CANADA-BRAZIL TECHNOLOGY TRANSFER FUND

a proposal for:

NORTHEASTERN BRAZIL GROUNDWATER PROJECT

Submitted to

THE CANADIAN INTERNATIONAL DEVELOPMENT AGENCY (CIDA)

and

AGENCIA BRASILEIRA DE COOPERAÇÃO (ABC)

by

GEOLOGICAL SURVEY OF CANADA (GSC)

COMPANHIA DE PESQUISA DE RECURSOS MINERAIS (CPRM)

COMUNIDADE SOLIDÁRIA

SUPERINTENDENCIA DO DESENVOLVIMENTO DO NORDESTE (SUDENE)

ASSOCIAÇÃO BRASILEIRA DE ÁGUAS SUBTERRÂNEAS (ABAS)

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EXECUTIVE SUMMARY

Canada and Brazil are joining forces in a project to combat the effects of the drought in northeastern Brazil, one of the most devastating calamities to hit South America this century. The project will seek to improve the quality of life of some 25 million people who live in the area by developing the region's groundwater resources, which will improve access for the population to a more regular and abundant supply of good quality water. This, in turn, will strengthen the region's agricultural and economic sectors, improve health, and provide the people with the capacity to better sustain themselves during the prolonged droughts that periodically beset the region.

To this end, Brazil, led by the Geological Survey of Brazil (CPRM), will launch major programs in three states, Ceará, Pernambuco and Rio Grande do Norte, each one involving a number of organisation that, between them, cover a wide range of disciplines and services (earth sciences, engineering, environmental, social services, health, etc.). These organisations, which include federal and state government organisations, academic institutions, the private sector, NGOs, consultants, and community organisations, have defined their roles within the project in a series of proposals that are collated in a separate volume entitled *Project Proposals from Brazilian Partners and Participants*. It will be the first time that such a concerted effort is launched in the Northeast to try to bring relief to the problems caused by drought.

Canada will help Brazil achieve its objectives within these programs by supplying the best and most appropriate technologies and methods available in the country, and by adapting them to the conditions in northeastern Brazil. Over 70 Canadian companies and private institutions have responded to a Call for Expressions of Interest, offering an immense variety of tools ranging from highly sophisticated technologies such as airborne geophysics and satellite image interpretation, to simple methodologies based on their experience of similar situations elsewhere in the world, such as implementing community water supply projects in rural settings. A representative sample of these responses can be found in a separate volume entitled *Expressions of Interest from Canadian Firms and Public Institutions*.

Canadian technology will be transferred to Brazil primarily through workshop, seminars, short courses, in-field demonstrations, joint pilot-scale projects, technical visits, and training Brazilian personnel in Canada. This will enhance the capacity of Brazilian institutions involved in groundwater research and management, to conduct surveys, studies and water management projects that will effectively lead to an improvement in the water supply in NE-Brazil. As the newly acquired techniques replace old ones, and hypotheses and targets are tested by drilling wells or by implementing other recommendations, we anticipate that, early in the project, there will be improvement in the water supply of communities within designated pilot areas in the three states.

Technology will also be transferred at the community level through education and training projects with emphasis on hygiene, water resource conservation and protection,

simple water system maintenance, equal access principle, user-pay and alternate financing schemes, etc. Surveys to evaluate the needs of the population, and public sessions to promote community involvement in the project will also be conducted. This will improve the level of awareness and basic water management skills of the rural population to ensure maximum benefits and sustainability of the results of the projects.

Long-term sustainability and replication of the project's results will be attained by establishing solid and lasting linkages between participating Canadian and Brazilian private and public institutions, and individuals. This will ensure the widest possible dissemination of the project's results and the continuance of Canadian technological influence in the region long after CIDA's involvement in the project has ended.

The Geological Survey of Canada (GSC) and CPRM will co-manage the project with the participation of other strong partners: the influential national social action organisation, Comunidade Solidária; the prime development agency for northeastern Brazil, SUDENE; and the very dynamic Brazilian groundwater association, ABAS. The project is expected to begin early in the 2000-2001 fiscal year, and last a total of three years. Canada will contribute close to $1.8 million to the project, of which $1.36 million are being requested from CIDA. Brazilian institutions have committed over $6.8 millions.

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November 2nd, 1999

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BACKGROUND

(1) Context

Northeastern Brazil, the most populated semi-arid region on earth, is also one of the most underprivileged in Latin America. Despite recent government efforts to reduce poverty, generate economic growth and raise the standard of living, a large proportion of the region's 25 million or so inhabitants continue to fight economic marginalisation and social exclusion[1].

Most of the region's woes can be linked to a scarce water supply resulting from irregular rainfall, extremely high evaporation rates, terrain conditions that are unfavourable to infiltration and, thus, to the development of extensive groundwater resources, and a poorly understood natural phenomenon that turns the groundwater brackish and generally unsuitable for human or animal consumption, or irrigation. Furthermore, the population, especially in rural areas, doesn't have the technical know-how to properly manage the water resources that do exist. Under such circumstances, it is difficult for the community to produce the food it needs to sustain itself, even at best of times.

And then, there are the droughts, when the normally rainy months produce little or no rain. Such droughts can affect very large areas and last for several years. The Northeast has just been through one of the most devastating droughts this century. The population of nine states watched helplessly as their water supply dwindled, their crops failed, their livestock died, and their land turned into a lifeless dust bowl. At one point, in May 1998, the FAO[2] reported that 4.8 million people in the Northeast were at immediate risk of starvation.

The droughts, which some say have become more severe in the last decades, have grave and long lasting social consequences. They give rise to mass exodus of the work force towards urban centres that cannot cope with the influx; they generate diseases due to undernourishment and the consumption of poor quality water; with the diseases comes an increase in the mortality rate, especially infant mortality. The disintegration of agriculture gives rise to hunger and inevitably, social unrest follows.

For generations, the population of northeastern Brazil has lived under the threat of drought. And because the droughts are cyclical rather than permanent, governments have been slow to implement large scale projects that would provide the needed long term solutions to the problem. For example, plans to divert water from the São Francisco River

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[1] For more information on various aspects of the crisis, please see the following articles in Appendix A: (1) *Land of Awes* by Émerson Luís, Killing Drought in the Brazilian Northeast; Brazil-Brazzil, June 1998 (http://www.brazil-brasil.com/cvrjun98.htm); and (2) *Drought Hammers Brazil's Northeast, Again* by Kathleen Bond, News from Brazil, No. 320, September 18, 1998 (http://www.zmag.org/Bulletins/psej320.htm)

[2] Food and Agriculture Organisation, a United Nations Agency

towards other watersheds in the Northeast, have been put on hold because of political constraints and the enormous costs involved[3].

Each time there is a prolonged drought, the government responds hastily with short term emergency relief measures: food distribution; indiscriminate drilling of wells more or less at random; construction projects and repair to dams, mostly to create employment; facilitating private loans for minor waterworks projects; and increasing the distribution of drinking water by tanker trucks. These measures barely allow the population to survive the difficult periods and offer no lasting solutions. When the rains finally return, the emergency measures are dismantled and nothing more happens until the next drought.

What is needed is better management of the existing water resources in order to maximise the benefits that can be derived from them and to be prepared to confront crisis situations, such as those created by drought, when they occur. A sound water management strategy should be based on the thorough knowledge of how much water there is, where it is and of what quality, as well as an in-depth understanding of how various factors affect these parameters. Then, measures should to be taken to optimise access to the resource for maximum benefit to the population while ensuring proper conservation and preservation against man-made pollution and natural contaminants.

More and more, Brazilians are conscious of the need to think long-term about water issues in the Northeast, and to adopt appropriate water management practices. Changes are not yet happening for three basic reasons:

- the political will to confront the problem head-on is still elusive;
- the Northeast is technologically isolated from the rest of the country and the world; and
- the various groups concerned with water issues in northeastern Brazil have not rallied the way they should to fight this common affliction.

On the first issue, the political will, there is hope that things are about to improve. The urgency to enact strong legislation and appropriate regulatory policies is well recognised in political circles and, with more and more finger pointing, interference with drought relief efforts for political or private gains, is expected to diminish drastically.

The second and third issues are the ones that the proposed project will attempt to address. On the technological isolation issue, it was evident during project development (*see below*), that fighting the drought in the Northeast is being carried out using mostly traditional methods and antiquated tools. A huge number of small dams have been built and continue to be built leaving the waters they hold subjected to extreme rates of evaporation and salt build-up. Technology exists to protect this water from evaporation. This technology is called *artificial aquifer recharge*; the municipality of Waterloo in Ontario is using it in their water management program.

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[3] For more information on the scheme to divert the waters of the São Francisco River, please see *Old Plan, Old River* by Émerson Luís, Brazil Drought in the Northeast - History and Solutions; Brazil-Brazzil, June 1998 (http://www.brazil-brasil.com/p18jun98.htm), in Appendix A.

There are many other technologies that exist that could improve the water situation in northeast Brazil, but are not being used because those responsible for water management are not aware of them or they are perceived as too complicated, requiring equipment that they don't have. What is really needed is exposure to the technology and proper training. The proposed project will provide this exposure and training to the people whose responsibility would include applying these technologies if they were available.

The following are just a few examples of problems that could be dealt with using modern technologies:

1. Groundwaters in most of the northeast region are naturally brackish and unfit for consumption or irrigation. This is presently dealt with by installing expensive desalinisation equipment that produce only enough water for drinking. The artificial aquifer recharge technology can be used to flush or "push back" the brackish water and replace it (or dilute it) with fresh water during the rainy season, so that larger volumes are available for other usage, including irrigation during the dry seasons or periods of drought.

2. About 40% of the wells in the northeast have been abandoned by their owners because their yields are too low. There are several technologies that can be used to stimulate yields in wells. Explosives to shatter the rocks have been used by the Brazilians with mixed results and consequences. Canadian companies offer an alternative called hydro-fracturing. With this method, explosives are not used, only pressure to pry open the fractures, not shatter the rock. There are many advantages to hydro-fracturing over the use of explosives, and the technique is very economical. Many presently unproductive wells in the Northeast could be recovered at a fraction of the cost of drilling new wells.

3. Sometimes, drilling new wells is necessary, but Brazilian crews in charge of spotting wells are not equipped with the best tools to do so effectively and/or don't have the know-how to take full advantage of the tools that they do have. It is ironic, for example, that in a region where water is so scarce and so many wells need to be drilled, that the region was never surveyed by airborne geophysical (electromagnetic) methods. Canada is at the forefront in the application of airborne geophysics for groundwater exploration and aquifer mapping, and Canadian technology is being used around the world for this purpose. But not in northeastern Brazil, where those who are involved in finding solutions to the water problems rely instead on more traditional, century old methods, such as basic geological mapping and tectonic analyses.

4. Irrigation is another area in which modern technology can have a significant impact. Effective irrigation can be done using a fraction of the water that is consumed by ordinary systems. Techniques such as drip irrigation, buried irrigation, spray irrigation and micro sprinkler irrigation, some of them computer

operated, have turned deserts such as Israel and California into net food exporters. Several Canadian companies specialise in developing such systems.

There are countless other areas where Canadian technology and experience can make a difference: e.g. satellite imagery (Landsat, Radarsat), ground penetrating radar, isotopic geochemistry, borehole logging, ground geophysics, borehole photography, low cost energy systems (wind, solar), water purification systems (ozone, electrocoagulation, reverse osmosis), innovative water well drilling techniques (water hammer, Tubex system), etc.

For reasons that are unclear, northeast Brazil has been very slow to import foreign technologies that could help resolve the region's water problems. Furthermore, the Northeast cannot obtain the technologies it needs from the more technologically advanced part of the country to the south, because water problems in southern Brazil are very different from those in the Northeast and most technologies developed for the South would not be of much use in the Northeast. For those reasons, the Northeast is said to be technologically isolated.

Then why Canada? Because Canadians have a global outlook when it comes to developing new technologies. Technologies that are developed to respond to Canadian needs are quickly adapted for a world-wide market. Canadian universities and other learning centres in hydrology and related sciences are the envy of the world in terms of their versatility and level of excellence. Our service industry, consultants and researchers have been conducting water projects for decades in every corner of the world, including in most arid and semi-arid regions and third world countries, where they have acquired vast amounts of relevant experience. This experience and technology are indeed what northeast Brazil is lacking and desperately needs. The proposed project will inject a good dose of this technology into northeast Brazil institutions.

With regards to pulling together to resolve the common ill, it appears that years of frustration in being unable to achieve a significant breakthrough in fighting the effects of the drought has all but killed any enthusiasm and hope that might have existed to find workable solutions. This has left many institutions working in semi-isolation, nurturing, in many cases, an attitude of powerlessness in front of the immensity of the problem. For this reason, potentially valuable contributors of experience and skills, such as the universities, have not devoted their fair share of attention and resources towards the crisis that is taking place on their own turf. Their work is too often conducted in total disregard of the real issues, such as diseases and starvation, environmental degradation, the need for community education, etc. They admit to that, often claiming that it is not their role.

But this is just a matter of persuasion. As will be shown elsewhere in this document, the proposed project, as it is being developed, has already succeeded in rallying the universities to the cause, as well as other players, many of them with no previous history of working together. As is clearly stated on page 16 of the Pernambuco proposal[4], this

[4] See *Project Proposals from Brazilian Partners and Participants* in separate volume.

will be the first time that a project succeeds in bringing together such diverse groups as geoscientists, specialists in health, education, social action, environment, NGOs and community organisations. This formula has never been tried in northeast Brazil and, in the opinion of most who have been involved to date, offers great potential for success.

