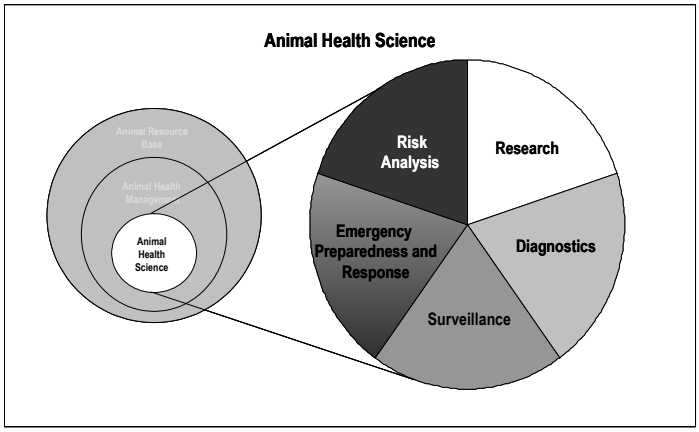
In the spring of 2006, a Strategic Foresight[1] process was initiated with active participation from the animal health science community. The process was focussed on animal health science needs twenty years into the future, in 2026. The aim was for an Agenda[2] for animal health science that would allow partners to plan proactively, thus enabling effective preparation for a range of potential futures. The process resulted in the development of five scenarios (Annex A) of the future circa 2026 that highlight key uncertainties facing strategic decision makers.

Building off of the Strategic Foresight initiative, a Working Group on Future Animal Health Science (Working Group membership at Annex B) was established in summer 2007 to inform the development of the National Animal Health Strategy (NAHS), due to be completed in summer 2008, and contribute to the implementation of the NAHS through the development of a Animal Health Science Agenda.

In late 2007, the WG undertook a Strategic Foresight exercise and employed the five scenarios to develop a proposed strategic direction for Animal Health Science, including a Vision and Goals. The completion of an Animal Health Science Agenda, including Objectives and step-wise Action Plans over the next years will involve networks of participants from regional science communities in Canada. The Agenda is expected to be completed by the end of 2008, with implementation beginning in 2009.

1.2 Scope

Animal health science aims to increase knowledge of animal health through study and research as well as the development and delivery of applications of that knowledge to improve animal health, cure and protect against diseases and increase overall understanding of animal function.



For purposes of the WG deliberations, the scope of animal health science was considered to include pure sciences as well as the economic, political and social elements involved. This work is completed across Canada by veterinarians, scientists, chemists, biologists, support staff and laboratory technicians working in

[1] Strategic foresight has been described as "The strategic thinking that precedes strategic planning and action". It is conducted using processes that help participants anticipate the future and think clearly of what is important and then integrate that thinking in a practical way into strategy development and policy and decision making.

[2] Animal Health Science Agenda will be comprised of strategic direction, comprising Vision, Goals, Objectives and Action Plans, that will be built around Science Capabilities with focus on roles of regional partners.

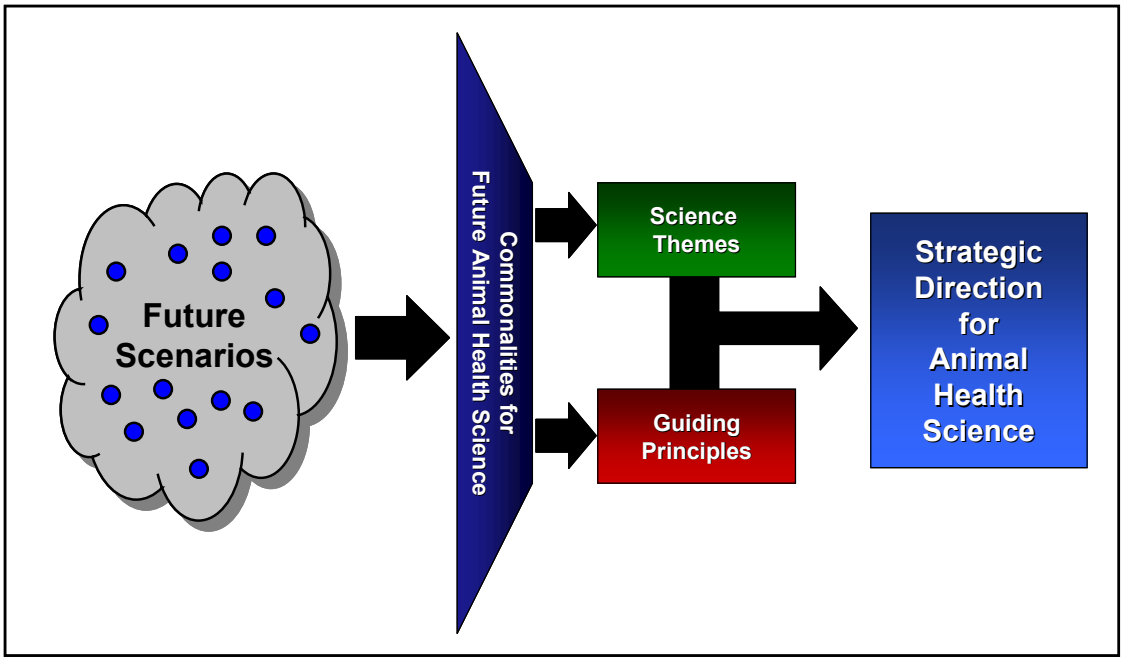
government, academia, industry and NGOs. As illustrated in the diagram above, animal health science encompasses the following activities:

- **Research**: includes the pure sciences (biology, chemistry, physics, etc. and including human medicine) to analyze risk pathways to identify and address underlying causes as well as its application to improve prevention, health monitoring, treatments, medical devices and cures;
- **Surveillance:** all activities surrounding the ongoing systematic collection, collation, analysis and interpretation of data and dissemination of information;
- **Diagnostics:** development and use of clinical, laboratory and field tests that detect illness in animals;
- **Risk Analysis**: includes determining the risks involved, establishing measures to mitigate said risks, and ensuring that the necessary stakeholders are included in the process;
- **Emergency Preparedness and Response:** involves the planning and training for an event to create capacity to respond efficiently and effectively to contain the outbreak as well as the role of knowledge transfer and education to inform the public and decision makers.

