WE ARE ALL DOWNSTREAM:

TEACHING MIDDLE YEARS SCIENCE FROM A SUSTAINABILITY PERSPECTIVE

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Abstract

The 21st century has emerged with Canadians experiencing great concern about how we do things in the world. The degrading environment preys greatly on the minds of Canadians while our actions may not match our thoughts. How do we educate our students as future leaders about sustainability and help them understand that our individual actions make a difference? How do we teach our students about these highly complex issues that we are inundated through the media?

The intent of this study was to make a difference in students' and teachers' lives. First it needed to be determined if teachers felt that there was a gap in the current way that we are teaching about sustainability. The results of a teacher survey and a literature review identified several different risk and protective factors: those that either constrain or support the teaching of sustainability in a science classroom. The three risks that were discovered to be the strongest were preparation time, availability of resources and that sustainability issues are often highly complex. These concerns became the foundation for informing the implementation phase of this study.

This study took the information shared by Manitoba teachers regarding sustainability and a resource was designed to meet the needs of these teachers. This resource met all of the specific learning outcomes (SLOs) as mandated by Manitoba Education, Citizenship and Youth (MECY) for the grade 8 Water Systems cluster. The resource was piloted with 5 classes, which were compared to 5 control classes in the same schools. This study looked at improving both teaching and learning by increasing *Affinity for Science, Affinity for Sustainability, Knowledge of Water Systems* and *Actions Related to Sustainability*. The results suggest that when sustainability is framed in lessons

using Bronfenbrenner's Bioecological theory (1979) (looking at the systems in which both teaching learning are embedded) and utilizing The Natural Step's (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002) Four Systems Conditions, and is kinaesthetic in nature, there are significant differences in outcomes. There was a significant difference between the pilot groups and the control groups in three of the four areas, with little difference found in Knowledge of Water Systems.

Teachers reported enjoying using the resource, and finding it helpful. They also reported that their students were engaged by the use of the resource. The thesis summation suggests how the resource might be shared and improved upon with and by teachers around the province and beyond, and hope that it provides a framework for future lessons or units related to sustainability.

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Dedication

I would like to give thanks for the support I have received from my family throughout the years, but especially over the past three. I want to acknowledge my children Rowan and Aric, for whom I am trying to make this world a better place. I would like to thank my parents, Brenda and Alan, for without the unconditional support and uncountable babysitting hours, this work would not have been possible. To my in-laws, Carolynn and Alphonse who are also educators, thank you for the countless hours of quality time you spent with my children to give me quality time working on this project. To my husband Tony, thank you.

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Finally, a very special thank you to Dr. Gordon Robinson; a person who has dedicated his life to education and had no idea what he was getting himself into when signing on as my advisor. His efficiency and care were incredible.

Water is the lifeblood of not only our body but also our Earth. We as a species will not survive if we continue to use and mistreat water as we have been doing. It is not a renewable resource due to the degree to which we have been abusing it.

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Chapter 1: Introduction

1.1 Introduction

> ESD [Education for Sustainable Development] is a lifelong process from early childhood to higher and adult education and goes beyond formal education. As values, lifestyles and attitudes are established from an early age, the role of education is of particular importance for children. Since learning takes place as we take on different roles in our lives, ESD has to be considered as a "life-wide" process. It should permeate learning programmes at all levels, including vocational education, training for educators, and continuing education for professionals and decision makers (United Nations Economical Commission for Europe, 2005, p.5).

What is sustainability? Only 17% of the general Canadian public even knows what the term sustainability means . However, when explained, 82% of the Canadian public rate sustainability as the top or as a high priority national goal (McAllister Opinion Research, 2006), and only 32 percent say that most of the people they know personally do not care about environmental issues. Why then, are we as a nation not moving forward towards sustainability? I believe it is because education fails to provide even the basics required to be active or even concerned citizens.

In 1987, a report titled Our Common Future determined that “Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future” (United Nations Conference on Environment and Development, 1987, ¶ 49). For purposes that I will discuss in the literature review, I will use sustainability and sustainable development interchangeably.

Through this research, it is my intention to provide science-based information to teachers and students about issues surrounding sustainability that fit within the existing curriculum and to give them the power to realize that one can truly make a difference. This is what is called Education for Sustainability (EfS) or Education for Sustainable

Development (ESD). I want students to be able to have the ability to make a difference in their lives for the environment, other human beings, and economic systems now and in the future.

The research reported in this thesis looks at the risk and protective factors influencing the teaching and learning of sustainability issues in the Manitoba curriculum. The overall aim of this study is to develop a resource that uses The Natural Step (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002) as an ideological framework for the development of the resource and addresses all of the Specific Learning Outcomes required for the Manitoba Grade 8 Water Systems cluster within the Manitoba curriculum.

1.2 Research Questions and Intentions

Throughout this thesis I will show how using a resource that focuses on global sustainability as identified in The Natural Step will assist teachers in educating and developing critical thinkers, and promoting students to act on what they believe in. To this end, my thesis has two research questions.