(2) Project Development

Fortaleza Workshop, March-April 1998

The idea for a project on groundwater in northeastern Brazil was first raised in January 1998, by Mr. Samir Nahass, Head Advisor for International Affairs at CPRM who discussed it with Dr. Yvon Maurice of GSC[5]. At the time, Mr. Nahass and Dr. Maurice were jointly coordinating a high profile and very successful project for CIDA, in partnership with CPRM, CANMET and CETEM, on the sustainable development of Brazil's mineral resources. The success achieved by that project served as an incentive to explore new venues to continue the Canada-Brazil collaboration. Groundwater Exploration and Management in Northeastern Brazil, as a theme for a new initiative, could not have been chosen better; it addresses one of the world's most pressing humanitarian calamities; it is amongst the top priority issues for the Brazilian government; many facets of the problem can be addressed with modern technology, including Canadian technology; and it touches upon fields of expertise in which both CPRM and GSC want to expand.

Development of the project really began in March-April of 1998 when Dr. Maurice was invited to attend a five-day workshop on Groundwater in Northeastern Brazil, in Fortaleza, the capital city of Ceará. The Fortaleza workshop was truly a technical meeting which brought together top-notch geologists and hydrogeologists from several states in the Northeast and other parts of Brazil. The purpose was to review current knowledge of groundwater issues in the Northeast and examine ways to improve the water supply in the region. The meeting drew a clear picture of the state of the technology in Brazil regarding groundwater exploration and management. We heard a great deal on the application of traditional tools such as geological mapping, structural interpretation and basic hydrogeology. Brazilian hydrogeologists have also been busy monitoring groundwater parameters (e.g. well locations, flow rates, quality, usage, etc.) and assembling excellent databases, but it was clear that they were not using, and knew very little about, the more sophisticated tools that could help them in their efforts. We heard almost nothing, for example, on satellite imagery, ground or airborne geophysics, and nothing at all about some of the more powerful groundwater management tools such

[5] The first formal meeting to discuss this project was held in Rio de Janeiro on January 14, 1998 to which participated Mr. Samir Nahass, Dr. Yvon Maurice, and Mr. Frederico Cláudio Peixinho, Head of the Hydrology Department at CPRM, with several of his co-workers. The next day, January 15, a meeting was held in Brasilia with Mr. Onildo Marini of ADIMB (Agência para o Desenvolvimento Tecnológico da Industria Mineral Brasileira), a non-profit organisation involved in international cooperation. The outcome of these meetings was presented to CIDA in a memorandum dated January 22, 1998.

as artificial aquifer recharge, hydro-fracturing, borehole logging, computer modelling, isotope geochemistry, tracer tests, etc.

Towards the end of the meeting, Dr. Maurice was given the opportunity to present an outline of a technology transfer program which could be offered within the scope of a new Canada-Brazil Cooperation Project. The concept was received enthusiastically by most, but a few questioned what Canada, a country where there are no water shortages, could do to assist northeast Brazil, where conditions are so different from those in Canada. The answer to that question was to come later, from the Call for Expressions of Interest (see below).

Concept Paper, May 1998

After the Fortaleza meeting, concrete ideas for a technology transfer project on groundwater exploration and management for northeastern Brazil were written and presented to CIDA in the form of a Concept Paper. That document, which is also available in Portuguese thanks to Mr. Jean-Michel Ponsinet of CPRM in Rio de Janeiro, who did a superb job of translating it, is the first step in the application for funding under CIDA's Canada-Brazil Technology Transfer Fund (TTF). The process of preparing the Concept Paper also brought together the first group of interested institutions, three of which would become the original partners in this endeavour: GSC, CPRM and ABAS. GSC and CPRM already had a long history of technical collaboration under the previous project on the sustainable development of Brazil's mineral resources. ABAS, the host of the Fortaleza workshop, was seen as an ideal complement to the GSC-CPRM partnership because of its strong local influence and profound involvement in water-related environmental and social issues.

Mr. Clodionor Carvalho de Araújo, President of the Ceará nucleus of ABAS, with the help of his colleagues at CPRM's regional office in Fortaleza, canvassed other local organisations for interest and support. Letters of intent were received from five institutions namely, COGERH, a local water resource management company; the Department of Geology of the Federal University of Ceará; CAGECE, a state owned water and sewers company; SEMACE, a state environmental agency; and SRH, the secretariat for water resources of Ceará. Although all of the supporting letters came from the state of Ceará, expressions of interest in the project were presented verbally by representatives of other states that were present at the Fortaleza workshop, namely Pernambuco and Rio Grande do Norte.

The concept paper received favourable reviews at CIDA, and in a letter dated September 16, 1998, the Agency formally invited GSC and its partners to submit a full proposal to be considered for funding under the TTF. The letter included a number of recommendations that would have to be addressed in the subsequent project development phases, among them, the need to come up with significant financial contributions to the

project from GSC, CPRM and other Brazilian participants, and the necessity to involve the end users of the groundwater (i.e. the communities) in project activities.

1st Project Development Mission, December 1998

A mission to northeast Brazil was organised in December 1998 to formally present the proposed project to institutions and individuals who are involved with water issues in the region. Taking part from Canada were Dr. Yvon Maurice, project coordinator, Dr. Jim Hunter, geophysicist at GSC, Dr. Frederick Michel, hydrogeologist at Carleton University. Ms. Susan Southerwood of Water for People, who was stationed in Bolivia at the time, joined the group in Brazil. Her role was to advise on social issues and to examine the possibility of WFP becoming involved in the project. All activities took place in the state of Ceará and included information sessions in Fortaleza, the state capital, technical visits of local institutions, and a field trip to the Irauçuba area, about 250 km west of the city, where drought-related problems could be examined first hand. Sessions were also held with community leaders in Irauçuba and Tejuçuoca, two communities visited during the field trip.

The Head Advisor for International Affairs at CPRM, Mr. Samir Nahass who is also the Brazilian Coordinator for the Canada-Brazil Cooperation, came from Rio de Janeiro to attend the sessions. He and Professor João Manoel Filho of Universidade Federal de Pernambuco in Recife, skilfully co-chaired all the meetings.

About 40 people from various organisations[6], including some outside Ceará, attended the meetings in Fortaleza. The mission was organised by staff members of ABAS and CPRM's regional office in Fortaleza under the direction of Mr. Clodionor Carvalho de Araújo.

Ms. Louise Clément of the Canadian Embassy in Brasilia, and Ms. Marta Irving, both representing CIDA, and Dra. Amélia Maria Fernandes Alves, representing ABC, also attended. A 50-page report on the mission was prepared and is available upon request[7].

The mission provided the Canadians with the opportunity to:

1. Meet prospective Brazilian collaborators;
2. Introduce the TTF program and present the framework under which it operates;
3. Determine the current capabilities of Brazilian institutions regarding water-related technologies and evaluate their needs;
4. Obtain a perspective of the water supply situation in northeastern Brazil; and
5. Establish the types of technologies and extent of assistance needed from Canada.

[6] ABAS, ABC, APRECE, CAGECE, CEDEC, CPRM, FUNCAP, FUNCEME, ICCN, SECITECE, SOHIDRA, SUDENE, UFC, UFPE, UFRN, Victoria Assessoria (see key to acronyms in Appendix B)
[7] A summary of the report with field photographs is posted on the Project's Web Site at: http://brazil.agg.gsc.nrcan.gc.ca/missionrepsum.html

Although this mission was an essential step in the process of developing the project and was by all accounts a great success, it fell short of providing all the elements needed to draft the final TTF proposal. The main shortcomings were:

- The fact that the information sessions had rather large audiences, they did not lend themselves to the kind of interchange that would have been necessary to determine areas of interest and level of participation of individual groups. Furthermore, with few exceptions, the decision makers were not present at these sessions making it impossible to obtain any form of commitment from the different organisations with regards to their potential human or financial resource contributions and other support.

- Despite the fact that we had met with several community organisations during the field trip and got a good appreciation of their needs, the mission ended without a clear picture of how the social component of the project would function. In other words, we were still uncertain about how to involve the rural communities in the project in ways that would ascertain that the technologies to be transferred would benefit them. The main reason is that we had not met with a sufficient number of social action groups during the mission.

- There was a certain malaise amongst representatives from other states, especially Pernambuco, because they had not been included in the mission's agenda. It was quite clear that Pernambuco and Rio Grande do Norte wanted to take part in the project on the same level as Ceará.

- The Canadian delegation did not have all the information about which technologies exist in Canada that can help Brazil with its water problems, nor was it able to estimate the level of experience in the Canadian private and public sectors in applying such technologies to conditions similar to those that exist in the northeast of Brazil. Understandably, this led to certain scepticism among a few of the Brazilian participants. It suddenly became clear that we needed to canvass the Canadian private and public sectors for answers to these questions.

These shortcomings made it necessary to plan for another development mission to Brazil. This took place in May 1999.

Call for Expressions of Interest, February 1999

A pressing issue that needed to be addressed quickly was to ascertain whether Canada had, as we thought she did, the relevant technologies and experience to transfer to the Brazilians in the area of groundwater exploration and management. It was also important to know how considerable Canadian resources were in this area, and how much interest such a project would generate in Canada.

Using the official Government of Canada tendering site on the Internet, known as MERX[8], a call for expressions of interest was posted during the entire month of February[9].

The response was overwhelming and left no doubts that Canada had a great deal to offer Brazil in groundwater related technologies. Over seventy (70) replies were received covering the entire spectrum of water related technologies[10]. The level of interest and the enthusiasm was also much greater than could have been anticipated. Nearly all the respondents indicated in their submissions that they regarded the project as an extremely worthwhile undertaking. Private sector firms also saw opportunities to penetrate the difficult Brazilian market, while research institutions, including seven universities, considered the project as a unique occasion to apply their skills to a world class problem.

The responses show that Canadians are not only foremost in state-of-the-art technology, equipment and in their ability to carry out first-rate studies and surveys, but they also possess vast experience in applying their skills towards helping resolve problems in underprivileged regions of the world, through the long tradition that Canada has of helping countries in need. Thus, many of the respondents have gained considerable amounts of relevant experience by participating in water projects around the world on behalf of CIDA, IDRC, the World Bank and other humanitarian organisations. Many of these regions exhibit conditions that are similar to those found in northeastern Brazil and, therefore, their experience is extremely valuable and relevant.

Web Site, April 1999

Although the project's Web Site was created in February to provide additional information for the benefit of those who wanted to respond to the Call for Expressions of Interest, the site underwent major expansion in April with the posting of the project's first Newsletter[11]. This item was intended to keep informed all those who had responded to the Call for Expressions of Interest. But, because the site's URL was distributed to the major Internet search engines, it attracted a lot of attention throughout Canada, Brazil and other regions of the world. Many new contacts are being established on a regular basis as a result of having the Web Site, thus providing a continuously expanding pool of potential resources for the project.

Plans are to update the Web Site regularly and to notify everyone whenever additional information is posted. At the time of writing, the site contains two Newsletters (April and June 1999) and about a dozen other features, including maps and photographs. The

[8] http://www.merx.cebra.com/
[9] The text can be viewed on the Project's Web Site at: http://brazil.agg.gsc.nrcan.gc.ca/pwgscen.html
[10] A compilation of some 40 representative responses has been assembled into a separate volume entitled: *Expressions of Interest from Canadian Firms and Public Institutions*, May 1999. That volume forms an integral part of this proposal.
[11] http://brazil.agg.gsc.nrcan.gc.ca/newsletterv1n1.html

electronic mailing list is 200+ strong. The Web Site is trilingual and is hosted by the Applied Geochemistry and Geophysics Subdivision server at the Geological Survey of Canada.

2nd Project Development Mission, May 1999

The 2nd Project Development Mission lasted eighteen days (May 11 to 28, 1999) and included visits to five cities: Recife, Fortaleza, Natal, Rio de Janeiro and Brasilia. Dr. Yvon Maurice was the only participant from Canada; he was accompanied throughout by his Brazilian counterpart, Mr. Samir Nahass and by Mr. Humberto José T.R. de Albuquerque, Chief of Hydrogeology Division at CPRM. All three put in a great deal of effort which resulted in the mission being very successful, accomplishing far more than was originally anticipated[12].

The initial objectives of the mission were:

1. To present and discuss the Canadian responses to the Call for Expressions of Interest with representatives of key Brazilian organisations; this essential element, a precise knowledge of what Canada could offer in terms of technology, was lacking during the previous mission in December 1998. This time, Pernambuco and Rio Grande do Norte were on the agenda.

2. To meet one-to-one with the managers and decision makers of some key organisations involved in water projects to discuss the extent to which their organisations will be involved in the project and ascertain their commitment for financial and other support. Of prime interest were the main public companies that have the resources and equipment needed to carry out drilling and waterworks projects needed to support the technology transfer exercise.

3. Meet with environmental and social organisations to stimulate their interest and discuss ways of involving them and incorporating a strong social agenda into the project. Of special interest was a planned meeting with representatives of Comunidade Solidária, a high profile social action group connected to the highest levels of the Brazilian Government.

In all, 30 meetings were held with groups of wide ranging interests and priorities: community organisations, social service providers, environmental groups, universities, research institutions, federal and state waterworks companies, health organisations, financial institutions and funding agencies[13]. Participation of such diverse groups was regarded as an essential element of complementarity for the proposed project.

[12] For more information on the 2nd Project Development Mission and its outcomes, please see the June Newsletter posted on the Project's Web Site at: http://brazil.agg.gsc.nrcan.gc.ca/newsletterv1n2.html
[13] A partial list of institutions contacted is presented in Appendix B.

The reaction to the Canadian technologies as presented in the package of Canadian responses to the Call for Expressions of Interest was very positive[14]. There was interest for just about every type of technology being offered. Airborne geophysics applied to aquifer and salinity mapping, and artificial aquifer recharge, were regarded as particularly promising techniques for the region. Neither has ever been used in northeastern Brazil. Also, the unique Canadian expertise in hydrology of fractured rocks drew considerable interest especially from the universities. But it was the fact that most of the Canadian companies and specialists included in the package have world-wide experience, many of them in arid and semi-arid regions of the globe, that was considered the most important factor.