All together, these components were considered by the WG to provide a comprehensive overview of animal health science.

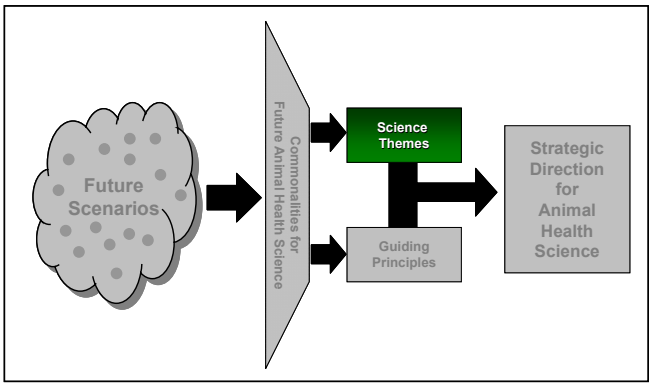
2.0 Commonalities for Future Animal Health Science

In November 2007, a Working Group on Future Animal Health Science Workshop identified major animal health science requirements arising from each of the future scenarios (i.e. what animal health science would be required in these future scenarios given influence of drivers, trends, and technology). Across the five future scenarios, participants then determined commonalities for future animal health science (see Annex C). An analysis of these common future science requirements resulted in the identification of **Science Themes** and fundamental **Guiding Principles** for the future.



2.1 Themes

Animal Health Science was defined by the WG to include Research, Surveillance, Diagnostics, Risk Analysis, and Emergency Preparedness and Response, were examined from the perspectives of Organization, People, Technology and Processes. As a result of the Workshop discussion, specific future science Themes began to emerge, which are outlined in the table below:

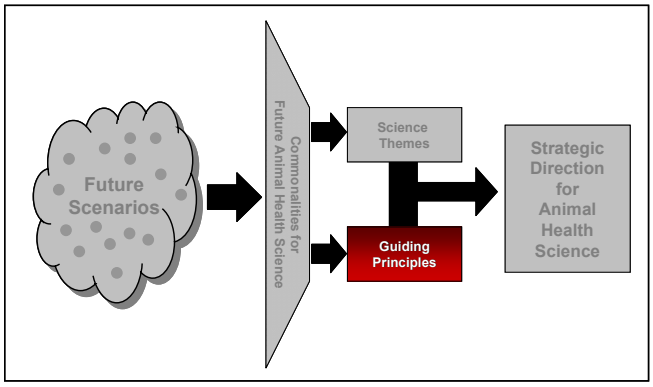


Organization	People
Integrated Networks – For effective animal health science activities, broad, horizontal, integrated networks (which include small and large-scale producers, animal and public health communities, regulators and consumers) will be required to monitor parameters that measure animal health, facilitate interoperability, support global animal health intelligence and establish the foundation for systems-based science. **Enhanced Inter-Organizational Understanding of Risk Pathways** – Increased knowledge and engagement of experts from multiple disciplines (e.g., wildlife specialists, social scientists, modellers, etc) within an integrated animal health science network will result in a better understanding of the factors that contribute to animal health and how to measure the health of animal populations. A key result will be improved risk mitigation strategies across the animal health - public health interface.	**Innovative Approaches to Training** – Traditional approaches to training in science and technology does not deliver the range of skills necessary to tackle the breadth of future issues relevant to animal health science. Encouragement of interdisciplinary approaches to training, more opportunities for scientists and technologists to broaden skill sets and diversify their knowledge bases, and international exchanges of knowledge and expertise will all help to address this problem and contribute to the development of coherent strategies across traditional sectors. **Broader Range of Contributing Agencies** – Future science systems will need to integrate effectively within the wider animal health systems and infrastructure, and this would include a stronger role for industry. From monitoring animal populations to applying control strategies during an animal health event, industry occupies a critical position in animal health management. Future technology will facilitate industry's ability to conduct monitoring surveillance and other data

	gathering activities in support of animal health.
Technology **Utilization of Innovative Real-time and Multi-point Monitoring Technologies** – Increased monitoring will be a basic requirement of future animal health science. Monitoring, applied to individual and populations of animals, will be necessary for internal feedback and decision making within, and across better organized and integrated animal health science systems. New monitoring technologies and methods will help reduce costs and will be simpler and easier to use (e.g., implantable nano devices, remote sensing coupled with disease modelling, etc). **Enhanced Traceability** – Consumers will demand science and technology-based tracking of foods of animal origin back to source in order to provide a detailed record of animal husbandry, welfare and nutritional status. Enhanced levels will be essential to the maintenance of public confidence in the food system.	**Processes** **Common Standards Development** – Effective management of future animal health will be contingent upon science-based multi-stakeholder agreement in areas such as interoperability[3], quality assurance, technical standards, data protocols, and systems of regulation and governance. Input will be required from information technology companies, diagnostic developers and animal health management stakeholders in the development of common standards. There will be a need to establish common standards for managing large volumes of data, such as genomic datasets. **Emergency Preparedness and Response** – There will be enhanced emphasis on science-based emergency preparedness and management processes to address emerging animal health threats and biosecurity concerns. Effective emergency management capabilities at the local level will be important in maintaining to public confidence.