> A) What are the risk and protective factors teachers identify as constraints and contributors to the implementation of a science-based sustainability curriculum while working in a system defined by the interaction of the world at large with student engagement in the sciences?
>
> B) What are the consequences in terms of student knowledge, orientation and action within science and sustainability of being participants in a science-based sustainability education curriculum that is structured on the foundations of The Natural Step?

The practical outcome of this study is to create a science-based sustainability resource that will not only promote an affinity for science (as one pathway to essential sustainability) but will also increase students' understanding of complex sustainability

issues. As well, the resource, when taught, will contribute to students' ability to make personal changes for a more sustainable future.

1.3 Background of CRYSTAL

This project is one of many research and development projects that fall under the umbrella of the Centre for Research, Youth Science Teaching and Learning (CRYSTAL). The entire NSERC (Natural Sciences and Engineering Research Council of Canada)-funded Manitoba CRYSTAL research program is built around an "ecological" systems approach, which seeks to increase the engagement and success of young people in the sciences. It does so by identifying positive and negative factors that reside within four interactive "systems", while reinforcing the former and mitigating the latter.

System A focuses on the Individual Learner. The research question asked here is "How do attributes of the learner combine to impede, contribute to, and sustain personal science and mathematics success?" (Robinson & McMillan, 2005, p. 66).

System B highlights the individual learner as part of a classroom and school community. The main research focus here is "How do attributes of the classroom and school community combine to impede, contribute to, and sustain science and mathematics success?" (Robinson & McMillan, 2005, p. 70).

System C looks at an individual learner as part of a local community. The associated research that partners with this system is "How do the attributes of the local community contribute to the development and success in science and mathematics for students?" (Robinson & McMillan, 2005, p. 74).

This project, as a part of System D identifies how the individual learner acts as part of the global community, and the research focus for this particular CRYSTAL is**:**

> How does the recognition by students that they are part and not separate from the global system contribute to their success in science and mathematics? How does the application of the guiding principles of The Natural Step assist students in recognizing that they can, by the rational use of science contribute to the inevitable movement towards sustainability? (Robinson & McMillan, 2005, p. 78).

This project attempts to address the perceived failure of students to recognize that they are part of the global system that is declining around them. If a relationship between students and science can be firmly established through the global system, young people may likely see that scientific endeavour can be rationally focused on moving the structures, organizations, communities, and activities towards sustainability, and that this can be done proactively rather than by inevitable default. This is important to develop as students must see a direct link to the value of science and what they are learning in their classrooms. The goal is to introduce educators to specific science, technology, society, and environment connections, as mandated by the Manitoba curriculum, to global sustainability science using the Robèrt's (2002) approach - The Natural Step. The Natural Step is a non-governmental organization that acts in an advisory capacity and trains businesses and communities on sustainability principles. It is a sustainability problem-solving approach that incorporates the first order principles of natural systems (Senge, 1990) to help businesses and communities learn how to create a more sustainable world and take part in that endeavour as they transition from school to post-secondary education or work. It has not been used within an educational context as researched in the literature. The use of The Natural Step, as a foundation for curriculum development, is consistent with a science, technology and society education curriculum orientation which is associated with value-based learning, leading to the development of necessary, democratic decision-making and informed action-taking capability.

1.4 Rationale for the Study

This research was determined initially by participation in the CRYSTAL project. As my interests lie in educational aspects surrounding sustainability, it was only "a natural step" that I would be a part of System D. The development of the resource was initiated by the comments received from a teacher survey distributed during Phase 1 of this project. This earlier aspect of the study indicated that it is important to Manitoba teachers to develop a resource that matched the current Manitoba curriculum while giving them the opportunity to teach sustainability from a scientific perspective. The current Manitoba Science curriculum is compartmentalized with only some attention given to sustainability. It is understandable that as the knowledge requirements of the school science curricula become more complex, the curriculum becomes discipline-based, mitigating against the necessary interdisciplinarity required for educating about sustainability. Although there are some learning outcomes within certain grade level curricula that focus on sustainability issues, research suggests teachers have had little training or education in this area and often feel unsure about teaching potentially controversial issues such as climate change or biotechnology.

The first stage in initiating sustainability education is to identify how a current curriculum might be used as a platform for a global sustainability focus. This is possible with several units in the Manitoba curriculum such as Weather (Grade 5), Diversity of Living Things (Grade 6), or Interactions in Ecosystems (Grade 7) but I proposed the development of a resource for the Grade 8 Science Water Systems cluster. Each grade of science contains an Earth Science cluster which facilitates teaching about sustainability. I chose to focus on the Water Systems Cluster because Manitoba is rightly concerned

about the condition of its rivers and lakes. Development of this resource is therefore very timely and it is my hope that it will assist grade 8 teachers to focus on this issue.

This Water Systems resource will be developed with three goals in mind. First, the resource will provide students the opportunity to increase their knowledge and understanding of both science and sustainability. Secondly, it will present science in a manner that is student friendly and will optimistically increase their affinity for science and issues surrounding sustainability. Finally, it will focus on developing students' critical thinking and foster their understanding of how their actions impact on the Earth, which will encourage empowerment by providing avenues for them to take action towards a sustainable future.