As important as it was for everyone to know what Canadian organisations had to offer in terms of technology to northeast Brazil, it was also essential for the Brazilians to decide what they wanted to do with this technology and how they saw the transfer take place. This is when it was decided that the Brazilians would prepare proposals, one for each state, in which these issues and others would be discussed in detail.

It was agreed that the proposals would be submitted within 30 days (i.e. by the end of June). This would allow time for the Brazilians to hold further meetings as required and to develop a project that is appropriate for their needs. A few guidelines were set for the preparation of the proposals:

- Each state was to choose a pilot area where the new technologies will be applied. Pilot areas should be located in rural settings and include communities that have serious water supply problems. The pilot project approach will make it easier to involve the communities in project activities and ensure that the program responds to their needs.

- From the list of Canadian technologies being offered, which ones would Brazilian institutions like to have transferred, and why? The proposal should include a discussion of why Canadian technologies are important to northeast Brazil and how such technologies will help the institutions involved.

- Identify the participating Brazilian organisations and define their respective roles. List personnel who will/may be involved.

- Elaborate a social plan: (a) discuss how the new technologies will benefit the communities in need, and (b) how will the population of these communities participate in the project.

- How to ensure that the results of the project continue to benefit the region after the CIDA project has ended.

[14] Six copies of the volume of Canadian responses to the Call for Expressions of Interest were left with key organisations in Brazil: one in Ceará (CPRM, Fortaleza); two in Pernambuco (University and CPRM, Recife); two in Rio Grande do Norte (University and CAERN, Natal) and one in Rio de Janeiro (CPRM).

- How will Brazilian institutions contribute financially to project costs.

In each state, teams were set up to coordinate the preparation of the proposals:

- in Recife, Sebastião Milton Pinheiro da Silva, José Carlos da Silva and Manoel Júlio da Trindade Gomes Galvão (all CPRM);
- in Fortaleza, Oderson Antônio de Sousa Filho and Jaime Quintas dos Santos Colares (CPRM); and
- in Natal, Emanuel F. Jardim de Sá (UFRN), Marcelo A. de Queiroz (CAERN) and José Geraldo de Melo (UFRN).

Two of the meetings held during the mission had special significance. The first was on May 14th at SUDENE's headquarters in Recife, and the second, with representatives of Comunidade Solidária in Brasilia, on May 26th. These organisations have a great deal of influence on the socio-economic development of the Northeast and both were invited to participate in the project as full partners with representatives on the project's Steering Committee. In addition, Comunidade Solidária was asked to appoint a Social Coordinator for the project.

The formal letters of invitation to SUDENE and to Comunidade Solidária, signed by the former Director-President of CPRM, Dr. Carlos Oití Berbert and Dr. Murray Duke, Director General at the GSC are presented in Appendix C. The response from Doutor Milton Seligman, Executive Secretary of the Comunidade Solidária Program, appointing Dr. Milton Rondó Filho as the project's Social Coordinator[15] and that of Doutor Aloisio Sotero, Superintendente of SUDENE[16], appointing Mr. Carlos Fernando Pinto Teixeira as their representative on the project's committee, are also included in Appendix C.

Submission of Brazilian Proposals, June-July 1999

The Brazilian proposals were received, examined and compiled during the months of June and July 1999. They were assembled into a volume entitled *Project Proposals from Brazilian Partners and Participants*, which is being submitted separately as part of this TTF application. The volume is divided into three parts, one for each state. Each part contains a summary proposal to which are attached specific proposals and expressions of interest from individual organisations that wish to participate. Although the proposals generally address the issues listed above, no attempt was made to standardise their content or format.

[15] Dr. Milton Rondó Filho has since been assigned other duties within the Brazilian Government and is unable to fulfil his mandate as social coordinator for the project; he has been replaced in this function by Dr. Antonio César Gonçalves Borges.
[16] In October 1999, Marcos Formiga took over from Aloisio Sotero as Superintêndente da SUDENE.

The Brazilian proposals have given a completely new perspective to the cooperation project. It is clear that Brazil intends to seize the opportunity that Canada is willing to inject new technologies in the Northeast to launch major new initiatives in each of the three states. These state projects will ensure that the new technologies are adopted quickly and applied to real life situations. The project is no longer just a Canadian-led endeavour in which Brazilians will participate, but it is now clearly a Brazil-driven operation to which Canada will contribute technology as required. The program, however, will be dependent on the new technologies, and input from Canada remains crucial to its success.

The clearest sign that the Brazilians are serious about this program is in the resources that they are prepared to allocate to it. So far, over 8.6 million reais (or about Can$ 6.8 million) have been identified. This amount is considerably more than the financial contribution that was initially expected from Brazil, but it is not a complete surprise when we consider that the Northeast water situation is a national priority and that the Brazilian government has already spent billions on the problem and expects to spend a great deal more before it is resolved.

The lion share of the Brazilian resources will come from CPRM, state water management and waterworks companies (EBAPE, SOHIDRA, SERHID, CAERN), research institutions including funding agencies (UFPE/LAHID, UFRN, CAPES/CNPq, PADCT, FUNCEME, ICCN), and other national and international agencies (CPRH, FNS, World Vision). As stated earlier, the program will also be breaking ground in bringing all these groups to work together towards resolving a problem that affects everyone. The Brazilian proposals show how this will be done, and Canada will help provide the technology when and where it is needed. The stage is indeed set for an excellent program to be implemented, with incalculable benefits to many.

Brazilian visit to Canada, September 1999

At the time of writing (August 1999) this visit has not yet taken place, but the agenda has been set and all preparations have been made. The visit will include stopovers in several centres in southern Ontario and western Quebec, with four days spent in Ottawa. In July, Dr. Maurice went on a week-long tour of the various organisations that will be part of the itinerary. These organisations have all submitted letters of interest to participate in the project. They were chosen so as to cover as much of the Canadian technological spectrum as possible.

In the Toronto area, the delegation will visit an airborne geophysical company with vast experience in water related surveys; a company that specialises in artificial aquifer recharge; one that has a great deal of experience in fractured rock aquifers; and one that specialises in remote sensing techniques. In Waterloo, the visitors will have the chance to see first hand the municipality's water management facilities at Mannheim, which will include a tour of an artificial aquifer recharge experimental station. They will also visit

the university, and several firms that provide water related exploration, management and environmental services. They will meet with personnel of CRESTech, one of Ontario's prestigious Centres of Excellence that specialises in earth and space technology with a strong water resources theme.

Closer to Ottawa, there will be a stop at Lakefield Research, a company that provides analytical and engineering services with a speciality in the recovery of contaminated water resources. In Ottawa, the group will visit and meet the staff at GSC and tour the facilities at CCRS (Canada Centre for Remote Sensing). They will also visit the headquarters of CIDA in Hull.

Representatives of at least two companies will be coming to Ottawa from other parts of the country for the sole purpose of meeting the Brazilian delegation. One is Fracflow from St. John's, Newfoundland, a company that specialises in the study of aquifers in fractured rocks, and the other, Serval from Calgary, a company with experience in dealing with water problems associated with oil fields. This has become an important topic in Brazil, particularly in Rio Grande do Norte, where Petrobrás, the Brazilian national oil company is trying to find an appropriate technology to decontaminate oil-well water in order to make it usable for the benefit of the population in drought stricken regions.

Choosing who will be part of the Brazilian delegation for the September visit was a difficult process because so many had worked hard on developing the project and most were very interested in coming. Since the visit would be mostly technical, it was deemed appropriate to involve only technical personnel at this stage, rather than a technical-social mix, which could have proven long and difficult to bear for some. Also, we thought that it was important for each state to have at least one representative. The candidate's ability in the English language was also a factor.

The final list includes two from Pernambuco (Prof. João Manoel Filho, hydrogeologist at UFPE and Mr. Sebastião Milton Pinheiro da Silva, geologist and remote sensing specialist at CPRM); one from Ceará (Mr. Fernando Feitosa, hydrogeologist at CPRM); one from Rio Grande do Norte (Prof. Walter Eugênio de Medeiros, geophysicist at UFRN); and one from head office in Rio, Mr. Humberto José T.R. de Albuquerque, Chief of Hydrogeology Division at CPRM.

TECHNOLOGY TRANSFER

In terms of the types of technologies to be transferred to Brazil, the project has been loosely sub-divided into eleven (11) areas of expertise. In principle, each area will be handled by a different group of experts, although, in practice, there will be cases where several groups will contribute to one area, and a single group will contribute to more than one area. What is important, is to apply the collective talent that Canada has to offer, in the most productive manner. The project coordinating teams will have the responsibility to ensure cross-fertilisation between the groups and between the Canadians and the Brazilians. Another important role of the coordinating teams, and indeed of every group involved in the project, will be to ascertain that all project activities respond to the project's social mandate : to bring long term relief to the communities in need.

The following text gives a very brief outline of what the technologies in each of the eleven categories will consist of, along with a list of potential candidates who may participate in the delivery of this know-how. These lists were assembled from the more than 70 responses to the Call for Expressions of Interest posted on the Internet in February 1999 (see Call for Expressions of Interest, February 1999, in Background, Project Development above). For more detailed information on the background of each organisation, its personnel, its area of expertise, and its interest in the Canada-Brazil project, the reader is invited to consult the accompanying volume entitled: *Expressions of Interest from Canadian Firms and Public Institutions*, May 1999[17].

Companies that will become involved in the project will, for the most part, be selected through open competition following well established government procedures. Some individuals or groups with special status may be selected on the basis of merit or as sole source providers if they meet certain eligibility criteria, including non-profit status, international recognition of individuals, or uniqueness of services offered.

(1) Assessment of the water supply situation of NE-Brazil in relation to other arid and semi-arid regions on earth

Several Canadian companies have accumulated wide ranging experience in assessing the water situation of other drought stricken regions of the world and have proposed and implemented innovative solutions for improving the quality of life in these regions through technology. Some of these companies will be invited to work and share their experience with state and federal institutions in NE-Brazil to explore new approaches to combat the effects of the droughts.

[17] Only about 40 companies and institutions, representing the most relevant to the project, are included in the volume; information on the others is available upon request

Companies that have expressed interest and may considered for this part of the project include:

1. Hydrosult Inc.; Montréal, Québec
2. Komex International Ltd.; Calgary, Alberta
3. Conestoga-Rovers & Associates; Waterloo, Ontario
4. R. J. Burnside International Ltd.; Orangeville, Ontario
5. Bel'MK Engineering Ltd.; Calgary, Alberta
6. AGRA Earth and Environmental Ltd.; Calgary, Alberta

(2) Remote sensing and Geographic Information Systems (GIS)

Interpretation of satellite images, particularly radar images from the Canadian satellite Radarsat, is a powerful technique to detect features at or near the earth surface which can reveal the presence of water underground (regional and local structures in the earth crust, vegetation pattern, buried channels, etc.). This component of the program will have strong training and institutional strengthening elements. There will be comprehensive assessment of Brazilian capabilities to carry our remote sensing projects, with training in Canada and in Brazil. Canadian institutions that will be involved in this project will have access to state-of-the-art equipment with which to train the Brazilians.

Companies and individuals that have expressed interest and may become involved in this part of the project include:

1. R. J. Burnside International Ltd.; Orangeville, Ontario
2. MIR Télédétection; Longueil, Québec, and AGEOS; Brossard, Québec
3. Atlantis Scientific Inc.; Nepean, Ontario
4. David F. Graham Consulting; Ottawa, Ontario
5. Rescan Environmental Services Ltd.; Vancouver, B. C.
6. Paterson, Grant & Watson Ltd.; Toronto, Ontario
7. University of Victoria, British Columbia
8. GeoSystems Integration; Ottawa, Ontario
9. The Canadian Map Maker; Gloucester, Ontario
10. Technologies DOZ Inc.; Boucherville, Québec

(3) Airborne geophysics

Geophysics, specifically electrical and electromagnetic techniques, are amongst the most important tools in groundwater exploration; airborne geophysics, using either fixed-wing aircraft or helicopter, can provide data over large areas quickly and economically. Electromagnetic techniques are capable of mapping variations in groundwater salinity, locate water-bearing structures, identify recharge areas, etc. all of which will be extremely important to improve the groundwater exploration success rate in NE-Brazil. There will be a training component for the interpretation phases of the project.

Canada is a world leader in the application of airborne geophysics to mineral and groundwater exploration. Canadian companies that have expressed interest in the project and may be considered for contracts include:

1. Questor Surveys; Calgary Alberta,
2. Dighem-Geoterrex; Ottawa, Ontario (fixed wing system)
3. Dighem-Geoterrex; Mississauga, Ontario (helicopter system)
4. High-Sense Geophysics Ltd.; Richmond Hill, Ontario
5. Paterson, Grant & Watson Ltd.; Toronto, Ontario (training in interpretation)

(4) Ground geophysics

Ground geophysical techniques are used to pinpoint structures in the earth crust that contain water or that may influence the accumulation of water in underground reservoirs. There are numerous techniques including a variety of electromagnetic and electrical methods, seismic, gravity, radar, magnetic, etc., many of which have not been tried, at least with state-of-the-art equipment, in the semi-arid regions of NE-Brazil. The project will cover a variety of techniques which will be tested in the field in carefully selected areas where the results can be used directly to find water for communities in need. Training will take place both in the field and in the classroom. The communities will be consulted for area selection and will be kept informed of the results and any follow-up plans.