2.2 Guiding Principles

Workshop discussions on future animal health science themes revealed fundamental principles that should guide people and organizations in developing strategic directions for future science to ensure common requirements are met in the future. Guiding principles that emerged at the workshop include:



- **Inter-disciplinarity** – Future animal health issues faced by Canadians will be determined by a complex multitude of factors such as human demography and behaviour, land

[3] Interoperability is the ability of diverse systems and organizations to work together (inter-operate).

use and agriculture, travel and trade, climate, social trends and economics, governance systems, animal and public health policies, public attitudes, natural disasters and national security. Animal health science that is needed to support the management of these issues must be multi-jurisdictional and multi-disciplinary in order to integrate diverse perspectives and broad skill sets.

- **Team Approach** – A team-based approach to animal health science will be required to promote cooperation and collaboration. Teams will need to be formed that also draw upon human health and environmental science expertise (i.e., meta-scientists). Interdisciplinary research programs, which tend to cross existing institutional partitions, require a team approach to be effective.

- **Rapid Response** – Public and private sector organizations need to be able to initiate action quickly to respond to evolving situations without the need for centralized direction. Frontline leadership is required in responding decisively to threats as they are encountered. Future diagnostics, monitoring and response systems will need to be embedded in local systems of culture and governance if they are to be practical and effective, complementing an overarching national approach.

- **Global Perspective** – Globalized economies and increasing trade have given rise to a global health paradigm where animal and public health threat are not so easily contained by borders and continental boundaries. Emerging and existing threats to animal health are global concerns and activities such as risk analysis, surveillance and intelligence must be global in nature.

- **Interoperability** – The ability to interoperate must be a feature of how organizations, people and technology work together. Future animal health science requires science-based stakeholders to work in a concerted and proactive manner. Similarly, future technologies such as hand-held diagnostic devices and information systems must be able to communicate in a seamless fashion and operate across varied platforms.

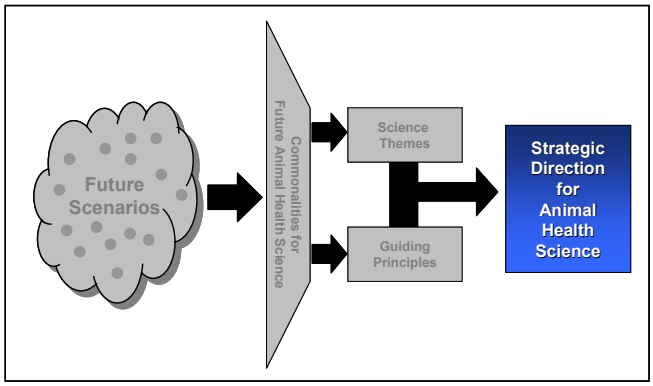
- **Prevention and Early Warning** – Future animal health will require robust science-based mechanisms for surveillance and intelligence to prevent or respond rapidly to threats to animal health. Trusted early warning systems that are local, real-time and diverse will be required to detect emerging threats and inform an effective preparedness and prevention system.

- **Societal Concerns** – Animal health science will be expected to contribute significantly to animal welfare, environmentally sustainable systems and the monitoring of those elements.

3.0 Strategic Direction

An analysis of these themes and principles has resulted in a proposed strategic direction for animal health science that includes a **Vision** and supporting **Goals**.

This strategic direction is the starting point for operational and implementation planning to prepare for future animal health science. This planning activity will commence in 2008 and will be supportive of the NAHS development.



The Vision and Goals for animal health science that will be realized through the development and achievement of Objectives and development and implementation of Action plans across national and regional animal health science communities.

3.1 Vision

A Vision for future animal health science is proposed, as follows:

> ***Vision***
>
> Animal Health Science will be a key contributor to human health and the economic, social and environmental sustainability of the animal resource base in Canada.

3.2 Goals

To achieve this Vision for future animal health science in Canada, the following Goals are recommended. These goals are intend to foster the development a robust animal health science system that is ***integrated***, ***innovative*** and ***relevant*** to the challenges facing animal health, nationally and internationally.

1. **Systems are Integrated** – There is great value to integrating animal health science outputs, including research data and emerging intelligence, with health management systems. This will be a considerable challenge as it will require the engagement of governments, academia and industry stakeholders, operating both nationally and internationally.

2. **Animal and Public Health Interface is Improved** – Infectious diseases will continue to be transmitted between wild and domesticated animal species and humans, with potentially devastating consequences. Sustainable and strategic linkages must be developed between the animal and public health science communities. Natural ecosystems and their interaction with humans will continue to be major sources of wildlife diseases that may threaten animal and human health. Monitoring of wildlife health will require improvement.

3. **Innovative Technology is Adopted** – Advances in diagnostic and sensing technologies – such as genomics-based diagnostics, smart swabs or high-throughput screening – are expected to be required. Animal health science must be positioned to take advantage of these advances in support of real-time, field testing, distinguishing vaccinated / non-vaccinated animals, support of emergency management, conduct of surveillance, determination of disease-free status of animals, etc. Organizations responsible for animal health science planning will need to set investment priorities to support rapid advances in areas that offer new potential applications, such as in information technology, biotechnology, nanotechnology, genetic engineering, artificial intelligence, human/machine interfaces, genomics, proteomics, and nanotechnology, etc.

4. **Broad Traceability Systems are Implemented** – Advances in science and technology will enable the implementation of traceability systems that identify and monitor elements affecting animal and human health (e.g., food elements and sources, diseases, toxins, genes, etc). Such systems will support public confidence and the desire on the part of consumers to better understand their own health and diets.

5. **Science Expertise is Accessible** – The breadth of future issues relevant to animal health science will require rapid access to a broad range of skill sets. Access to an integrated animal health science network, which includes international exchanges of knowledge and expertise, will allow for the effective contribution of experts from multiple disciplines. Efforts must be taken to recruit and retain highly these skilled personnel.

6. **Sustainability is Supported** – During the next 20 years, environmental degradation will continue due to pollution, intensification of production, pressures on wildlife habitat and invasions of alien species. Animal health science will be an important contributor to improving the efficiency of water and energy use and reducing negative environmental impacts. Economic, social, environmental and health sustainability will be important considerations for animal health science.