In the end, the objective is to develop students with an interest in science because it is important for their future (employment, access to advanced education and generally enhanced citizenry), but also – the future of their planet. With current curriculum changes occurring in the near future, the proposed development of a sustainability resource would permit timely incorporation of The Natural Sciences and Engineering Research Council's (NSERC) work into the Manitoba Education, Citizenship and Youth (MECY) curriculum documents (tools for sustainability) and into planned workshops associated with the implementation of new/revised curriculum. NSERC has made the CRYSTAL program a focus of support and funding due to the fact that they believe that increasing the success and engagement of young people in the sciences needs to be a major focus in the schools thereby reversing a trend recognized in many countries. Along with this support, MECY has recently created the position of Sustainable Development

Consultant in the School Programs Branch. This demonstrates that MECY is taking the issues surrounding ESD seriously.

Measures of success of the application of the Water Systems resource will be quantitative (e.g. altered trajectories of students' affinity towards science and sustainability, knowledge of the Water Systems Cluster, actions relating to sustainability) and qualitative (e.g. student comments to reveal the impact of curriculum material on the utility of science in a sustainability context).

1.5 Significance of the Thesis

Concerns about sustainability education are being faced around the world. Although this is undoubtedly a global issue it can effectively be tackled locally in the absence of global summits and years of lobbied political rhetoric. It is envisioned that this resource can be used by teachers who are looking for assistance in the delivery of complex sustainability issues. If the resource developed in this study proves to influence students positively then it may pave the way for further development of new resources that focus on other sustainability issues. I perceive that a major hindrance to the development and delivery of such resources is the perception in the educational community that the "complexity" involved is overwhelming. A strength in the resource described in this thesis is that much of that "complexity" can be readily stripped away by adherence to simply understood systems conditions.

Chapter 2: Literature Review

2.1 Introduction

As this thesis focuses on the development, implementation, and evaluation of a science-based sustainability education resource, this chapter will begin with a description of Education for Sustainability (EfS). I will provide a brief history of EfS within the international and local context. I will then examine the two foundations that will be used to develop the science-based Sustainability Resource. First, Bronfenbrenner's (1979) Bioecological Theory of the Ecology of Human Development and followed by Robèrt's, The Natural Step (2002) theoretical framework.

I will then describe a resource that can be used to demonstrate to students that they are individual parts of a global solution, and that science may be an important component of that solution. By using The Natural Step as a framework for the Manitoba Curriculum for Grade 8 Water Systems cluster (Manitoba Education and Training, 2000), students will hopefully see the value of staying involved in science as an important part of their future lives, work and possibly further education. By using Bronfenbrenner's Bioecological (1979) model as a foundation for developing the resource it is likely that the protective factors (factors that can support) can be maximized to foster the effective implementation of this resource. Including research on brain-based learning and information on assessment, as well as designing a lesson plan that is teacher-friendly will also occur in the section related to the Water Systems resource development. Finally, by reviewing other resources, I will be able to identify their strengths and weaknesses from an EfS perspective and find some lessons which I will adapt to include in the Water Systems resource being developed.

2.2 Education for Sustainability

Over the past two decades there has been a change in perspective from strict "environmentalism" to the more applied concept of EfS and Sustainable Development.

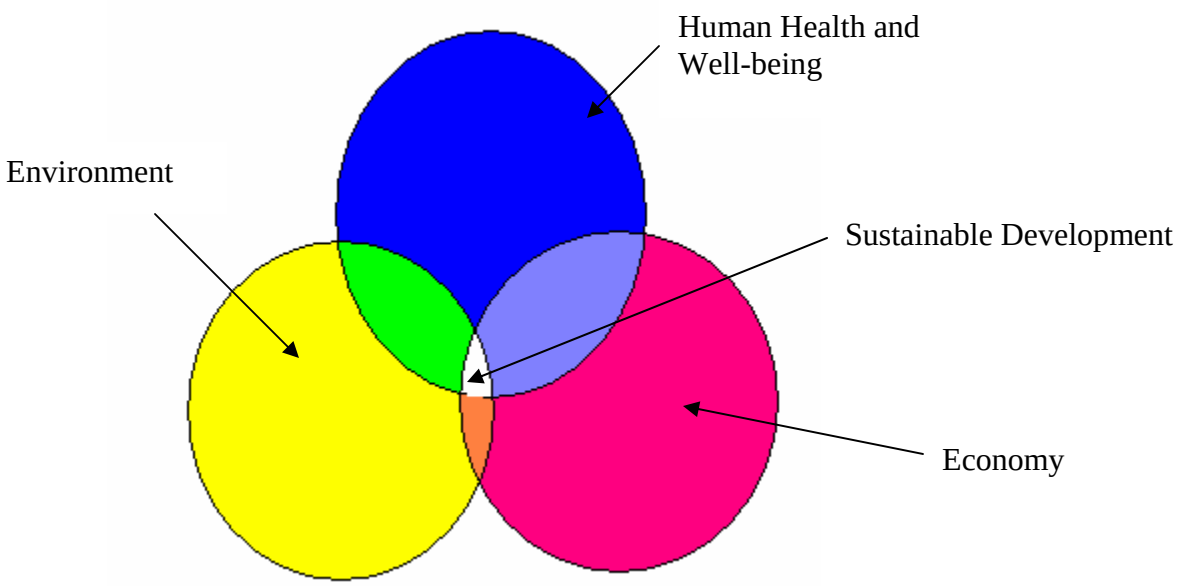

Figure 2.1. A diagrammatic view of a commonly used version of the three aspects that influence sustainability.