Companies and individuals that have expressed interest and may become involved in this part of the project include:

1. Scintrex, Survey & Exploration Technology; Concord, Ontario
2. J. Duncan McNeill, Consultant; Chester, Nova Scotia
3. Rescan Environmental Services Ltd.; Vancouver, British Columbia
4. Komex International Ltd.; Calgary, Alberta
5. R. J. Burnside International Ltd.; Orangeville, Ontario

6. Bemex Consulting International; Victoria, British Columbia
7. Géophysique Sigma Inc.; Ste-Julie, Québec
8. Consultants H.G.E. Inc.; Québec, Québec
9. Geo-Potentials Ltd.; Ottawa, Ontario
10. Hyd-Eng Geophysics; Waterloo, Ontario
11. Quantec Geoscience Ltd.; Waterdown, Ontario

(5) Hydrogeology of fractured rocks

Understanding groundwater flow and interconnectivity of fractures in a fractured aquifer environment is important to determine the water retention capacity and potential productivity of aquifers of the types found in NE-Brazil. This knowledge is crucial for the application of many of the groundwater management techniques that form part of this project. Canada has gained a wealth of experience on all aspects of water flow in fractured aquifers during the exhaustive studies performed in the Canadian Shield in support of the radioactive waste disposal programs. The opportunity has now arrived to apply this knowledge to help find a solution to a third world humanitarian problem. Canada is, by far, the most advanced nation in this field. The hydrogeology community of Brazil will benefit immensely from Canadian experience in this area.

Companies that have expressed interest and may become involved in this part of the project include:

1. Fracflow Consultants Inc.; St. John's, Newfoundland
2. Klohn-Crippen Consultants Ltd.; Sudbury, Ontario
3. Duke Engineering & Services (Canada), Inc.; Ottawa, Ontario
4. Atomic Energy of Canada Ltd., Whiteshell Laboratories & URL; Pinawa, Manitoba
5. R. G. Taylor and Associates; Toronto, Ontario

(6) Groundwater modelling

Modern computer software programs can be used to simulate how groundwater and contaminants flow under different environmental parameters and bedrock conditions. Such models can then be used to predict the effectiveness of various groundwater management and remediation measures. Groundwater modelling is very appropriate for training members of the academic community who use computers on a regular basis.

Models developed during the course of this project should be based on Canadian models using on NE-Brazil data. To achieve this, close collaboration with other sub-projects will be required for data collection, and proper testing and applications.

Companies that have expressed interest and may become involved in this part of the project include:

1. Waterloo Hydrogeologic Inc.; Waterloo, Ontario
2. Fracflow Consultants Inc.; St. John's, Newfoundland
3. Duke Engineering & Services (Canada), Inc.; Ottawa, Ontario
4. R. G. Taylor and Associates; Toronto, Ontario
5. Klohn-Crippen Consultants Ltd.; Sudbury, Ontario

(7) Groundwater management : special techniques

Amongst the most promising technologies that can bring long term solutions to the water problems of NE-Brazil are techniques such as artificial aquifer recharge to protect more of the water budget from evaporating, aquifer flushing and water mixing to reduce groundwater salinity, hydro-fracturing to stimulate yields, micro-irrigation to conserve water in agricultural projects, etc. Most of these techniques have been applied successfully in Canada and in other countries, but most have not been properly tested in NE-Brazil. Testing and the application of these technologies will require supporting activities such as trenching, drilling of wells, pumping, etc., which will be carried out with the technical and financial support of state government organisations and waterworks companies. Training of personnel from these organisations as well as community education will be important components of these projects.

Companies that have expressed interest and may become involved in this part of the project include:

1. Groundwater Services International; Mississauga, Ontario
2. North-South Environmental Inc.; Campbellville, Ontario
3. Jacques Whitford Environment Ltd.; Dartmouth, Nova Scotia
4. CH2M Gore & Storrie Ltd.; Waterloo, Ontario
5. R. J. Burnside International Ltd.; Orangeville, Ontario

(8) Rural infrastructure and community projects

Various Canadian companies and individuals with experience in water supply projects in third world semi-arid countries will be invited to share their experience, assess the situation in NE-Brazil from that point of view, and make recommendations. Pilot projects will be carried out in collaboration with Brazilian environmental and humanitarian organisations. These will focus on community needs and will include low-technology projects such as well rehabilitation, pump repair, maintenance, etc. Teams will include social workers with experience in community education.

Community consultation and education projects will also be conducted in conjunction with all of the other activities in the program in order to ensure that the project responds to the needs of the community and that project activities are well understood and agreed upon by the community leaders and the population in general. These projects will be delivered by Canadian social workers with relevant experience, in collaboration with local (Brazilian) NGOs and other specialists in community social issues. Some Canadian companies have social workers among their staff and/or work in close collaboration with Canadian institutions that provide such services.

Public institutions, private companies and individuals who have expressed interest and may become involved in this part of the project include:

1. SRK Consulting; Vancouver, British Columbia
2. Centre for Community Leadership; Vancouver, British Columbia
3. Tecsult International Ltée; Montréal, Québec
4. Techmat Inc.; Jonquière, Québec
5. Marcos Alvarez, Consultant; Ottawa, Ontario
6. Oxfam Canada; Montréal, Québec
7. Groundwater Services International; Mississauga, Ontario
8. R. G. Taylor and Associates; Toronto, Ontario
9. Isilda de Sousa, Consultant; Brossard, Québec
10. ETI Environmental Training Inc.; Waterloo, Ontario
11. People Development Ltd.; Halifax, Nova Scotia
12. Hydrogéo-Sol Inc.; Cap-Rouge, Québec

(9) Groundwater management: contamination prevention and site rehabilitation

To evaluate and mitigate problems related to aquifer contamination near disposal sites in urban areas and near the larger communities. Activities under this heading will only take

place if contamination of aquifers in the vicinity of disposal sites near the larger rural communities is found to be a problem, and the Brazilians authorities request assistance. Experienced Canadian companies and individuals may be invited to share their experience with the Brazilians by participating in seminars and field training sessions.

Companies and institutions that have expressed interest in these issues and may become involved in this part of the project include:

1. Lakefield Research Ltd.; Lakefield, Ontario
2. University of British Columbia; Vancouver, British Columbia
3. MGI Ltd, Environmental Specialists; Fredericton, New Brunswick
4. Norwest Mine Services Ltd.; Calgary, Alberta
5. Shawinigan International; Shawinigan, Québec
6. Washbourn & Gillis Associates Ltd.; Halifax, Nova Scotia

(10) Specialised equipment

This component of the project will examine the possibility of using different types of equipment to provide alternate and perhaps more efficient means of accomplishing certain tasks. For example, solar pumps, reverse osmosis and other desalinisation and water purification technologies (e.g. distillation, ozone, electrocoagulation), storm water management devices, etc., may find useful applications in NE-Brazil. Seminars or demonstrations of the equipment will be arranged either in Brazil or in Canada.

Companies that have expressed interest and may become involved in this part of the project include:

1. Aurum Research Ltd.; Etobicoke, Ontario
2. Sunmotor International Ltd.; Olds, Alberta
3. Egmond Associates Ltd.; Acton, Ontario
4. Central Water Conditioning; Watson, Saskatchewan
5. Klohn-Crippen Consultants Ltd.; Sudbury, Ontario
6. Robinson Environmental & Design; Kitchener, Ontario
7. Serval Integrated Energy Services; Grande Prairie, Alberta
8. Geo Kamp Ltd.; Oakville, Ontario

(11) Hydrogeology and hydrogeochemistry research

This will provide opportunities for joint Canada-Brazil university-based research on various aspects of hydrology, hydrogeology, and hydrogeochemistry. The project will focus initially on the chemistry of the groundwater in an attempt to understand the cause of the high salinity and evaluate its impact on life, particularly on the agricultural sector. This component will provide long term linkages between key Canadian and Brazilian institutions, and may produce extremely valuable data concerning the water supply of NE-Brazil.

This component regroups all the expressions of interest received from the universities and research institutes:

1. University of Waterloo; Waterloo, Ontario
2. Simon Fraser University; Burnaby, British Columbia
3. Carleton University; Ottawa, Ontario
4. University of Toronto; Toronto, Ontario
5. University of Victoria; Victoria, British Columbia
6. Geological Survey of Canada; Ottawa, Ontario
7. University of Ottawa; Ottawa, Ontario
8. University of British Columbia; Vancouver, British Columbia
9. CRESTech; Waterloo, Ontario

PROJECT DESCRIPTION

(A) Narrative

The participating states have each submitted a series of proposals for an elaborate project designed to improve the water supply situation in specific regions within their borders. The projects have been developed specifically for the Canada-Brazil collaboration, whereby Canadians will supply new technologies to the projects and the Brazilians will apply these technologies to improve the likelihood of meeting their objectives and the overall quality of the outputs. The projects have been developed in accordance with TTF criteria : they have very strong social objectives, the targeted populations will be involved in their implementation, they are based on an equitable cost sharing formula, and they will meet CIDA's gender equality provisions.

The Brazilian proposals are presented in detail in the accompanying volume entitled *Project Proposals from Brazilian Partners and Participants.* For each state, this includes a summary proposal and a series of specific or sectorial proposals and expressions of interest from individual organisations that wish to participate in the project. The following are highlights of these proposals.

(1) Pernambuco

The pilot area selected for Pernambuco corresponds to the Upper Moxotó Hydrographic Basin, a 4,500 square kilometre area located in one of the driest parts of the state. The project entitled *Desenvolvimento de Novos Métodos de Pesquisa, Captação, Manejo e Gestão das Águas Subterrâneas no Semi-Árido Cristallino da Bacia Hidrográfica do Rio Moxotó para o Abastecimento de Pequenas Comunidades Rurais e Urbanas*[18], seeks to improve exploration and management of the groundwater resources in the area and provide a greater and more regular supply of better quality water to some 85,000 people in 39 communities. The region is plagued with chronic poverty (70% of the population is categorised as poor), illiteracy and high infant mortality, attributed to undernourishment, bad water and the lack of medical facilities.

The Moxotó area requires major development of its groundwater resources because the region's surface waters are clearly insufficient to satisfy the needs of the population, especially during drought years. At present, however, a large proportion of the wells tapping the groundwater produce low yields and water that is too saline for human or

[18] Development of new methods, for research, recovery, protection and management of groundwater resources in the semi-arid crystalline areas of the Moxotó hydrographic basin, to supply small rural and urban communities.

animal consumption. This pattern is typical of the regions of the Northeast that are underlain by crystalline rocks. The proposed project will seek to improve groundwater yields and quality, and introduce a groundwater management strategy that will protect and conserve the resource. To achieve this, a multidisciplinary approach will be taken, one that will include introducing modern technologies from Canada as they become needed and applicable.

To be able to achieve the desired outcome will require a profound understanding of the factors that influence the quality and the quantity of groundwater, its distribution, its flow patterns, its vulnerability, etc. Equally important will be to sensitise individually and collectively the users on such issues as conservation, efficient use and protection of the resource, as well as to motivate them to learn how to maintain water self-sufficiency.

The team assembled for this project includes :

1. CPRM : Geological Survey of Brazil
2. LAHID/UFPE : Hydrogeology Laboratory of the Federal University of Pernambuco
3. Social Services Department of the Federal University of Pernambuco
4. FUNDAJ : Joaquim Nabuco Foundation
5. FNS : National Health Foundation
6. CPRH : Environmental Agency of Pernambuco
7. EBAPE : Rural Supply and Development Corporation of Pernambuco
8. EMBRAPA : Brazilian Agriculture Research Corporation
9. SRH : Water Resources Secretariat
10. ABC Groundwater : NGO
11. World Vision : NGO
12. Various Prefectures and Community Associations

Although a considerable amount of basic data already exists for the Moxotó area (e.g. basic geologic mapping, well location and water quality databases, etc.), the project will seek to enhance the knowledge base by conducting in-depth hydrological work including aquifer mapping, structural analysis, and groundwater flow interpretation. Such studies will be carried out by geologists and hydrogeologists mostly at CPRM and UFPE with input from Canadian specialist as required. Remote sensing and ground geophysics will be important tools for the structural analysis and aquifer mapping, and training in these areas will form a sizeable portion of the technology transfer exercise. It will be very important to carry out an airborne geophysical survey early in the project so that the data can be used to guide the subsequent phases of the program. This will likely be done by a Canadian geophysical company with a Brazilian subsidiary.

With regards to the groundwater flow interpretation, Canadian specialists in hydrology of fractured rocks and groundwater modelling will work with Brazilian hydrogeologist on pilot scale projects. This will involve geochemical monitoring, static and dynamic level measurements in wells, borehole logging and down-hole photography to understand how water circulates and how pumping affects drawdown, salinity, yields, etc.

Then, Brazilian waterworks companies, SRH and EBAPE, will become involved in improving the water supply to the communities. Using data obtained from the geophysics and remote sensing surveys, high-yielding wells will be drilled in strategic locations. Canadians will work with the Brazilians companies on innovative drilling methods, on the recovery of abandoned wells and on improving yields in others using techniques such as hydro-fracturing, and on replenishing depleted aquifers using artificial recharge. Reverse-osmosis desalinisation equipment will be installed on the new wells that have sufficient flow. However, the entire issue of groundwater salinity and how to deal with the problem will be examined jointly by Canadian and Brazilian specialists in the matter, including finding alternatives to the reverse-osmosis technique, currently the only one available in the Northeast. Underground dams and other water storage solutions will be examined. This will be piloted by ABC Groundwater, an NGO with special interest in the matter.

Environmental issues related to groundwater usage will be monitored closely. Personnel at CPRH will examine ways of protecting aquifer recharge areas from industrial, agricultural and urban contaminants. Many Canadian companies and public institutions, including several municipalities, have a great deal of experience in this area and help, including training, will be provided as required. CPRH is also interested in developing ecologically sound procedures for disposing of the brines coming out of desalination plants, and in studying soil vulnerability and in methods of recovering salinised soils. As part of the project, CPRH will reinforce their environmental monitoring capabilities and conduct public education campaigns on environmental issues. In a parallel project led by a select team of CPRM hydrogeologist, the process of desertification, which impacts a large area of the Northeast especially in Pernambuco, will be investigated in the hope of finding ways to counteract its effects.