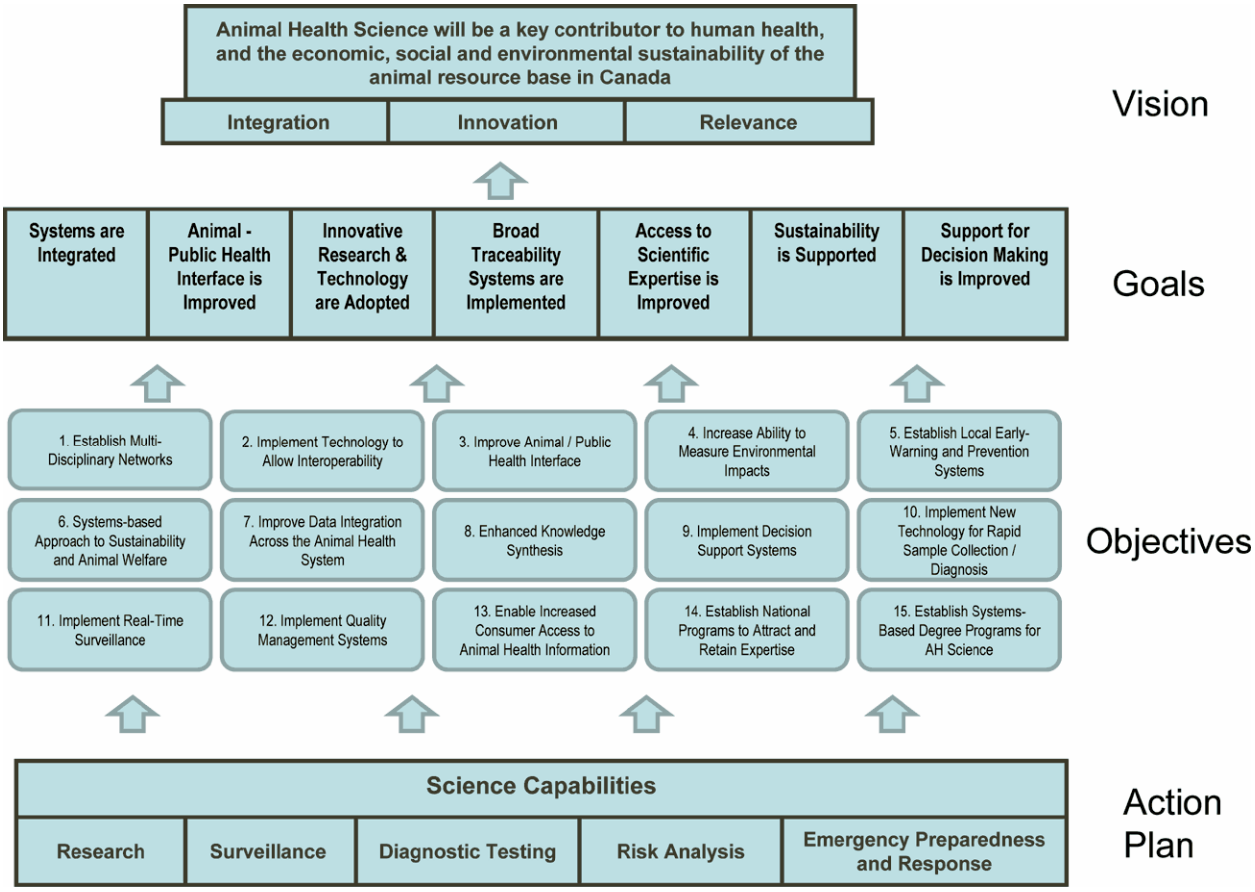
7. **Support for Decision Making is Improved** – Decisions, policy advice and design of intervention strategies pertaining to animal health will be more effective through the application of science, including data analysis and mathematical modelling, to measure and monitor the health and welfare of animals and people.

3.3 Objectives and Actions

In January 2008, the Working Group on Future Animal Health Science Workshop performed a back-casting exercise to identify tangible indicators of success in achieving previously identified Goals. Participants were asked to identify both short and long-term indicators of the realization of Goals for use in determining the potential Objectives that will be required in achieving the Vision for future animal health science in Canada. This analysis led to the development of proposed **Objectives** and associated **Actions** required to achieving long term Goals in a step-wise manner over the next 5, 10,15 and 20 years.

Taken together, the Vision, Goals, Objectives and Action Plans will comprise the **Animal Health Science Agenda** (Figure 1). It is proposed that Action plans will be built around Science Capabilities with focus on roles of regional partners.

Figure 1. Proposed Framework for an Animal Health Science Agenda (Feb. 15, 2008)



Proposed Objectives	Potential Future Actions
Objective 1: Multi-disciplinary networks are established and funded to support animal health science initiatives	• A detailed animal health systems analysis is performed by animal health representatives and researchers to determine capacity, effectiveness and areas for improvement • A disciplinary profiling process is initiated by P/T animal health representatives and researchers to determine future requirements for animal health science • Recruitment and retention strategies are designed by F/P/T animal health representatives to fill identified gaps • F/P/T animal health representatives design a strategy to collocate various disciplines in physical centres, increasing communication and coordination between various animal / public health domains • The development of multi-disciplinary teams by F/P/T animal health representatives, to be used as standard procedure in beginning new projects • All animal health partners must determine the roles and responsibilities of government science, industry science and academic science in achieving the objectives of the Canadian animal health system
Objective 2: Technology is implemented that will allow the Canadian animal health system to interoperate and share information effectively	• Animal health representatives, researchers and laboratory directors perform a detailed animal health systems analysis to determine the effectiveness of current technology and areas for improvement • F/P/T animal health representatives, researchers and laboratory directors develop plans to procure needed technologies, and prepare for the procurement of anticipated technologies to fill the gaps identified in the systems analysis • Clear definition of data ownership and sharing arrangements are developed between levels of government, academia and industry • Software and systems to share information quickly and effectively are procured by animal health representatives, researchers and laboratory directors • Technology foresight capability is established by F/P/T animal health representatives, researchers and laboratory directors to identify useful technologies as they become available
Objective 3: Potential public health impacts of the animal-health interface are prevented, detected, and responded to effectively.	• Animal health researchers, academia and public health representatives identify common areas of concern and identify best practices for assigning roles and responsibilities. • F/P/T animal health representatives, researchers and public health representatives implement systems to share urgent information immediately regarding emerging threats and response.