This shift has occurred, as has been suggested by Tilbury and Cooke (2005). Environmentalism is predominantly *a movement against something*, e.g., stopping pollution and other activities that are damaging to the environment. Sustainable Development, on the other hand, takes a more proactive approach towards positive outcomes, which although consistent with environmental protection and restoration, aims to do things differently; instead of just stopping and cleaning up a riverbank, for example, it is more focused on addressing the underlying problems (Tilbury & Cooke, 2005). This is a pathway towards overall sustainability. Sustainability involves more than

understanding how health and well-being, the environment, and economic systems are connected as illustrated in Figure 2.1. There are some concerns about the oxymoronic tone of the phrase “sustainable development”. It would be very difficult to actually have development (in a traditional North American sense i.e. continuous growth) that is truly sustainable, so I prefer to use the term sustainability, although both terms are often interchangeable. It is known that sustainability focuses more upon the quality of one’s life than that of development (Tilbury & Cooke, 2005). The quality of life can be determined by the interaction of the three areas mentioned above, health, economics, and environment, but again, a quality of life is very subjective and depends on the individual and the lifestyle one is accustomed to.

Sustainability is about change: making wiser decisions prior to action, and adapting current practices that can be modified, to fit a holistic ecologically benign framework. We must change our mental models, policies, and how we act. It is about creating a vision, implementing actions, and constantly reviewing and improving (Tilbury & Cooke, 2005). EfS “focuses on preparing individuals to live sustainably on the planet and refers to a process for thinking, teaching and learning principles for sustainability that include knowledge, values and attitudes” (McDonald, 2006, p. 1010). This perspective of sustainability is better represented in Figure 2.2. Economy is embedded in human equity, which in turn is embedded in the ecology of the planet. Without constituent ecosystems and their natural capital, there could be no human activity. Furthermore, economic systems are no more than subsystems of natural systems. The disrupting of ecosystem services has wide-reaching affects upon other living beings that co-exist on this planet; humans are only one small part of Earth’s community.

Error!



Figure 2.2. Factors influencing sustainability. (Dunbar in Timpson et al, 2006) Used by permission.

2.3 History of International Education for Sustainability

The idea of Education for Sustainability has existed in various forms for over fifty years. In the 1940s, “Environmental Studies” was the term for teaching local geography, history and nature study in an integrated curriculum (Palmer, 1998). As the importance of the environment in education increased, Environmental Studies became known as “Environmental Education” in the United Kingdom in 1965 (Palmer, 1998).

Environmental Education was also the phrasing adopted for *Our Common Future,* a report of the United Nations Commission on Environment and Development (1987).

This report, also known as the *Brundtland Report,* provided the world with the commonly used definition of sustainable development, focusing on humankind attaining what it now needs, but not impacting the ability of people in the future to acquire what they need. In June of 1992 *Agenda 21* was developed in Rio de Janeiro at an Earth Summit. This agenda was designed as a comprehensive plan of action to be undertaken by the United Nations and implemented by every nation in the twenty-first century. This agenda called for all governments to increase the accessibility to sustainable development education. This was further endorsed by the Johannesburg Summit in 2002 which was followed by the United Nations declaration for the Decade of Education for Sustainable Development to be from 2005 – 2014.

2.4 National and Local Education for Sustainable Development

Canada appears to have responded positively to *Agenda 21*. In 2002 the federal government created *A Framework for Environmental Learning and Sustainability in Canada* (Environment Canada, 2002). In 2000 Manitoba Education, Citizenship, and Youth published *Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators* (Manitoba Education and Training, 2000). Creating a document for the school system specifically about sustainability may well have been a move in the right direction by promoting EfS.

Despite this positive effort, a variety of factors are likely to be preventing the full actualization of sustainability education in Manitoba schools. For example, because there is no separate sustainability course within the Manitoba curriculum, sustainability is not

taught to the depth it should due to many opposing factors. Although there are many curriculum links found in current Manitoba curricula to sustainability, there are only a few explicit links including the term “sustainability”. As well, it is possible that the political orientation of the times may impact the degree of sustainability in Manitoba as it influences the purpose of education; it really depends on the current ruling government. *The Manitoba Sustainability Report* (Province of Manitoba, 2005), the first report required under *The Sustainable Development Act* lists various concepts and issues under one of three foci of sustainable development: economy, environment and human health and well being. The Province of Manitoba has placed education under the heading of economy. I see it as a more natural fit under the heading of human health and well being, recognizing that to some this may well be viewed as excessively anthropocentric, and not sufficiently inclusive of the intrinsic value of non-human entities without which ecological integrity could not be sustained.

For the Government of Manitoba, there is the possible perception that the goal of education is mainly an issue of economics. It is to Manitoba’s economic benefit to graduate more students from high school and centres of higher learning in order to secure our future. I believe that education is easily integrated under all three headings of economic development, human health and well-being, and the environment but feel that human health and well being is the priority.