One of the main beneficiaries of the results of the project will be the agricultural sector, especially the small community farms on which most of the rural population depends for its livelihood. Canadian specialists in micro-irrigation systems will work with EMBRAPA engineers to find new, more efficient, ways of utilising the scarce water resources.

Water quality and how it relates to health will be the main concern of the National Health Foundation (FNS). They plan to carry out sanitation and environmental projects, and provide education programs for the communities within the pilot project area. They will use the information obtained through the technology transfer project to drill new wells and set up simple water supply systems. This, they anticipate, will improve the quality of the water available to the communities and reduce the incidences of water-borne diseases. The new water systems will be managed and maintained by the communities and FNS will provide the necessary training and education.

On the social side, the Joaquim Nabuco Foundation (FUNDAJ) has proposed to carry out a detailed socio-demographic study of the Moxotó area in order to place the various parameters that affect the well-being of the communities in a proper perspective. The

shortage of water and poor soil conditions are often cited as the main problems, but social, economic and political factors are equally important in the overall societal framework. By analysing a series of variables, FUNDAJ hopes to build an accurate profile of the population and, supplemented by field work (site visits, interviews, etc.), be able to forecast the potential impact of project activities on that population. This information will be extremely valuable to adjust project activities to maximise the benefits to the communities. Furthermore, it will stimulate community participation in the project, help identify social problems to be addressed, and minimise negative impact on certain segments of the population.

The Social Services Department of the Federal University of Pernambuco will complement the work of FUNDAJ by stimulating community involvement in the project and by promoting fundamental concepts including preservation and rational use of water resources, hygiene, groundwater protection, equal access, etc. First, they will investigate water usage habits and level of awareness of water issues in the population. Then, working with community organisations, social action groups and project participants, they will set up water management units in the six municipalities included in the Moxotó area, organise activities specifically to involve the community, organise education and training programs to promote the application of the new technologies and ensure that the results of the project are adequately dispersed throughout the region. Their responsibility will also include monitoring progress and recommending corrective action when needed.

Canadian organisations with experience in community education and/or in setting up simple water and sanitation systems in underdeveloped countries will be invited to work with organisations like FNS, FUNDAJ, and the Social Services Department of FUPE on community projects and share their experience.

Finally, progress and efficacy of the project as well as its socio-economic and environmental impacts will be constantly monitored against goals and objectives by an experienced team of analysts and project planners from World Vision. Their responsibilities will include providing quality control, cost-benefit analyses, impact studies, financial auditing, and a final independent evaluation of the project, focussing on successes, deficiencies, impacts, and recommendations . This will help steer the project towards optimal usage of the available human and financial resources, and will provide the Steering Committee with the information it needs to keep the project on track.

(2) Ceará

The project that has been proposed for Ceará is in many respects similar to the one described above in relation to Pernambuco. Various Brazilian institutions will join forces to execute multidisciplinary projects aimed at improving the water situation in their respective pilot areas. Canadians will contribute technology as required. Operating in three states rather than one will be cost-effective for the Canadians because, in most cases, the same group of experts will deliver the technology to more than one state in a

single mission. This will increase the impact because more Brazilian institutions in different locations will be able to use the technologies in more areas with potential benefits to a larger number of communities.

In Ceará, the pilot area measures about 3,000 square kilometres and is home to more than 128,000 people. It is centred on the town of Irauçuba in the north-central part of the state, one of the driest and most socially deprived regions in the Northeast. The area was visited during the 1st Project Development Mission in December 1998, which provided the opportunity to meet various representatives of community associations and to discuss water and related issues that concern them. The amount of interest that was generated for the project during that visit is evident in the letters and documents that were submitted by three municipalities, Irauçuba, Itapajé and Tejuçuoca. These letters are included in the separate volume containing the Brazilian proposals.

The organisations which will participate in the project in Ceará are;

1. CPRM : Geological Survey of Brazil
2. SUDENE : Northeast Brazil Development Agency
3. SOHIDRA : Waterworks Agency of the Water Resources Secretariat of Ceará
4. COGERH : Water Resources Management Company
5. FUNCEME : Meteorological and Water Resource Foundation of Ceará
6. ABAS, Nucleo Ceará : Brazilian Groundwater Association, Ceará Branch
7. ICCN : Natural Science Institute of Ceará
8. SEMACE : Ceará Environmental Agency
9. UFC Dept. Física : Federal University of Ceará, Physics Department
10. UFC (LGPSR) : Federal University of Ceará, Geophysics and Remote Sensing Laboratory
11. Autonomous Environmental and Social Consultants
12. Various Prefectures and Community Associations

As was the case for the Moxotó area, there is considerable amount of geological and hydrological information available for the Irauçuba area, which will allow new technologies to be introduced without the need to collect large quantities of basic data. In fact, an excellent water resource database is available on CD-ROM for the entire state of Ceará.

Most of Ceará is underlain by the same rock types as found in the Moxotó area and, as in Pernambuco, an early airborne geophysical survey is recommended to establish a base on which subsequent work can be carried out. This will provide the background for testing new ground geophysical methods and remote sensing tools to detect fracture systems that can be drilled for high-yield wells. CPRM, FUNCEME and the Geophysics Laboratory of UFC will be involved in this part of the program. The same Canadian specialists who will transfer technology in Pernambuco will also be involved in Ceará.

Drilling wells and other waterworks projects will be carried out by SOHIDRA, the state's main hydraulic engineering firm; water management will be handled by COGERH, the state owned water management company. Working alongside Canadian specialists, they will test and implement technologies that will improve access to safe water for the communities. As indicated in their submission, SOHIDRA possesses a wide variety of heavy equipment which will be made available for follow-up project activities. These include drilling equipment, pumps, compressors, desalinisation plants, etc.

The environmental agenda in Ceará will be largely carried out by ICCN, an NGO with experience in conducting land use assessments, impact and environmental risk studies, as well as conducting environmental education and sensitisation projects. Their personnel will be trained in Canada in using such environmental tools as remote sensing, groundwater protection techniques, and land use mapping. SEMACE and private environmental consultants will also be involved in this aspect of the project.

The field trip to the interior of Ceará, and the meetings held with the leaders of three municipalities during the Project Development Mission in December 1998, clearly demonstrated the high level of community solidarity and organisation that exists in the region. This will make it relatively easy to deliver education and social programs to these communities. This task will be carried out mainly by independent professionals, supported by ABAS and other Brazilian organisations with input from Canadian social workers as required.

(3) Rio Grande do Norte

In Rio Grande do Norte, two separate projects have been planned, each one with its own set of particularities requiring distinct approaches and technologies. In a general way, RGN is geologically different from Pernambuco and Ceará. A much larger proportion of its territory is underlain by sedimentary rocks in which groundwater occurs in "porous aquifers", as opposed to the crystalline rocks and "fractured aquifers" that characterise most of drought stricken areas of Ceará and Pernambuco. Usually, areas of sedimentary rocks have fewer water supply and quality problems compared to crystalline terrains simply because they have more capacity to store water due to their higher porosity. But in RGN, because many cities and communities live off the region's main sedimentary aquifer, the Açu Formation, there is a real danger of over-exploitation in certain areas. Water from the Açu is distributed throughout the state for human and animal consumption, and irrigation, through a system of pipelines, even to the communities located in the crystalline areas to the south. Should this aquifer degenerate and start yielding lesser quantities of poorer quality water due to over-exploitation or contamination, the effects could be disastrous for the many thousands of people who depend on it for their livelihood. By the same token, parts of the Açu are not producing as much as could be expected and experts believe that a better understanding of its hydrology could generate more production and, therefore, lessen the stress on the portions of the aquifer which are currently producing. Determining the best approach to protect the Açu Formation from over-exploitation and pollution, and improve yields in certain areas, is essentially what **Subproject II** (as presented in the Brazilian Proposal Volume) will attempt to accomplish.

The Water and Sewers Company of Rio Grande do Norte (CAERN) will take the lead on this subproject, with the participation of the Federal University of Rio Grande do Norte, the State Environmental Agency (IDEMA) and the Water Resources Secretariat (SERHID). The latter has agreed to drill wells and provide other infrastructure support.

The groundwater situation in RGN is not unlike that which exists in many parts of western Canada, where water used for agriculture and human consumption derives largely from sedimentary aquifers that are vulnerable to over-exploitation and contamination. Therefore, much expertise presently exists in Canada to resolve these types of water related problems. Some of this expertise resides with companies that service the Canadian oil industry, which often finds itself facing hard-to-resolve water situations.

Petrobrás, the Brazilian national oil company is particularly interested in this subject. The company exploits deep oil fields in sedimentary formations in other parts of the state. With the oil comes large quantities of water that, even after undergoing a standard cleaning process, remains contaminated with oil and cannot be used for consumption nor irrigation. The company has no choice but to reinject the oily water underground into the formations from which it originally came from. But Petrobrás is eagerly seeking an

economically viable technology to give this water a more noble function. Should one be found, it would greatly alleviate the water shortages in some of the driest parts of the state[19]. Through a posting on the project's Web Site, several Canadian companies have proposed different solutions. One of the most promising, from Klohn-Crippen Consultants of Sudbury, Ontario, suggests using electrocoagulation, a technique developed to decontaminate oily wastewater from oil tankers (ship bilge water) that dock in Vancouver.

The pilot area for **Subproject I** is located in the southeastern part of the state, within the region underlain by crystalline bedrock. The area lies outside the region supplied by piped water and the population has to rely on shallow bedrock wells for most of its water requirements. In that sense, the problems here are similar to those in Pernambuco and Ceará (e.g. fractured aquifers, low permeability, extreme evaporation, brackish water, etc.).

The Research and Post-Graduation Program in Geodynamics an Geophysics (PPGG) of UFRN, in collaboration with the State Environmental Agency (IDEMA) and the Water Resources Secretariat (SERHID) are proposing a study designed to improve the success rate of drilling high yielding wells based on remote sensing and ground geophysics. A wide range of geophysical equipment will be tested, and Canada will be in an excellent position to transfer technology in this area as well as in remote sensing techniques. UFRN has a strong geophysical group so that the technology to be transferred will be of relatively high calibre.

The subproject also foresees testing targets defined by the geophysical and remote sensing pilot studies by drilling new wells in critical locations. These locations will be chosen in consultation and with the input of community and social action groups, including Comunidade Solidária which is currently active in that region. There will probably be opportunities to introduce in RGN the same water management and well rehabilitation technologies (e.g. artificial aquifer recharge, hydro-fracturing, etc.) that will be demonstrated in Pernambuco and Ceará. The transfer would take place concomitantly in the three states by the same groups of experts.

[19] According to Petrobrás officials, between 3,000,000 and 50,000,000 litres of oil-well water is extracted each day from company oil wells.

PROJECT DESCRIPTION

(B) Point Form

Goal

To improve the quality of life of the people of northeastern Brazil who are severely impacted by drought, by developing the region's groundwater resources and providing long-term access to a more regular and abundant supply of good quality water.

Anticipated Impact

Strengthening of the economic and agricultural sectors, improvement in health and other quality-of-life indicators, and better means for the population to sustain itself during the prolonged droughts that periodically beset the region.

Purpose #1

- ***Objective:*** Enhance the capability of Brazilian institutions involved in groundwater research and management, to conduct surveys, studies and water management projects that will effectively lead to an improvement in the water supply in northeastern Brazil.

- ***Activities:*** Transfer of "high" technologies to Brazilian technical institutions by Canadian specialists through workshop, seminars, short courses, in-field demonstrations, joint pilot-scale projects, technical visits, and training Brazilian personnel in Canada.

- ***Inputs:*** CIDA funds will be used to cover costs of Canadian specialists travelling to Brazil including travel cost, consulting fees, equipment rental and transportation, and the preparation of teaching material. Local high-tech firms may be hired to supply equipment and operators. CIDA funds will also be used to cover all costs of training Brazilians in Canada. Brazilian institutions will provide logistical support in Brazil, including adequate teaching facilities (e.g. space, audio-visual and computer equipment, simultaneous translation, etc.) and field support (e.g. vehicles, fuel, drivers, labourers).

- ***Expected results (outcomes):*** The staff of participating Brazilian institutions will acquire the knowledge and skills necessary to carry out more effective applied groundwater research and management based on Canadian technologies. It is also anticipated that the institutions themselves will become progressively better equipped to carry out groundwater related studies and surveys as they acquire the recommended tools to carry out such studies and surveys.

- ***Risk and risk management:*** Problems of communication (language) could interfere with the technology transfer exercise and seriously compromise its effectiveness. Risk management, in this case, will consist of providing translators and interpreters, including simultaneous translation for classroom sessions. Another option would be to select preferentially Canadian contractors that can provide Portuguese or Spanish speaking staff, as many do.

Purpose #2

- ***Objective:*** Improve the water supply situation in selected areas of Pernambuco, Ceará and Rio Grande do Norte by applying the newly transferred Canadian technologies.

- ***Activities:*** Brazilians institutions with input from Canadian specialists as required will carry out recommended studies and surveys, test targets and hypotheses by drilling wells, apply well rehabilitation techniques, test new drilling methods, install equipment (e.g. pumping stations, desalinisation plants, etc.) and carry out all necessary infrastructure projects to implement the new technologies (e.g. drilling wells, building dams, trenching, in support of artificial aquifer recharge), etc.

- ***Input:*** All costs associated with the implementation part of the project, including waterworks construction activities, will be borne by Brazilian institutions. CPRM and the universities will carry out mostly surveys and studies, whereas state owned waterworks companies will be responsible for the infrastructure projects. Brazilian institutions will also purchase the equipment needed for the project from Canadian or other suppliers. CIDA funds will be used to support Canadian participation in this component as in the previous. In cases of surveys to be contracted to Canadian companies (e.g. airborne geophysics), a cost-sharing formula will be adopted.