Proposed Objectives	Potential Future Actions
Objective 4: Increased ability to measure environmental impacts in relation to animal health is established	• An increased ability is developed to measure environmental impacts in relation of animal health by F/P/T animal health representatives, researchers, laboratory directors, industry, and agricultural health economists. • F/P/T representatives, researchers and laboratory directors develop baseline measures for environmental impacts to better inform sustainable practices.
Objective 5: Early-warning and emergency prevention systems are adapted to an increased focus on local production	• F/P/T animal health representatives, researchers and industry adopt new technologies (eq. real-time bio sensors, improved animal tracking technology etc.) that allow for faster sample collection and diagnosis. • Animal health researchers, F/P/T representatives and industry assess current real-time surveillance capacity, and identify areas for improvement in preparing for emerging threats. • F/P/T animal health representatives de-centralize decision-making authorities and emergency response systems. • Industry adapts transport and supply systems to meet increased focus on local production.
Objective 6: Systems-based approach to animal health science is established which connects health related concerns with socially and environmentally sustainable practices.	• F/P/T animal health representatives and researchers work with agricultural health economists and industry to review current practices and supply recommendations for improvements throughout the system. • The roles, responsibilities and accountabilities of all animal health and welfare partners are clearly defined • F/P/T animal health representatives develop a system of “best practices” based on the recommendations of researchers, laboratory directors, and industry to increase the sustainability of animal health related operations and science • CFIA and F/P/T animal health representatives and industry associations must implement new practices and regulations to reduce negative environmental impacts and improve sustainability across the animal health system
Objective 7: Improved data integration that enables the provision of the right information to the right people at the right time.	• Representatives of government, academia and industry define clear standards for data ownership. • F/P/T animal health representatives, laboratory directors, and researchers throughout the animal health community and related industry consult to determine data requirements in terms of quality, timeliness, etc. • F/P/T animal health representatives develop a system for sharing and ensuring access to important data in a timely and efficient fashion

Proposed Objectives	Potential Future Actions
Objective 8: Knowledge synthesis processes and programs are enhanced to enable the effective sharing of information	• Based on the establishment of multi-disciplinary networks, P/T animal health representatives work with researchers and scientists to improve knowledge dissemination between scientific domains. • F/P/T animal health representatives must work with academia to develop systems-based knowledge-transfer exercises and training programs inclusive of multiple disciplines
Objective 9: Decision support systems are implemented	• F/P/T animal health representatives, researchers and academia perform a detailed animal health systems analysis to determine capacity, effectiveness and areas for improvement • F/P/T animal health representatives work with researchers to develop decision models based on best practices and likely scenarios
Objective 10: New technologies are implemented that allow for rapid sample collection and diagnosis	• Animal health representatives, researchers and laboratory directors perform a detailed animal health systems analysis to determine the effectiveness of current technology and areas for improvement • F/P/T animal health representatives consult with researchers and laboratory directors to develop a technology foresight capability to identify useful technologies as they become available • Various levels of government, academia and industry engage in consultations to ensure new technologies are being utilized at the right stage, and that emerging technologies are procured by the right organizations (e.g., government, academia, industry etc.) • F/P/T animal health representatives, researchers and industry assess and adopt new technologies that allow for faster sample collection and diagnosis.
Objective 11: Real-time surveillance is implemented.	• Animal health researchers, F/P/T representatives and industry assess current real-time surveillance capacity, and identify areas for improvement in preparing for emerging threats. • F/P/T animal health representatives, researchers and industry adopt new technologies (eq. real-time bio sensors, improved animal tracking technology etc.) that allow for faster sample collection and diagnosis.
Objective 12: Quality management practices are implemented across the national animal health system	• F/P/T animal health representatives work with researchers, academia and industry to define quality management standards and processes for data collection, storage and maintenance. • Establish national consensus on quality standards and processes across a national animal health system. • F/P/T animal health representatives, researchers and industry engage in the implementation of a quality management system for animal health.

Proposed Objectives	Potential Future Actions
Objective 13: Consumer access to animal health science data is improved	• F/P/T animal health representatives, researchers and industry perform an assessment of the animal health system's capacity to relay information to the general public. • F/P/T animal health representatives and researchers perform an assessment of the consumer demand for information to determine the infrastructure that will be necessary to provide it. • Responsibility for the communication of information must be clearly defined among animal health partners • Information transfer options and best practices are clearly defined by F/P/T animal health representatives and industry. (e.g., information campaigns, public database etc.) • CFIA, P/T animal health representatives and industry associations implement new programs to ensure public access to public and animal health information
Objective 14: National programs are established to attract and retain animal health science expertise and encourage on-going learning and cross-fertilization among disciplines	• F/P/T animal health representatives and industry develop inter-governmental and industry exchange programs to harmonize human resource and administration systems between government, academia and industry, allowing expertise to flow more freely throughout the animal health system • Industry HR groups are consulted to develop common standards and exchange programs to provide competitive compensation. • Based on the harmonization of standards through the development of exchange programs and the elimination of barriers to mobility, F/P/T animal health representatives design competitive compensation packages and programs to attract and retain highly skilled individuals from multiple science and health related domains. • Federal government implements immigration policies that facilitate the entry of foreign scientists and researchers into Canada.
Objective 15: Veterinary degree programs are established which emphasize a systems-based approach and a focus on increased communication and integration between disciplines.	• Veterinary Schools consult with F/P/T animal and public health representatives and industry to identify and anticipate gaps in related degree programs. • Veterinary Schools develop flexible, systems-based degree programs (e.g. Doctorate of Integrated Health Systems) • Animal and public health representatives and researchers supply ongoing support and input for the development of flexible, systems-based programs and degrees • Recognition of new credentials and degree programs by the animal health community and Chief Veterinary Officers