Teachers’ knowledge of sustainability may also be a concern. Without basic knowledge of sustainability, the 13, 000 teachers of Manitoba are unlikely to teach what they do not know. It is difficult and unlikely that that these teachers will be able to promote or address sustainability. Manitoba Education, Citizenship and Youth is making

good headway in educating teachers about sustainability by supporting educators with funding and more recently, workshops (McDonald, 2006). This process will take time but with additional resources more teachers can be reached faster. The creation of an ESD Consultant for the school year 2007-2008 is an excellent move, but will this position be maintained?

2.5 The Ecology of Human Development and Ecological Systems Theory

Although there is specific reference to EfS within the Manitoba curriculum, there seems to be a variety of factors that are likely to be influencing the implementation of EfS within Manitoba schools. If a curriculum resource is to be developed, implemented, and have impact on students, an awareness of the factors influencing implementation is necessary. In this work, Bronfenbrenner's (1979) Bioecological model of human development is used as a framework for identifying and organizing these factors.

Three decades ago Bronfenbrenner (1979) developed his "Ecological Systems Theory" (also known as Bioecological model) in which he explained that behaviour and development are a combined function of the many interacting systems that are occurring around and within the child. He focused particularly on developmental changes triggered by life events, which may have originated in the external environment or within the child. Essentially, whatever triggers the event alters the existing relationship between the person and the environment thus creating a condition that may activate developmental change (Bronfenbrenner, 2005). The environment and the child are always interacting and changing and as teachers, we must understand that we are only one of these interacting systems (Figure 2.3). Clearly, Bronfenbrenner's (1979) Bioecological theory of development states that human development is a product of the dynamic interactions of

the person and all levels of his/her environment. For the purpose of this study in respect to the delivery of the EfS resource, the person of concern is the teacher responsible for teaching to the requirements of the Manitoba curriculum. In other words, why are teachers not teaching EfS?

Bronfenbrenner would suggest that both teacher and teacher-environment factors are impacting the teacher's practice. "Teacher personal attributes or intrinsic factors such as teaching interest and motivation are critical dimensions and often cited barriers in the delivery of science programs" (Lewthwaite, 2004, p. 137). If these factors affect the delivery of traditional science programs, it is likely that these will be barriers to EfS as well. Lewthwaite, Stableford and Fisher (2001) state that other teacher personal attribute factors such as professional science knowledge (including curriculum, science content and science pedagogical knowledge) affect science delivery. Teachers need to understand the basis of EfS, and how to incorporate it into a science classroom setting ensuring that they are achieving the curriculum learning outcomes. The environmental factors influencing science delivery are quite complex (Lewthwaite, 2004). However, Bronfenbrenner's Bioecological model provides a systematic framework for organizing and understanding these factors. According to Bronfenbrenner (1979), the environment encompasses the physical, social, and cultural features of the immediate settings in which human beings live (e.g., family, school, and neighbourhood). Bronfenbrenner (1979) describes the ecological environment as five interactive systems, each nested within another. The first system represents the teacher. The remaining four systems range from the immediate face-to-face setting to the more remote setting of the larger culture (Hoffman, Paris & Hall, 1994). The "microsystem" consists of a teacher's students,

supports, and resources. Examples of supports for the teacher are colleagues, friends and family. Within this system, teachers relate directly to others (Bronfenbrenner, 2005). If teachers have a quality resource that supports them in their teaching of EfS, they will be more likely to teach in that manner. It is also likely that if students are very responsive to the implementation of EfS, teachers are more likely to continue to make reference to it in their teaching.

Within the next system, the "mesosystem", the school essentially dictates the culture. If EfS is a priority for the school, then the teacher will have greater support from the administration to teach with a sustainability focus. The school's belief systems and values will strongly influence the expectations endorsed at the school level and without a clear vision, the school will not be able to promote sustainability to the extent it should (Tilbury & Cooke, 2005).

The "exosystem" is the third system and refers to external influences that do not directly involve the teacher but influence the teacher's environment in an indirect manner. For example, support for EfS from the school division or community can directly influence divisional policy. Finally, the structure farthest from the teacher, the "macrosystem", refers to societal and cultural ideologies and laws that affect upon the individual. Manitoba's policies, curriculum, governmental agendas and teacher education protocols both at the university and professional learning levels represent the macrosystem, and are likely to influence the school's response to EfS as a *bona fide* curriculum area.