- ***Expected results (outcomes):*** General improvement in the water supply situation in northeastern Brazil, first in selected pilot areas where the newly transferred technologies will be tested and applied as part of the proposed project and, later, in other parts of the region as the technologies become progressively more widely adopted.

- ***Risk and risk management:*** (1) This phase of the project is the one which will depend the most on Brazilian resources. Therefore, it is vulnerable to a serious downturn in the Brazilian economy or to shifting priorities of government or of the participating institutions. However, the issue is unlikely be given less prominence by the government and the institutions because it is a national priority, a great deal of money has been spent and will continue to be spent on the

problem, and the funds for the project will derive mostly from the institution's regular budgets and, therefore, are less likely to be affected by cuts than if they were new funds. But if, for any reason, this component needed to be curtailed, the project could still be very successful by concentrating on the less expensive technologies. (2) Canadian technologies may prove to be inadequate to solve northeastern Brazil's water problems. However, there is no question that within the range of technologies that are being offered by Canadian private and public institutions, some will be found to have useful applications in northeastern Brazil.

Purpose #3

- ***Objective:*** Improve the level of awareness and basic water management skills of the rural population to ensure the maximum benefits and sustainability of the results of the projects.

- ***Activities:*** Community education and training projects with emphasis on hygiene, water resource conservation and protection, simple water system maintenance, equal access principle, user-pay and alternate financing schemes, etc. Surveys to evaluate the needs of the population, and public sessions to promote community involvement in the technology transfer project. Input from Canadian organisations as required.

- ***Inputs:*** Implementation of this component will be largely carried out by Brazilian social action groups and NGOs, most of which have limited financial means. However, they will contribute human resources, and they will receive all the necessary logistical support from the other project components. CIDA funds will support Canadian organisations who become involved in this component of the project.

- ***Expected results (outcomes):*** Better understanding and gradual adoption of sound water management principles by the population and their leaders. This will result in better conservation and waste disposal practices; more adequate maintenance of water system hardware; more equitable sharing of the water resource; better understanding of individual responsibilities, etc. Some employment created through direct involvement in project activities.

- ***Risk and risk management:*** Since they will be dependent on other components of the program for logistical and other support, there is a danger that social and related activities will become marginalised within the project. However, by involving strong social action groups at the project's management level (Comunidade Solidária in Brazil and OXFAM Canada), there is little risk of this happening.

Purpose #4

- ***Objective:*** Establish long-term linkages between Canadian and Brazilian private and public institutions involved in groundwater research and management to ensure the sustainability and the widest possible dissemination of the project's results, and continuance of Canadian technological influence long after CIDA's involvement has ended.

- ***Activities:*** By taking every opportunity to promote and bring on collaboration between Canadian and Brazilian institutions, especially when such collaboration has a chance to develop collaterally to the CIDA project. Organise and encourage participation in events that will foster contacts and interaction between Brazilian and Canadian organisations and specialists.

- ***Inputs:*** Resources needed to implement this component are mostly included in the other component's inputs. A minimal fund may be set aside to allow participation in special events when the cost of such participation cannot be included with other project activities.

- ***Expected results (outcomes):*** Canadian public institutions and individual scientists and technicians continue to interact with their Brazilian counterparts on water relater issues[20].

- ***Risk and risk management:*** There is no doubt that interaction between Canadian and Brazilian individuals and institutions will continue to take place after the CIDA project has ended. What is not known is the extent to which it will happen. It will depend, to a large extent, on two factors: (1) the availability of at least some funds on either side to conduct joint activities; and (2) the applicability and usefulness of Canadian technologies to northeast Brazil water problems. What may be more problematic, is to ensure that these activities continue to benefit the communities in need. The four Brazilian partners in the project, all of whom have enormous social responsibilities in the region, will no doubt see to it that the social purpose of transferring foreign technologies is not forgotten.

[20] This is already taking place as a result of project development: (1) several Canadian companies have responded to a request for ideas on how Petrobrás, the Brazilian national oil company, could decontaminate large volumes of oil-well water in Rio Grande do Norte to make it suitable for consumption and irrigation. Companies were alerted to the problem through a posting on the Project's Web Site at: http://proasne.net/newsletterv1n1.html#Oily Water ; (2) Waterloo Hydrogeologic, an Ontario company that specialises in groundwater modelling, is scheduled to give a workshop in Fortaleza in November 1999. This came about as a direct result of contacts made during project development.

Management Structure

The project will be managed by a permanent Steering Committee composed of members from each of the partner institutions: GSC, CPRM, ABAS, SUDENE, and Comunidade Solidária as well as a representative from the Ministry of Mines and Energy. The Steering Committee will meet twice a year to discuss results in the previous semester and make plans the next. The Steering Committee will receive advice and input from an Advisory Committee made up of representatives from the most active participating organisations, both Brazilian and Canadians. Advisory Committee meetings will generally take place during technical missions and record their deliberations in short reports or minutes.

The day to day running of project business will be handled by a group of four, two General Coordinators, one Technical Coordinator and one Social Coordinator. Group members will communicate between them via e-mail or telephone as often as necessary. They will work closely with coordinating units in each of the three participating states. These local units will be made up of at least three members, two technical representatives and one social representative. Their role will be to organise project activities and ensure that these activities respond to project objectives.

Figure 1 shows the project's organisation chart. At the time of writing, most positions for the various functions had been filled with only a few appointments remaining to be confirmed. CVs of key members are included in Appendix E.

Steering Committee

- Dr. Yvon Maurice, Coordinator, Canada-Brazil Cooperation, GSC
- Mr. Samir Nahass, International Advisor for International Affairs and Coordinator, Canada-Brazil Cooperation, CPRM
- Dr. Itabaraci Nazareno Cavalcante; President of ABAS, National Institution (to be confirmed)
- Mr. Carlos Fernando Pinto Teixeira, SUDENE
- Dr. Antonio César Gonçalves Borges, Program Comunidade Solidária
- Mr. Rubens Rulli Costa, Ministry of Mines and Energy

General Coordination

- Dr. Yvon Maurice, Coordinator, Canada-Brazil Cooperation, GSC
- Mr. Samir Nahass, International Advisor for International Affairs and Coordinator, Canada-Brazil Cooperation, CPRM

Technical Coordinator

- Humberto Rabelo de Albuquerque: Head of Hydrogeology Division, CPRM

Social Coordinator

- Dr. Antonio César Gonçalves Borges, Program Comunidade Solidária

Local Coordination for Pernambuco

- Professor João Manoel Filho: Head of Hydrogeology Department, Federal University of Pernambuco, Recife (technical representative)
- Mr. Sebastião Milton Pinheiro da Silva: Senior Geologist (GIS/Remote Sensing specialist), CPRM's regional office in Recife (technical representative)
- Mr. Enjôras de A. Medeiros Lima, Deputy Head of CPRM's Regional Office in Recife (alternate)
- Mr. João Suassuna, Senior Researcher, Joaquim Nabuco Foundation, Recife (social representative)

Local Coordination for Ceará

- Mr. Fernando Feitosa, Senior Hydrogeologist, CPRM's Regional Office in Fortaleza (technical representative)
- Mr. Oderson Antônio de Sousa Filho, Geologist, CPRM's Regional Office in Fortaleza (technical representative)
- Mr. Jaime Quintas dos Santos Colares, Deputy Head of CPRM's Regional Office in Fortaleza (alternate)
- Elisabete Siqueira, Secretária de Ação Social, Município de Tejuçuoca (social representative)

Local Coordination for Rio Grande do Norte

- Dr. Emanuel F. Jardim de Sá, Professor of Structural Geology, Universidade Federal do Rio Grande do Norte, Natal (technical representative)
- Marcelo A. de Queiroz, Senior Hydrogeologist, CAERN, Natal (technical representative)
- Dr. Walter E. Medeiros, Professor of Geophysics, Universidade Federal do Rio Grande do Norte, Natal (alternate)
- Dra. Maria de Fátima de Freitas Rêgo, Secretaria de Recursos Hídricos, Natal (social representative)
- Vera Lucia Lopes de Castro, Secretaria de Recursos Hídricos, Natal (alternate)

Participants (for Advisory Committee)

- Canadian Public and Private Organisations
- Brazilian Federal and State Agencies
- Universities and Research Institutions

- Community Associations
- Social Service Organisation
- Private Companies and Consultants

PROJECT BUDGET

Table 1 summarises the levels of resources to be contributed by Canada and Brazil respectively towards implementing the project. The table also provides a breakdown of the amounts to be contributed by Brazil's Federal Government (CPRM) and by organisations in each of the participating states, and by CIDA and GSC. The amounts listed for Brazil were taken directly from the proposals submitted by the various organisations in each state. These proposals can be examined in the accompanying volume entitled *Project Proposals from Brazilian Partners and Participants.* The resources that CPRM is allocating to the project will be divided equitably amongst the three participating states and includes Brazil's share in the cost of the airborne geophysical survey.

Through a standard formula used to calculate the cost of GSC's participation in international programs, based on employee salaries, benefits and overheads, it was estimated that running the NE-Brazil Groundwater Project will cost GSC $173,700 per year, or roughly $521,000 for the three years[21]. GSC will charge CIDA a flat $40,000 per year or $120,000 for the three years to administer the program, excluding travel costs incurred by the program managers to attend administrative meetings, which is estimated at $10,000 per year. The difference, $401,000, represents GSC's minimal in-kind contribution to the project. To this figure will be added a difficult-to-estimate contribution reflecting lower rates charged to CIDA (about 50% to 66% of normal rates) for GSC's involvement in project activities. This would include professional fees, analytical and cartographic services, and informatics. CPRM estimates its personnel and overhead costs of administering the project at R$100,000 per year, or R$300,000 for the three years.

CIDA funds will be utilised mainly for technology transfer activities and will cover Canadian personnel costs, professional fees to Canadian private sector firms and consultants, travel expense of Canadians travelling to Brazil, and expenses related to training Brazilian personnel in Canada. CIDA funds may also be utilised to hire consultant in Brazil when it is cost-effective to do so, and to cover international air fares of personnel from Brazilian institutions that have limited means of assuming such costs, when they travel to Canada for training.

The amount and proposed use of the funds requested from CIDA is presented in Table 2. The amount requested for technology transfer has been calculated on a per-activity basis. An activity would consist, for example, of a two to four week mission to Brazil by two or three Canadians to hold workshops and carry out field work in one, two or, in some cases, three states. Another example would be training two or three Brazilian nationals in Canada for a period of up to two months. From previous experience, we estimate that the cost of individual activities will average $40,000, and we plan to hold about eight such

[21] All $ figures are in Canadian dollars and R$ are in reais; the conversion factor of R$1.266 per $ was used in this document.

activities each year, or some 24 activities during the three years of the project. On that basis, CIDA funds devoted to technology transfer will total $960,000. An additional $250,000 is requested to carry out a most important airborne geophysical survey. This amount will be matched by Brazil.

Table 3 shows the source of Brazilian funds and how they will be utilised[22]. Brazil intends to run the projects in each state continuously during the three years of CIDA's involvement, and probably beyond that. The budget shown on Table 3 is for three years, however. As indicated above, CPRM's operation budget (O & M) includes a matching amount to Canada's for airborne geophysics in each of the three participating states.

The waterworks and infrastructure budget, which includes drilling wells and installing desalinisation equipment, building dams and trenching for aquifer recharge, and other constructions generally requiring heavy equipment, is shown in a separate column to emphasise the importance of these activities in the project. About $2 million (when personnel costs to operate the machinery are included) have been identified so far to support these activities. This number is likely to grow as the project progresses and when the actual needs for waterworks and infrastructure elements materialise.

Other Sources of Funding

We have been approached and have entertained discussions on the possibility of collaborating with other agencies to augment the impact of the CIDA project in NE-Brazil by adding complementary activities that would be funded by other organisations. These proposals are still embryonic at this stage and are not expected to materialise until a decision has been taken on the CIDA project. Nevertheless, they could represent a significant input into the drought relief effort in NE-Brazil. By working together, we can ensure that these efforts are complementary to the CIDA initiative, avoid duplication and maximise the benefits to the populations in need. Some supporting documents are included in Appendix D.

The principal contacts are:

(1) Geoterrex-Dighem, a Canadian Geophysical Company, is proposing to approach the World Bank to seek funding for additional geophysical surveys in NE-Brazil. If the results of the pilot geophysical surveys to be carried out under the CIDA project prove to be useful, as we expect, additional surveys over much larger areas could help bring relief to a much larger population.

(2) The Centre for Research in Earth and Space Technology, CRESTech, an Ontario centre of excellence, has already agreed to support financially member organisations that become involved in the CIDA project in NE-Brazil. Letters indicating such support have

[22] Some contributions from important participants (e.g. SRH and EMBRAPA in Pernambuco) have yet to be confirmed and are not included in Table 3.

been received from several private sector firms, and recent discussions with CRESTech officials indicate that the Centre will also consider supporting university involvement in the project. Such support from CRESTech will reduce the cost to CIDA of hiring professional from member institutions and facilitate longer term projects, especially projects that will involve university-based research.

(3) The GSC/CIDA project has prompted the United States Geological Survey (USGS) to approach the US Agency for International Development (USAID) for funding to support water relief projects in NE-Brazil. GSC and the USGS will work together to develop the USGS/USAID project to ensure complementarity and avoid duplication.

(4) Oxfam's participation in the CIDA project will be funded by its own Drought Emergency Programme Fund. Only preliminary discussions (mostly e-mail exchanges) have taken place to date with Oxfam. However, we expect matters to develop quickly once the CIDA project has been approved.