4.0 Next Steps

The intention of this draft Animal Health Science Agenda is to propose a strategic direction for animal health science, which includes a Vision, Goals, Objectives and Actions. Recommendations or preferences for Goals and Objectives will be more likely supported if widespread national consensus can be achieved. To develop this national consensus, an iterative engagement process for communities in Canadian animal health science is proposed for 2008.

4.1 Regional Workshops

To develop consensus around Goals and Objectives and to develop regional Action Plans focused on key Animal Health Science sectors and issues (e.g., farmed animals, zoonoses, etc), a series of regional workshops for Canadian animal health science are planned for 2008

This engagement process will commence with facilitated Regional Workshops involving 10 regional participants at each of the five Veterinary Colleges during February and March 2008. The aim of the Working Group is to continue to use the Strategic Foresight process to develop an Animal Health Science Agenda for Canada that will support the National Animal Health Strategy by developing Vision, Goals, Objectives and Actions in collaboration Animal Health Science partners.

Workshop participants will be expected to:

- prepare for each workshop by reading assigned background materials and drafts (e.g., workshop reports, draft strategic direction, etc) prepared by the WG (material will be available at www.healthyanimals.ca);
- actively participate in the workshops by contributing to innovation, cooperation and consensus across communities;
- help explain or "roll out" the tentative conclusions reached and any other workshop results to all leaders of stakeholder groups and as many other stakeholders as are or can be interested; and
- collect feedback from their stakeholder group for WG consideration in supporting nation-wide strategic planning of future animal health science.

4.2 Workshop Agenda

Workshops will be coordinated by the Deans of the Veterinary Colleges with assistance from CFIA Area Laboratory Network Directors. Local facilities will be used and the workshops are expected to be one-day events, with breakfast, lunch and coffee breaks provided for participants. The workshop agenda would entail the following:

- Presentation of a proposed future animal health science strategic direction, which includes a Vision, Strategic Goals, and draft Strategic Objectives;

- Roundtable discussion on each draft Strategic Objective to determine what are the implications for each region or community; and,
- For communities that do not support specific draft Strategic Objectives and or Actions, identification of alternatives for consideration.

Subsequent workshops will be conducted from May to September 2008 to build national consensus on a modified strategic plan that reflects the feedback gathered from the regional workshops.

Annex A – Future Scenarios

Potential Scenarios for 2026

toward which Canadian animal health science must plan

#1: Canada Becomes a Meat Producer for the World

#2: Decreased Demand for Animal Protein

#3: Concentration on Human Health

#4: Focus on Environmental and Climate Change

#5: Genomics Capabilities Alter Species

Potential Future #1: Canada Becomes a Meat Producer for the World

Principal Change Driver: Global market conditions create an opportunity for Canadian food producers.

Situation: The world has seen twenty years of climate change and population growth. In much of the world, the landscape is dryer, rougher and emptier than it used to be, except where cities sprawl, crowded with factories and displaced country dwellers. There is famine in much of the world, spreading far beyond the usual hot equatorial areas. Traditional trade patterns and markets are disrupted or eliminated. The economies of China and India are booming. Both countries have growing middle classes that are abandoning their traditional diets for more Westernized fare — and that means meat; lots of it.

How Canada copes: Canadian producers are responding with a massive increase of intensive livestock production. Since large swaths of formerly arable land around the world are now poor quality or useless for farming, Canada, with its plentiful supply of (relatively) fresh water is an important global food source. Corporations, not individuals, control food production; most food is produced by a very few highly profitable corporations. Traditional agriculture is moving steadily northward and eastward in the country with the climate change. Surviving wild animals are also heading north and east to escape drought. Lands now unsuitable for traditional agriculture have a new use as locations for factory farms. Opposition to intensive animal production and fear of animal-based diseases breeding on the factory farms and spreading to the human population has been mitigated by strong food production guidelines and codes of practice. To maintain global market share corporate food producers are self interested in insuring demonstrably sustainable development within social, economic and environmental expectations.

Governments focused on protecting fresh water supplies have restricted the amount of water available for all forms of agriculture and introduced requirements for use of alternate fuels, biofuels in particular. These trends, combined with drought elsewhere in the world means global food prices are soaring driving an upward spiral in the cost of animal feed.

There are fewer people available or interested in working on farms in Canada, but those that do tend to be better educated and better able to sustain a living based on “lifestyle” farms, emphasizing small crops and organic production. There is growing local demand for this type of food production regardless of increased costs to consumers.

Impact on animal health regulation: Risk management is seen as the key to economic viability, which has led to increased oversight and demand for outcome measurement from food producers. Significant investments in new technologies emerging from interdisciplinary sciences — genomics, biotechnology, engineering and information technology — are working with the more traditional health sciences to develop safe and sustainable food production, humane animal raising and better real-time surveillance and diagnostics. Science resources are also targeted in preserving biodiversity, finding alternative protein sources and trying to help species adapt to new environments.

Potential Future #2: Decreased Demand for Animal Protein

Principal Change Driver: A growing portion of the North American population becomes vegetarian; others are eating far less meat.