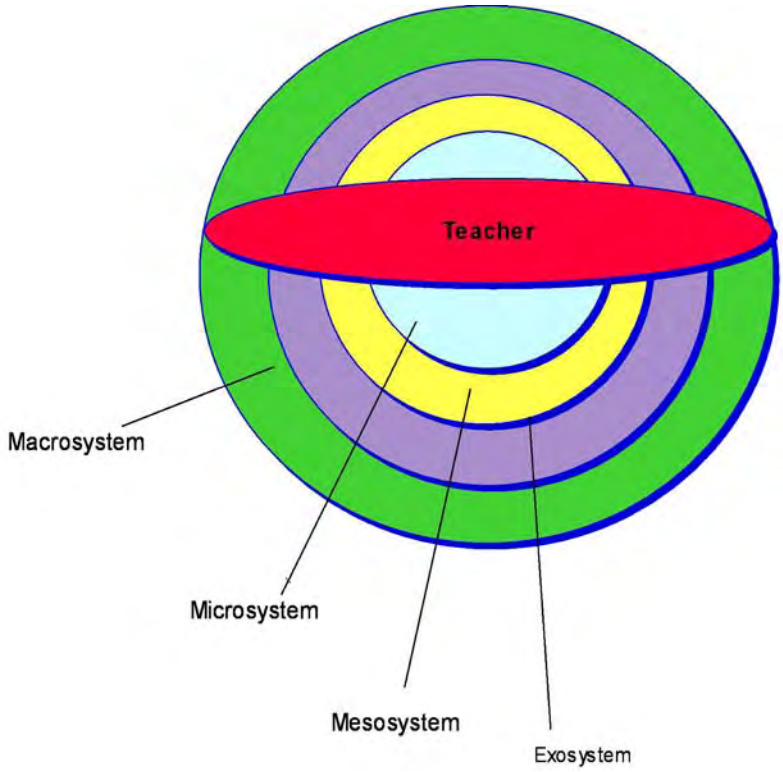

Figure 2.3. The interacting systems and how they interact with the teacher.

Bronfenbrenner is implying that if the systems are working together in a supportive manner, "development" is likely to occur. Within the context of this study, I would hope that if all systems were working together to support teachers in teaching EfS, this would be evidence that development within the students and the teachers is occurring.

The macrosystem refers to the consistency observed within a given culture or subculture in the form and content of its constituent micro-, meso-, and exosystems, as well as any belief systems of ideology underlying such consistencies. Thus, cultures and subcultures can be expected to be different from each other but relatively homogeneous internally in the following respects:

- the types of settings they contain,

- the kinds of settings that persons enter at successive stages of their lives,
- the content and organization of activities, roles, and relations found within each type of setting and,
- the extent and nature of connections existing between settings entered into or affecting the life of the developing person (Bronfenbrenner, 1979).

Educators must be aware that many systems affect the teachers when it comes to curriculum delivery. These systems are at individual, school, and local levels. By understanding these processes, it is easier to develop and assist teachers in successfully implementing resources.

2.6 The Role of Risk and Protective Factors and Resiliency

It is unlikely that for any teacher the systems noted above would all work supportively in delivering an EfS program. Although a teacher may be highly interested, confident and motivated, his administration may not see the value in promoting EfS in the classroom. Similarly, external examinations provided by some school divisions are usually strictly based on knowledge, rather than the context within which that knowledge is imparted in the particular year that may be relevant to the current situation (such as the flood of 1997), thereby giving little attention to students who have embraced EfS. Thus, the students may not get the deserved recognition for a change in values or behaviours. It is clear that some teachers may overcome or succumb to the risk factors working against them; specifically some will succeed while others will not be able to promote sustainability in their classrooms. This is consistent with research in other areas in development. For example, Rutter's (1987) research in resiliency adds to the understanding of how the bio-ecological systems can have an influence on an individual's

development. He proposes that both risk and protective factors contribute to a person's development and therefore resiliency (Rutter, 1987). According to Rutter, risk factors are individualized factors in a person's environment. Examples of risk factors for a science teacher could be basic science or sustainability knowledge, or interest in the subject area.

Rutter (1987) suggests that protective factors are the working processes within an individual (e.g. motivation to gather further knowledge in a subject area). In a teacher's environment, positive factors can be supportive administration or interested parents that become a part of positive outcomes in a teacher's personal development. Risk and protective factors are seen to be dependant on the individual, the context and the time. Personal development is more likely to occur when risk factors are minimized and protective factors are maximized. Unfortunately, maximizing protective factors does not necessarily promote positive development for everyone.

There are many risk and protective factors that can either impede or support the implementation of education about sustainability. In the section that follows I will examine these factors and identify which level of Bronfenbrenner's model they would reside in.