Table 1: Project Resources

Canada	**R$**	**Can$**
• CIDA: financial contribution (requested)		$1,360,000
• GSC: personnel, overhead (in kind):		$401,000+
Total Canada		**$1,761,000+**
Brazil		
• National institution (CPRM)		
○ Administration: personnel, overhead (in kind):	R$300,000	$237,000
○ project implementation: salaries, O&M, capital	R$3,314,000	$2,618,000
• Pernambuco, state and local institutions (UFPE, CNPq, CPRH, EBAPE, FNS, World Vision)		
○ project implementation: salaries, O&M, capital	R$2,796,000	$2,209,000
• Ceará, state and local institutions (SOHIDRA, FUNCEME, ICCN)		
○ project implementation: salaries, O&M, capital	R$939,800	$742,400
• Rio Grande do Norte, state and local institutions (UFRN, CAPES/CNPq, PADCT, SERHID, CAERN)		
○ project implementation: salaries, O&M, capital	R$1,282,800	$1,013,400
Total Brazil	**R$8,632,600**	**$6,819,800**

Table 2a: CIDA Funds; main expenditure categories

Purpose	Amount
Project administration: $40,000 / year x 3 years + $10,000 / year travel	$150,000
Project activities: $40,000 / activity x 8 activities / year x 3 years	$960,000
Airborne geophysics (amount to be matched by Brazil)	$250,000
TOTAL	**$1,360,000**

Table 2b: CIDA Funds; estimated disbursement schedule

Budget item	Amount
(1) Personnel costs (excludes contracted personnel)	$240,000
(2) Travel costs - Canadians travelling to Brazil (excludes contracted personnel)	$130,000
(3) Contract costs to Canadian organisations and private consultants (includes personnel costs, professional fees, and travel expenses)	$760,000
(4) Costs of training Brazilian personnel in Canada (includes travel and living expenses in Canada when not part of a contract)	$140,000
(5) Costs of hiring local consultants in Brazil	$50,000
(6) All other reasonable and justifiable expenses	$40,000
TOTAL	**$1,360,000**

Note: some flexibility in the distribution of funds between budget items will be needed to adjust project activities to circumstances as they arise.

Table 3: Proposed Brazilian contribution in R$ (Can$)

Organisation	Personnel Costs	O & M	Capital	Waterworks & Infrastructure	Total
National					
CPRM*-admin.		R$300,000** ($237,000)			R$300,000 ($237,000)
Pernambuco					
CPRM	R$800,000 ($632,000)	R$413,500 ($326,700)	R$65,000 ($51,400)		R$1,278,500 ($1,010,100)
CPRH	R$462,000 ($365,000)	R$110,000 ($86,900)	R$50,000 ($39,500)		R$622,000 ($491,400)
FNS	R$99,000 ($78,200)	R$35,000 ($27,700)		R$140,000 ($110,600)	R$274,000 ($216,500)
UFPE/LAHIB	R$260,000 ($205,400)	R$94,500 ($74,700)	R$91,100 ($72,000)		R$445,600 ($352,100)
EBAPE		R$75,000 ($59,200)		R$1,360,500** ($1,074,800)	R$1,435,500 ($1,134,000)
Visão Mundial		R$18,900** ($14,900)			R$18,900 ($14,900)
Total Pernambuco	**R$1,621,000 ($1,280,600)**	**R$746,900 ($590,100)**	**R$206,100 ($162,800)**	**R$1,500,500 ($1,185,400)**	**R$4,074,500 ($3,218,900)**
Ceará					
CPRM	R$625,500 ($494,100)	R$210,000 ($165,900)			R$835,500 ($660,000)
FUNCEME	R$370,200 ($292,500)	R$9,400 ($7,400)	R$138,900 ($109,731)	R$100,000 ($79,000)	R$618,500 ($488,600)
SOHIDRA	R$89,600 ($70,800)	R$6,000 ($4,700)		R$75,700 ($59,800)	R$171,300 ($135,300)
ICCN (est.)	R$100,000 ($79,000)	R$50,000 ($39,500)			R$150,000 ($118,500)
Total Ceará	**R$1,185,300 ($936,400)**	**R$275,400 ($217,600)**	**R$138,900 ($109,700)**	**R$175,700 ($138,800)**	**R$1,775,300 ($1,402,500)**
Rio Grande do Norte					
CPRM	R$800,000 ($632,000)	R$400,000 ($316,000)			R$1,200,000 ($948,000)
UFRN	R$416,000 ($328,600)				R$416,000 ($328,600)
SERHID	R$65,000 ($51,400)			R$278,100 ($219,700)	R$343,100 ($271,100)
CAERN	R$172,800 ($136,500)	R$54,300 ($42,900)			R$227,100 ($179,400)
CAPES/CNPq	R$94,800 ($74,900)				R$94,800 ($74,900)
PADCT	R$3,000 ($2,400)	R$22,800 ($18,000)	R$176,000 ($139,000)		R$201,800 ($159,400)
Total RGN	**R$1,551,600 ($1,225,800)**	**R$477,100 ($376,900)**	**R$176,000 ($139,000)**	**R$278,100 ($219,700)**	**R$2,482,800 ($1,961,400)**
TOTAL PROJECT	**R$4,357,400 ($3,442,300)**	**R$1,799,400 ($1,421,500)**	**R$521,000 ($411,600)**	**R$1,954,300 ($1,543,900)**	**R$8,632,600 ($6,819,800)**

* In this table, CPRM's non-administrative resources have been divided amongst the three states; readjustments may be necessary later.

** Includes personnel costs

PROJECT JUSTIFICATION

The project addresses a priority humanitarian issue of international stature

Even before it is given the green light, the proposed project has been referred to, both in Canada and in Brazil, as one of the most important international cooperative efforts to focus on that South American country in recent years. That it should be labelled as such is not surprising because, after all, it will address one the highest priority issues of the Brazilian government and a world-scale humanitarian calamity, that is drawing increasing attention by the world media. Most of the recent articles have focussed on the plight of the 25 million or so people that live in northeastern Brazil, mostly because the region has just come through a severe and devastating drought that caused widespread hardship, destroyed the region's economy and cost the government billions in short term relief measures. The region needs long term solutions to cope with the drought, which is what the proposed project will attempt to do by introducing state-of-the-art technologies in the area of groundwater exploration and management.

The project conforms to the TTF objectives and eligibility criteria as set by CIDA and ABC

By addressing the drought problem in the Northeast, the project is responding to development needs and priorities in Brazil. It is largely a social development project with a strong environmental agenda, and thus is fully compliant with the mandate of Canada's bilateral cooperation program in Brazil.

By focussing on groundwater exploration and management, areas where Canadian expertise is recognised world-wide, the project will facilitate the transfer of Canadian technologies that are highly relevant to Brazilian needs and priorities. Technologies will be transmitted directly to partner institutions in Brazil who will then adapt them to their own situation and development context. The technology transfer will take the form of training, technical exchanges, in-field demonstrations, and joint pilot projects in areas where Canadian institutions have strong capacities which respond to the priorities of the Brazilian partners. Brazilian partner institutions have shown a clear interest in Canadian technologies in the area of groundwater exploration and management and are prepared to do whatever is necessary to adapt these technologies to their situation.

By involving a wide range of public and private institutions in both Canada and Brazil, the project will foster institutional linkages, relationships and partnerships between the two countries. The main partners, in both Canada and Brazil, are strong organisations with excellent track records in their respective areas of responsibilities. Partner institutions and potential participants of both countries have been involved in the project development process from the beginning; their inputs are included in the accompanying volumes of proposals and expressions of interest.

Brazil will benefit substantially from the transferred Canadian technologies and methodologies

In the short term, Brazilian technicians from various organisations will be trained and will become familiar with the new technologies. Gradually, we will witness a general strengthening of the institutions involved in the program with a building of capacity in the area of groundwater exploration and management. But equally important is the fact the Canadian specialists who will be transferring the technologies will be chosen amongst the most qualified and experienced in the country and their approaches and methodologies are expected to have a significant influence on the way future groundwater projects are conducted in northeastern Brazil. The multisectorial framework on which this project is being built is already regarded in Brazil as an innovative and ingenious approach to tackle the problems caused by the drought. This working model, which is commonly used in Canada, is practically untested in northeastern Brazil. As the project was being developed, the anticipation that the whole exercise would lead to significant improvement in the way northeastern institutions work together, became a motivating factor for the organisers.

In the medium term, as the new technologies are applied in the field, there will be noticeable improvement in the water supply situation of certain communities. Also, education programs on hygiene, water conservation, equipment maintenance, etc., delivered directly to the communities, will also contribute to improving the situation. The links that are expected to develop between Canadian and Brazilian organisations should lead, in the medium and long term, to activities beyond those supported by the project.

In the long term, with the widespread application of the new technologies and improved access to better quality and more abundant water, there should be significant improvement in the agricultural and health sectors, and in the local economy in general. Also, the communities will become much better equipped to cope with future droughts which, in turn, will make them less dependent on government relief programs. This will have positive effects on the regional and even national economies. We should see a marked improvement in the quality of life of the population.

Canada and Canadians will also benefit from the project

By targeting the drought in NE-Brazil, recognised world-wide as a major humanitarian calamity affecting the lives of millions of people, the project will enhance the profile of Canada and Canadians abroad, and solidify even more the already enviable perception that foreign nations have of Canada's aid programs. CIDA, GSC and other Canadian participants will benefit from the increase in national and international recognition..

Canadian companies and consultants will benefit directly from contracts to deliver goods and services required by the project. Furthermore, the Canadian private sector, as it participates in project activities, will have the opportunity to showcase its wares and expertise, and in all likelihood, this will develop in long term business opportunities. The

previous CIDA-sponsored project in Brazil, conducted by GSC and CPRM between 1995 and 1999, resulted in commercial spin-offs that exceeded several times the original cost of the project. The present project is expected to generate even more economic benefit for Canadian companies because they will be involved to a far greater extent than they were in the previous project.

Finally, Canadian specialists and technicians, researchers, students and others who will be involved in the project will gain valuable experience that will serve them in their careers. Some of this know-how will eventually be adapted to serve Canadians and the populations of other countries in need.

Sustainability, environment and gender equity

Two factors will ensure that the results of the project are sustained and replicated beyond the period of CIDA funding:

(1) The strong linkages and partnerships that are expected to develop between Canadian and Brazilian organisations will continue and very likely expand in the medium to long term as the merits of the new technologies from Canada are recognised. This will occur not only in the form of commercial deals (the sale of goods and services), but also in the other areas such as academic research and social programs. Once social projects and programs have been well established and their benefits are recognised, there is no doubt that they will continue to be promoted and supported by the government of Brazil and international agencies such as Oxfam and World Vision.

(2) The Brazilian government as well as the partners in the project and many of the participants have enormous social responsibilities in the region and everyone is looking for solutions. There is no doubt that if some of the results of the project are found to provide such solutions, we will see them being applied and replicated throughout the northeast.

From an environmental standpoint, the project will have a beneficial impact. Greater success in groundwater exploration will mean that far fewer wells will need to be drilled in order to supply the same amount of water. Fewer reservoirs will be required to retain surface waters as technologies are introduced to protect this water from evaporation. Aspects of the project, including community education programs, will deal with groundwater conservation, wellhead protection, waste disposal practices and the remediation of contaminated sites. None of the activities that are planned within the project make use of industrial or other types of contaminants. The impact on the landscape, flora and fauna will be minimal.

With respect to gender equity, there are obstacles to overcome mostly in the technical areas of the program, where traditionally women have not been equitably represented in the workforce, neither in Brazil nor in Canada. In the social, health, and education areas of the program, however, we foresee no difficulty meeting gender equity targets. In fact,

judging from the proposals received from most of the Brazilians organisations, the participation of women in these areas is expected to exceed that of men. With regards to project management, efforts will be made to identify more women to represent their organisations at the steering and local committee levels.

CANADIAN INSTITUTIONAL PARTICIPATION

The Geological Survey of Canada (GSC), will be the project's leading institution in Canada[23]. It is a branch of the Earth Science Sector (ESS) of the Federal Department of Natural Resources (NRCan).

Profile of the organisation

Established in 1842, the GSC is Canada's national geoscience agency, with 550 employees working at six locations across the country: Dartmouth, Nova Scotia; Ste-Foy, Québec; Ottawa, Ontario; Calgary, Alberta; and Vancouver and Sidney, British Columbia.

GSC's mission is to provide Canada with a comprehensive geoscience knowledge base contributing to economic growth, sustainable development, health and safety, and environmental protection. The GSC works in close collaboration with other government departments in Canada at all levels, with Canadian industry and universities, and with other countries and international organisations. Internationally, GSC is currently involved in collaborative projects with Argentina, Bolivia, Brazil, Chile, China, Guinea, Japan, Peru, United States, the South Pacific, East and Southeast Asia, and in the multinational Ocean Drilling Program. Some of these projects are funded by CIDA, the World Bank and similar organisations.

GSC's strength lies in its continuous development of a dedicated, internationally renowned staff. The organisation is persistently seeking to establish partnerships with provincial, territorial and federal government agencies, industry, universities, and national and international geoscientific organisations. GSC is committed to demonstrating and promoting scientific excellence and to continually improving its products and services.

GSC has a broad range of expertise including in several areas that are relevant to the present project: airborne and ground geophysics, remote sensing and GIS; hydrogeology and hydrology; hydrogeochemistry. Specifically in hydrogeology and groundwater management, the GSC is well positioned to provide expertise in those areas as it has been steadily strengthening its hydrogeology program over the last few years. As a national organisation, GSC's efforts are focused on facilitating, with a variety of partners, methodology development for acquiring and synthesising information required for regional, cross-boundary and long-term issues relating to groundwater. The GSC has several hydrogeologists on staff both in Ottawa and at its Québec office.

GSC's current hydrogeology projects span the entire country, both in densely populated urban areas and in rural settings. All are built on a foundation of innovative field and

[23] Some segments below are quoted from GSC 1998-1999 Annual Review and other internal documents.

digital mapping techniques, broad partnerships, and the timely communication of results to stakeholders.