Situation: Scientific studies have piled up on the hazards of animal protein. Some years ago results of a 20-year study proving the level of meat consumption in North America was a factor in many serious illnesses was published by the AAAS in *Science*. Subsequent confirmations and embellishments appeared in the *New England Journal of Medicine* and *Nature*. A year later, the U.S. surgeon general told Americans they needed to cut their meat consumption by 50% for their health's sake. The public press picked up the story and has been running continuous sensational campaigns remarkably similar to the anti-tobacco campaigns of the 1990's.

The data on how animal products contribute to cancer, heart disease and obesity was tough enough for us to swallow; but the study and the recommendation came in the middle of several years of small outbreaks of animal based diseases, which have made the general public increasingly uneasy over zoonotic and other animal-related disease threats to public health. In fact, chronic wasting disease had jumped from wild animals to domestic herds but it was still a shock, a few years later, when it was found to cause a new type of CJD in people.

How Canada copes focus: Due to falling demand for meat, North American restaurants have many more non-meat items on their menus. Canadian meat production is concentrated in fewer big, intensive operations focused on off-shore exports. Energy demands have driven up the cost of Canadian grains and oilseeds to three times 2006 costs, and political events in South America are cutting off supplies of cheap feed. Even with the food corporations' economies of scale, meat is much more expensive than it used to be. There is an increased North American demand for soy food products and for fish.

More trouble is on the horizon for large producers as governments increase water restrictions for agricultural use, particularly near big cities. The concentration in intensive farming is hard on the rural economy — there are fewer jobs to be had. Small, diversified farms focusing on organic farming, however, are thriving. Public demand for "safe and nutritional" goods has let organics capture 10% of market share. Less water is being used for livestock and less is polluted with run off. Overall, people are healthier because of their new diets.

Impact on animal health regulation: The lower demand for meat has reduced beef and swine herds by 50% making disease surveillance an easier task. Animal science is focused on insuring that basic screening and protection programs work well in both the big intensive meat production operations and the small organic farms. Other sciences are converging to create and manage flexible data bases for real time surveillance, diagnostics and disease monitoring.

Potential Future #3: Concentration on Human Health

Principal Change Driver: Increased zoonotic challenges to human health.

Situation: After two decades of widespread zoonoses— avian flu, BSE, West Nile Virus and others unknown in 2006 — our relationship with animals has changed. The wildlife that once defined Canada is severely impacted by disease and is still a health threat to humans. Citizens wonder if every animal product could carry illness. Summers are hotter; winter has become a grey shadow of what Canadians once knew. Without bitter cold, animals and insects from far to the south extend their ranges, bringing disease with them to people, animals and plants with no immunity. Potential pandemics have been adequately contained, but at least two of them were the results of bio-terrorism, deliberate mutation and introduction of animal-based viruses into the human population through the food supply.

In many parts of Canada, water is hard to come by and everywhere its quality can be low. Irrigation is becoming expensively impractical and many regions have had to abandon their traditional crops. Some areas, of course, have new farming options, wheat farming in the Mackenzie Delta for example, but it is far from clear whether these new crops will compensate for the production we've lost.

Internationally, long-term but low-level internal wars are disrupting the flow of resources, including fossil fuels and food. The food supply in Canada is affected — methods that use a great deal of fuel are being abandoned, cost has greatly reduced food imports and some foods can't be had at any price.

How Canada copes: Almost 1/3 of us have given up animal products entirely; those who still eat animal products want them grown close by, where disease is less likely and the process is controlled by people we could find if we had to. The animal rights movement is stronger and people are realizing society's rights may trump individual rights in times of international illness. In some areas, water quality improves as intensive farming decreases. Demand for "boutique" food is a boost for the countryside; small, specialized farms are flourishing.

Impact on animal health regulation: Because of repeated epidemics, governments keep raising safety standards for food and have shifted their focus to managing epidemics in human populations. A lot of animal health science effort goes into detecting and preparing for foreign animal disease sources because not all exporting countries adhere to international standards. In Canada, there is far more testing of food at more points in the production chain including right on the farm, by owners who want to prove their crops and animals are disease-free.

Animal health science has had to become more integrated, multidisciplinary and committed to an all-encompassing notion of health — human, animal and environmental. Research priorities are agreed to by a common health-science community (industry, consumers and governments), which is focused on preventing disease and protecting the public. Most, if not all, agencies and nations are working to uphold a single set of international standards for food safety.

Potential Future #4: Focus on Environmental and Climate Change

Principal Change Driver: Climate change and environmental degradation

Situation: Global warming has surged forward, fed by 20 more years of industrial growth and increasing wealth in former developing nations, which pours cars onto their roads and air conditioners into their buildings. Traditionally wealthy nations have cut back emissions but have not eliminated new pollution nor begun to compensate for environmental damage already done.

On top of that, a conflict on the far side of the world turned ugly when one side used nuclear weapons it wasn't supposed to have. The atmosphere is choked and bouncing back heat to earth on days when the sun can hardly be seen.

As a result, global biodiversity is at risk. Floods in Southeast Asia have wiped out rice supplies for millions of people. Successive droughts in the prairies means grain fields are parched and animal feed is scarce and expensive. Warmer weather has extended the ranges of animals, insects and birds, upsetting ecosystems, bringing disease and wiping out domestic and wild herds and flocks of all kinds. People and animals trade deadly infections so human contact with wild or farm animals is limited and enforced. Our pets are the only animals most of us see anymore.

How Canada copes: Lack of water and the high cost of energy make intensive farming impractical but some effort is going into Asian-style integrated high-efficiency farming. Much of the grain we can produce goes to create energy. New sources of protein have to be found. The polar ice cap is gone so there are commercially viable fish farms in the arctic — and no polar bears to raid them. However, that alone can't feed a hungry world and attention is turning to manufacturing synthetic, single-cell proteins as a controlled food source. This degree of change in our environment changes our relationship with food. Our attitude toward food production shifts; it is no longer a commodity, it has become a regulated utility subject to government oversight at all points in production.