2.5.1 Risk Factors influencing Education for Sustainability.

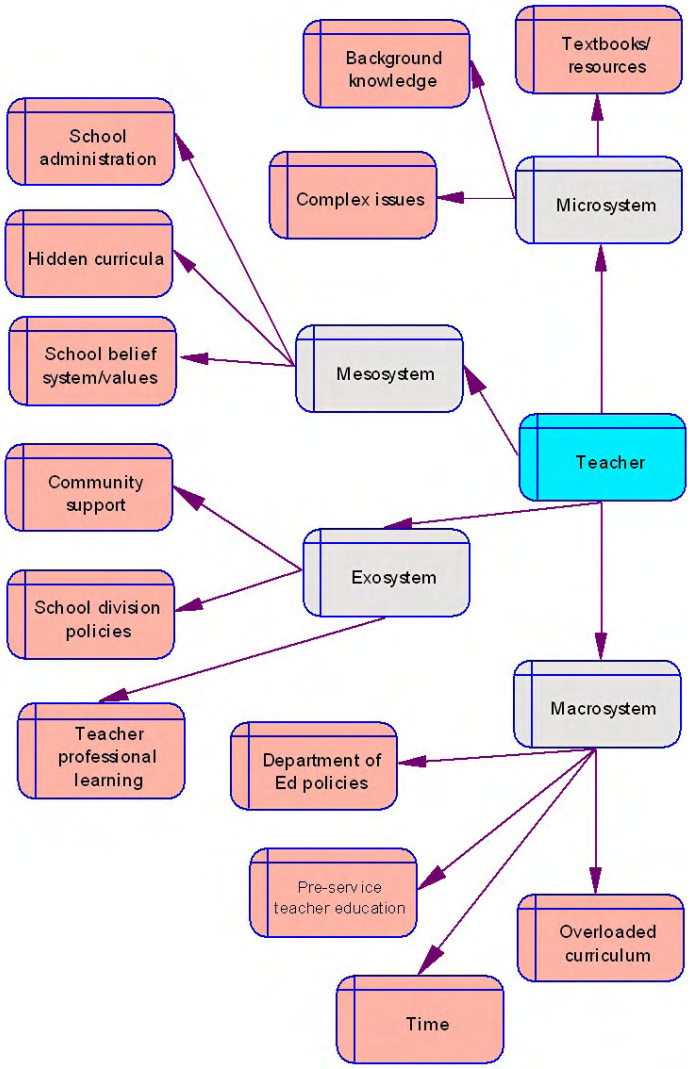

Figure 2.4. Flow chart examples of risk factors found within the four systems.

Although some personal attribute and environmental factors have been examined in the previous section, they have mostly been generic. In the context of this work it is appropriate to ask what factors might be specifically influencing EfS? Beginning at the microsystem, the level closest to the teacher, a factor that might hinder a teacher's ability to promote or deliver sustainability education is that many sustainability related topics are so highly complex (Gayford, 2002; Gayford, 2004; Groves & Pugh, 2002; Hart, 2003;

Stapp et al., 1996b; Summers et al., 2003; Summers et al., 2005). This is a situation that may appear to be worsened by what appears to be a constantly and rapidly changing information base. This may be to a point where it is perceived to be difficult for a teacher to be up-to-date on the most recent information when we are just beginning to learn about such issues as climate change and some of the human rights atrocities occurring across the globe. Another aspect of sustainability issues that fit with the complexity of these issues is that many issues related to EfS are controversial even among the experts (Gayford, 2002; Gayford, 2004; Groves & Pugh, 2002; Hart, 2003; Stapp et al., 1996b; Summers et al., 2003; Summers et al., 2005), such as issues surrounding climate change and use of fossil fuels. It is hard to know the latest facts and how to distribute information in an appropriate manner when experts cannot even agree. It can, however, be argued that the complexity behind any individual component of a sustainability issue does not hide root causes and consequences.

Another risk factor is the potential for lack of resources (Elshof, 2005; Summers et al., 2005) may contribute to teachers not having a strong grasp on some of the more complex, controversial and ever changing information available. If teachers could find resources that were trustworthy and demonstrated how to link sustainability into existing curricula, that might help them integrate these issues more easily.

When there is a lack of resources for teachers, they turn to the one resource that is often available, the textbook. It appears that for many years the opinion on the use of text books creates a division of opinion on what the students are learning versus memorizing with the latter being viewed as mitigating against independent thought (Tyler, 1949). Current textbook driven science tends to present scientific concepts as an abstract set of

disconnected decontextualized facts: scientific laboratories are often sterile places where students carry out formulaic experiments. Seeing no connection between classroom learning and their daily lives, many students lack motivation and, as a result, are not prepared to be scientifically literate citizens (Simmons, 2001).

Another risk factor within the microsystem is that with different teachers teaching separate subject areas there becomes a problem with collaborative cross-curricular teaching due to time constraints and practicalities (Cortese, 1999; Farrell & Papagiannis 2002; Stapp et al., 1996a; Summers et al., 2005). It has been shown that when sustainability is spread out over the disciplines it loses its impact (Hart, 2003; Puk, 2003; Summers et al., 2003), which is equally disturbing. When attempting to split up sustainability across the curriculum it is easily forgotten in favour of what will be on the standardized exam. It is an unrealistic expectation of students to expect the essential connectedness of EfS to descend *de novo* on the reductionist paradigm.

A final example of a microsystem factor potentially influencing teachers is student background knowledge and interest in EfS. There is a lack of student awareness and/or knowledge of sustainability issues, according to the War Child Opinion Poll (2006). This lack of awareness may affect their concern about these issues. Although most Canadian youth express deep concern about the specific global issues surveyed, sizeable minorities of between four and five out of ten students are less passionate about these issues. This particular survey also finds that there is a direct positive correlation between the degree to which youth follow global issues and their concern about those issues (War Child Opinion Poll, 2006). This study also found that most Canadian youth is learning about world issues in school. However this largely appears to be related to

traditional topics such as wars and other conflicts that are taught in the context of any history class. It appears that less attention is being devoted to more contemporary world issues such as global inequities, human rights, the HIV/AIDS pandemic, terrorism and environmental sustainability (War Child Opinion Poll, 2006).