Project Management

The project will be managed from GSC's headquarters in Ottawa. GSC will provide superior management to the project, with an experienced full time project manager and secretarial/financial administration support staff. A 60 sq. metre office, equipped with modern computer facilities and other amenities, will be fully dedicated to project management for the entire duration of the project.

The following GSC staff members will be involved in the project:

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(2) Advisor, project management and social/environmental issues

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GSC is the most appropriate institution in Canada to implement the proposed project with Brazil. The five principal reasons are:

(1) As an organ of the Canadian Federal Government, that is also a world leader in its field, GSC can provide foreign governments with the assurance of quality, reliability and long-term commitment that they seek when they enter into international partnership agreements. The proposed project would not materialise if it was not led by a strong federal government institution.

(2) GSC has had a long and very successful history of collaboration with Brazil, specifically with CPRM. The two organisations enjoy an extremely cordial relationship that has developed over the years and strengthened considerably during the 1995-1999 CIDA-sponsored project on Sustainable Development of Brazil Mineral Resources. Several key members of the previous project team, including the Canadian and Brazilian project co-managers, will continue to serve under the proposed project. This will ensure a smooth start-up process for the new project.

(3) GSC is one of very few national institutions that have the range of technical expertise that will be needed to carry out the proposed project. Although most project activities will be carried out by other institutions, including the private sector, GSC has the specialists who will be needed to plan project activities, monitor progress and assess the results.

(4) GSC's credibility and excellent reputation as an achiever will make it possible to recruit the most proficient specialists in Canada to participate in the proposed project. This ensures that Brazil will receive the best technology available in Canada and increase the chances for a successful outcome to the project.

(5) GSC's credibility and excellent reputation in Brazil will facilitate and legitimise the process of transferring technology from Canadian institutions, including the Canadian private sector. Many Canadian firms look upon GSC's leadership in the project as invaluable support in their efforts to improve their visibility in Brazil.

The proposed project fits in the overall priorities of the GSC as the organisation seeks to augment its capacity in the area of groundwater research and management. To this end, GSC has recently staffed a Chief Hydrogeologist position and has been involved in several landmark hydrology projects, including the highly successful Oak Ridge Moraine project in southern Ontario which established new methods of evaluating groundwater resources. Some of the techniques and models developed at Oak Ridge may find applications in the proposed project in Brazil.

On the International scene, the proposed project is in full harmony with the objectives outlined in the International Business Strategy for the Earth Science Sector 1997-2001

document. The project will advance international scientific knowledge and promote international market access for Canada's technological industries, particularly small and medium-sized Canadian businesses. The project will also help disseminate Canadian social and environmental values.

Many other Canadian organisations, both private and public, will participate in the project. In a majority of cases, they will be selected to take part in individual project activities through a competitive process. A representative sample of the most likely candidates is contained in the accompanying volume entitled *Expressions of Interest from Canadian Firms and Public Institutions*. A short profile of each organisation along with a description of its capabilities in the area groundwater exploration and management, are presented in the document.

The majority of the organisations that have expressed interest in participating in the proposed project are eagerly seeking opportunities to work in Brazil. Most regard the CIDA project as the initial opening they need to become involved and there is little doubt that the majority will take every opportunity to continue to offer their skills to the drought relief effort in northeastern Brazil, independently of the CIDA project. We anticipate, in fact, that the project will become self-sustaining before CIDA's involvement ends in 2003.

BRAZILIAN INSTITUTIONAL PARTICIPATION

The Geological Survey of Brazil - CPRM will be the project's leading institution in Brazil. CPRM is a public enterprise operating under the Ministry of Mines and Energy of Brazil.

Profile of the organisation

Established on August 15th 1969, CPRM obtained by legal decree, all the attributes of a Geological Survey of Brazil and, consequently, has institutional and social mandates similar to those of other geological surveys worldwide. CPRM has a staff of about 1,700, of which about 600 are in the professional category, including 426 geophysicists and geologists, 33 mining engineers, 54 hydrological engineers, 22 chemists, and several electronic engineers, cartographers, administrators and upper level human resource personnel.. Many of its professionals have Masters degree and Doctorates obtained in Brazil as well as from reputed foreign universities, including some from Canadian universities.

The headquarters of the organisation are situated in Brasilia, Federal District, but its main office is in Rio de Janeiro. It also maintains eight regional offices strategically located in various parts of the country: Porto Alegre (RS); São Paulo (SP); Belo Horizonte (MG); Goiânia (GO); Salvador (BA); Recife (PE); Belém (PA) and Manaus (AM). In addition, there are several support offices that provide assistance to the regional offices, Fortaleza (CE), Teresina (PI); Porto Velho (RO), Itaituba (PA), being the most important.

The mission of CPRM is to guarantee the basic geological and hydrological information needed for the economic and social development of Brazil. As an organ of the federal government, it is involved in planning and coordinating public policies. Although it has no legal jurisdiction over mining or in managing mineral rights or properties, CPRM participates actively in the mineral sector by supplying the data needed by the government to set guidelines for the sustainable development of the mining industry, and by contributing geoscientific information over the entire Brazilian landmass, some 8.5 million square kilometres.

In fulfilling its mission, CPRM administers an annual budget equivalent to R$ l25 millions, with which it carries out and co-ordinates all the geological mapping in the country at regional, semi-regional and detailed scales. This mapping program, known as Programa de Levantamentos Geológicos Básicos is the organisation’s most important responsibility.

Whenever possible and appropriate, this program is elaborated in conjunction with state organisations, Brazilian universities and technology centres that specialise in earth sciences, always through accords in which the financial responsibilities of the parties involved are defined. It should be pointed out that the geologic mapping program carried

out by CPRM has to date covered at different scales over 5.2 million square kilometres, or 60% of Brazil's landmass, of which more than 1.3 million square kilometres correspond to regions of very difficult access and/or with complex geology, as is the case for the Northeast.

The organisation continues to enhance its capabilities in mineral research, including the study of the economic viability of mineral deposits. It has carried out more than 150 such studies to date on behalf of various government departments. Currently, the program focuses on gold deposits, non-ferrous metals, mineral substances used in agriculture, ornamental stones, and high-tech metals.

CPRM also carries out studies and projects in hydrogeology that focus on determining groundwater reserves and their chemical and physical characteristics, mostly in the driest parts of the country such as the Northeast. To this end, the organisation maintains a large group of hydrogeologists in the cities of Recife (PE) and Fortaleza (CE), some with more than 20 years of experience in the region and a good knowledge of what the problems are and what needs to be done with regards to improve the groundwater supply.

With regards to surface waters, the organisation is responsible for the installation, operation and maintenance of the pluviometric and hydrographic networks throughout the country, and to provide statistically treated data as required by the various government bodies. Currently, CPRM operates a national network of 2,000 hydrometric stations,
Under contract to the National Electrical Energy Agency- ANEEL, of the Ministry of Mines and Energy.

To support these programs the organisation has access to the Central Laboratory of Mineral Analyses which has all the modern facilities required for bacteriological analyses as well as quantitative and qualitative analyses of waters; soils, rocks and minerals. Its Cartography Centre offers services in aerophotogrammetry, airborne geophysics, and satellite imagery in support of the production of cartographic base maps. CPRM is also developing techniques of digital cartography, allowing the production of detailed thematic maps from 1:250.000 scale maps. This system is being used for the production of soil maps, hydrographic basin maps and environmental impact maps related mainly to mining.

CPRM has adopted a model of geologic research that focuses on providing benefits to society while guiding government planning towards rational exploitation of the country's natural resources and coherent land use, all under the banner of sustainable development.

The Data Processing Centre at CPRM has presently about 650,000 items of technical information stored in its computers, all of significant interest to the geoscientific community. Its Geological Information System known as SIGA, and the Natural Resource Information System, SIR, are used by CPRM as well as by other institutions as sources of data in a variety of geoscience and environmental projects. These systems are

entirely digital, allowing fast distribution and retrieval of information for domestic use and also internationally through the Internet.

On the international scene, CPRM is partner to several bilateral cooperation agreements with countries in the first world, mainly Canada, and other countries of Latin America, as well as several countries of Africa, Asia and Europe. These international exchanges have permitted CPRM to remain technologically up to date.

Project Management

On the Brazilian side, overall project management will be under the responsibility of the International Affairs Secretariat of CPRM, while Technical Management will be performed by the Water Resources Department, also part of CPRM. Both units are situated at CPRM's Central Office in Rio de Janeiro.

Implementation of the project will be carried out largely from CPRM's regional offices in Recife and Fortaleza, both of which have highly competent technical, managerial and administration staff. All of the facilities related to logistics, computer support and access to the Internet, will be made available for the project, which is considered by the Ministry of Mines and Energy as well as by CPRM as one of the most important.

The following CPRM staff members will have managerial and administrative responsibilities within the project :

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CPRM is the most appropriate institution in Brazil, in terms of personnel and logistical capabilities, to co-ordinate this project in cooperation with the Geological Survey of Canada. The principal reasons are as follows :

1. In May of 1995, CPRM and the Geological Survey of Canada (GSC) signed a Memorandum of Understanding (MOU) which gave considerable strength to the technical cooperation arrangements between the two organisations. During the last four years, CPRM has benefited from the assistance of world renowned Canadian specialists, particularly in the areas of gold geology, airborne geophysics, and analytical chemistry. CPRM geologists and chemists had many opportunities to undergo training at some of the best Canadian geoscience institutions. Canadian scientists also benefited from experience gained by working with CPRM staff in different regions of Brazil including some, such as the Amazon, where geological and environmental problems are unique. All these exchanges were made possible and were greatly facilitated by the existence of the MOU between GSC and CPRM. This agreement will continue to be in effect during the proposed project and will continue to serve our collaborative efforts.

2. Since its inauguration in 1969, CPRM has held important responsibilities towards the nation's water supply To accomplish its mandate, it maintains a strong department of hydrogeology which carries out relevant studies and surveys, many of them on behalf of other agencies. For example, it provides most of the hydrology and hydrogeology services required by Agência Nacional de Energia Elétrica do Brasil.

3. Much of CPRM's effort are directed towards groundwater problems in the driest parts of the country, including northeast Brazil. As a result, during the past 25 years, CPRM has accumulated a substantial amount of basic geological and hydrological information about Brazilian aquifers, including a survey of some 60,000 wells for which it maintains a comprehensive database. This information will be very important for the proposed project and CPRM is one of very few institutions in the country that can provide it.

4. CPRM has long been seeking opportunities to include projects in hydrology and hydrogeology in its collaboration with the Geological Survey of Canada. To this end, CPRM has enhanced its data gathering activities in northeast Brazil, over the past few years, hoping that such a joint project would materialise. Therefore, the proposed project fits perfectly into CPRM's current program objectives.

5. CPRM has all the facilities in its two regional offices in northeastern Brazil, Fortaleza and Recife, to be able to offer all the necessary logistical support to the project, including office space, personnel and equipment, support for field operations, and for holding seminars, workshops, etc.

The Northeastern Brazil Groundwater Project, to be carried out in collaboration with the Geological Survey of Canada, is of great interest to CPRM as it addresses an issue that has been for many years one of the major preoccupations of the Brazilian government. Canadian technologies to be introduced as part of the proposed project will supplement and enhance various methodologies that have already been developed in Brazil and, for the most part, will continue to be utilised. After they have been adapted to northeastern Brazil conditions, these improved technologies will be transferred to other regions of Brazil and/or exported to other countries in need, thus multiplying the benefits of the project.

An impressive number of government and non-government organisations have enthusiastically expressed their interest and willingness to participate in the project. Their fields of expertise cover the entire spectrum of relevant disciplines, including geoscience, engineering, social services, education, etc. Their statements and profiles are contained in the accompanying volume of Brazilian proposals. To ensure proper representation of the different areas in the decision process, CPRM and GSC have invited strong institutions to join the project as partners. These are :

SUDENE, or Superintendência do Desenvolvimento do Nordeste, was created in 1959 with the mandate to coordinate and carry out programs to strengthen the socio-economic base of the region. In its 40 years of existence, SUDENE has accomplished a great deal in the area of human resource development, public administration, and economic development. Through promotion and incentives, the region's economic development has kept pace, and even surpassed at times, the national economic growth rate. SUDENE also carries a heavy social agenda. In addition to being the principal agency responsible for drought relief throughout the Northeast, it manages several important programs for the benefit of the rural communities, in agriculture and irrigation, sanitation, energy, transport, etc. SUDENE's influence in the Northeast will makes it a very important partner in the proposed project. Further information on SUDENE and its activities can be found in Appendix C.

Comunidade Solidária, is a federal program aimed specifically at fighting poverty and social exclusion throughout the country. Efforts are directed towards the poorest segments of the population in an attempt to include them in the process of social and economic development. The program is heavily committed to the Northeast where poverty is rampant. Its agenda includes six main themes: (1) infant mortality; (2) food and nutrition; (3) education; (4) rural (family) agriculture; (5) sanitation and housing; (6) labour and family income. Comunidade Solidária accepted our invitation to join the proposed project with a great deal of interest and enthusiasm. They will provide critical input on the social aspects. More information on Comunidade Solidária is contained in Appendix C.

ABAS, the Brazilian Groundwater Association, provides a vital link between different groups that are concerned with groundwater issues, ranging from researchers and engineers, to the end users. Founded in 1978, ABAS has been very active in educating and in promoting important issues related to groundwater usage, conservation, protection, etc. Their role includes organising meetings and other public events, stimulate cooperation, disperse information through publication and publicity campaigns, and provide reliable information to the politicians and other decision makers. Through its contacts and publicity instruments, ABAS will play an important role in the proposed project by establishing and maintaining linkages between the Canadians and Brazilians, and by helping disperse the results of the project to where they can be most useful. An information sheet on ABAS is included in Appendix C.