Already a largely urban nation, more Canadians shift to the cities as farms and natural resources fail. In the cities, industries collapse because of the cost of energy. The middle class shrinks; the gap between rich and poor widens.

Impact on animal health regulation: Consumers and governments are increasingly risk averse, demanding high safety standards for food, assurance its origins can be traced and low environmental impacts. Integrated, remote information systems track and model disease. Linkages among food, energy and environmental sciences are standard with an increased emphasis on integrated modeling. All scientific resources are invested in common goals of protecting the food supply and preserving minimal air and water quality. There is an increased focus on interdisciplinary research funding and inter-departmental decision making.

Potential Future #5: Genomics Capabilities Alter Species

Principal Change Driver: Steady growth in genomic knowledge and lessening public opposition to genomic manipulation.

Situation: Over the past 20 years full genomes of all large animals, all food crops, many pollinating insects and birds have been systematically mapped. This knowledge base has been applied in the creation and maintenance of massive genetic testing and tagging programs applied to humans, food animals and crops. Genetic manipulation skills have grown commensurately leading to widespread germ cell modification and cloning of animals and plants to produce better disease and drought resistance, more tissue, hormone and bioproduct of commercial interest. Genetic manipulation has also made xenotransplantations safer; as a result, they have become more common. Pesticides and herbicides have also been modified to more accurately target identified genetic weaknesses. Novelty pets have been created through genetic manipulation and the public has accepted the use of animal cell-based protein foods. The Olympic Games and other elite sports now have two divisions: one for 'traditional' athletes and one for 'enhanced' athletes, the later made possible by germ cell alternations in genetic structure.

How Canada copes: The structure of Canada's human health care system has allowed Canada to be a world leader in developing the genetic tagging systems that identified the associations of genetic, environmental and behavioural patterns with specific human diseases and debilitations. Through international consortia, this knowledge made possible the development of genetically tailored therapeutics. The same knowledge base was available for application in animal health but was not developed by Canadian animal health scientists. Small and medium-sized Canadian meat producers have sold out to high-tech industrial scale producers with the scientific and manufacturing capacity to utilize close to 100% of the animal cell-based protein available in the production of a wider line of food substances. As the cost of animal production goes up due to increasing feed prices, these same industrial food producers are including larger percentages of synthetic animal-cell based protein in their production lines. There is a small, but steady and lucrative national and international market for specialty animal production for organ xenotransplantation. Canada's relative abundance of clean water, clean air and space to sequester animals allows Canadian small farmers do well in these markets as they can meet high quality standards.

Impact on animal health regulation: Animal health regulation is increasingly challenged by both the genetic diversity enabled by gene manipulation and by the genetic focusing enabled by genetic cloning. Standards for food safety are challenged by the increasing sophistication of real and synthetic animal-cell based protein foods. Standards for animal and human health are challenged by the growth of organ farming for xenotransplantation. Ethical considerations involved in genetic manipulation remain an issue for society and therefore for governments.

Annex B – Working Group on Future Animal Health Science Under the National Animal Health Strategy *(as of Feb 15th, 2008)*

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Annex C – Commonalities for Future Animal Health Science

Commonalities for Future Animal Health Science					
	Research	**Risk Analysis**	**Diagnostics**	**Surveillance**	**Emergency Preparedness and Response**

Science Outcomes	• Integration of systems
	• Monitoring : individual animal / human
	  ○ Population level
	  ○ Use in feedback, decision making (RT)
	• Societal understanding of the entire system and how science will meet societal objectives
	• Public confidence, influence by science
	• Traceability. ID – animals, food, toxic, genes, etc
	• Efficiency of water energy use, lower environmental impact
	  ○ "Closed" – loop systems for safety, efficiency
	• Animal welfare				

Organization	• Multi-disciplinary, multi-jurisdictional across innovation systems • New organizations required	• Info sharing & common approaches to risk analysis • Common awareness across organization • Systems management approach to science	• Increased integration, especially with local small producers	• With increased production, industry will take on a greater role in auditing, QA, standards to ensure public confidence and Animal Health – Public Health integration • Increased integration, especially with local small producers	• Government will have greater involvement in environment / wildlife management • Biosecurity risks are prevented, responded to, and contained at the individual / system level • Decentralized knowledge and capacity established at the local / community level capacity

People	• Understanding among Partners and Stakeholders of:
	  ○ The entire system
	  ○ Their roles in relation to the system, as well as the protocol and roles of each member, strengthening overall commitment				

	• Employ balanced, "skilled" and	• Risk pathway, knowledge • Flexible access to	• Expertise able to work at the farm	• Appropriate training and education at all	• Creations of emergency

Commonalities for Future Animal Health Science					
	Research	**Risk Analysis**	**Diagnostics**	**Surveillance**	**Emergency Preparedness and Response**
	"generalists who are metascientists • Employ social scientists who understand understanding trends, impacts, psycho-social considerations • Develop and use networks • Interdisciplinary skills • Reward collaboration	expertise • Specialists in modelling • Wildlife specialists. • Ethics professionals	level	levels, especially hazard identification	management teams that are able to respond and manage crises
Technology	• Genomics • Informatics	• Decision support • Modelling • Team / system support • Data management & IT systems to support knowledge transfer	• Real-time, rapid tests conducted on-farm	• Trusted early warning systems that are local, real time, diverse and low cost and focussed on animal welfare, environmental impact and disease • Miniaturization • Use of sensors	• Communication
Processes	• Integrated systems to manage increased complexity	• Integrated risk assessment processes and systems • Integrative processes for decision-making; • Development of standards	• Quality assurance processes and real-time laboratory sample tracking	• National and international surveillance processes	• Global "Inter-operability" enhances communication (small producers, industry, government, etc) • Global action (response, prevention, etc.)