Also, many issues are extremely interdisciplinary and especially so when looking at a controversial issue from a complete sustainability outlook. It appears that interdisciplinarity, an essential prerequisite for EfS, poses a problem for the traditional school set-up, particularly in senior years. An example would be learning about mining. Discussing the actual manner in which materials are taken from the Earth would fall under scientific domain, but the impact upon the local people would fall under the social sciences, and the economic costs to the local people and the people purchasing the products created from the materials mined again fall into another category. Furthermore, the manner in which science is currently taught may create a disconnection between students and the environment. Sitting in a classroom learning about a gold mine that may be thousands of miles away may well not create a bond between children and the environment. It is hard to care for something you are not geographically able to connect to (Bowers, 1993; Chapman, 2004; Smith, 1992; Suzuki, 1997). It is recognised that many may argue that all on earth are connected, but it is indeed difficult for young students to care about a distant event or place when they are not intimately connected to it. This appears to call for a shift towards a different approach to science education, which includes promoting scientific literacy and engaging students in scientific inquiry.

> From a practical perspective, this shift is driven by a sense of growing disparity between the science education provided in schools and the needs and interest of the children who will be our future citizens… school science tends to be a

> preparatory education either for those who will become future scientists or for those attempting to pass standardized tests. (Barab & Luehmann, 2003, p. 454)

The objective of education is to promote critical thinking and ability to resolve issues, but our current education system seems to be promoting and even reinforcing the unsustainable progress that has been leading to the current crisis of students' lack of interest and understanding of science (Farrell & Papagiannis, 2002). We need to help our children understand the issues in order for them to make a difference. It is understood that high-level education is supposed to promote sustainability but it often gives the appearance of an unsustainable society in the current way it is set up through curriculum and methods of delivery of that curriculum. If we can use education as a tool for change we must first look at changing education to promote this forward thinking (Huckle & Sterling, 1996).

The exosystem is influenced by the opportunities that teachers have to upgrade their skills related to teaching sustainability. In one survey of teachers, there were no respondents that reported that they had received any professional development that was interdisciplinary and connected to ESD, and that none of the schools that the teachers belonged to had a policy statement regarding ESD (Summers et al., 2005). If there are no professional learning opportunities for teachers and if the school and division do not support the idea of ESD in the schools then it is difficult for the teacher to pursue this as serious subject matter.

Expanding outward to the mesosystem, individual school policy and administration support can play a colossal role in the teacher's ability to promote EfS. The tone of the school is set by the administration and students are very aware of the message being sent. It is not only what the schools are teaching, but also what is not

being taught. Students are well aware of other forms of implicit education occurring within the school walls. ”Hidden curricula” of schools convey the values that are really important to the school, even when they contradict the lessons of the classroom. For instance, a soda machine in the hallway can speak louder than any number of lectures about nutrition and the absence of recycling bins contradict the values of a school that wants to reduce their waste footprint. Schools are systems and they are communities. Schools are themselves important nodes in the web of institutions that constitutes society. Whatever happens in schools will have profound effects on the rest of society (Centre for Ecological Literacy, 2006).

At the macrosystem level in many jurisdictions in Manitoba, school and divisional policy may work against the development of programs that support EfS. Often standardized tests and how schools rank against each other giving little attention to the core mandate of EfS - striving towards improving our quality of life while not putting our ecosystems at risk (Tilbury & Cooke, 2005). These global competitions view education as a service of the globalized economy (Sterling in Tilbury & Cooke, 2005; Suzuki, 1998). This is not recent news.

The risk factors do not stop with school policy, textbooks and hidden curricula. There are many concerns within the science community about the decreasing proportion of students pursuing careers in science and technology (Organisation for Economic Co-operation and Development Global Science Forum, 2006). In high schools and many middle schools, science is taught strictly from discipline-based curriculum due to the complexity of the issues covered but perhaps also because of the still-present adherence to the reductionist model to which science has conformed, and which mitigates against

interdisciplinary thought and endeavour. It might make sense to teach specific skills but scientific endeavours, especially as they relate to sustainability, do not occur in a vacuum. It is very hard to teach about sustainability without bringing in all sciences as well as other core curricula such as English, mathematics or the social sciences. It is difficult to teach themes or core ideas when the prevailing reductionist method to understanding which focuses on individual subject areas and non-representational knowledge prevails (Summers et al., 2003; Sterling in Tilbury & Cooke, 2005).

Another risk factor is the already overloaded curriculum (Gayford, 2002), which is considered part of the macrosystem. It is likely that many teachers, for a variety of personal attribute and environmental reasons may leave out the outcomes specifically related to EfS. Many middle years teachers are not science specialists and yet are thrown into teaching science. Many expect science teachers to teach about the environment and other issues such as water quality (Bowers, 2003; Gayford, 2002; Groves & Pugh, 2002; Stapp et al., 1996a; Summers et al., 2003) with little or no background and a lack of confidence to deliver such important topics with ever changing information. This leads to a teacher who wants to understand the topic at hand spending valuable time doing so instead of planning lessons, taking on new school commitments and actually enjoying these activities (Summers et al., 2003). In my preliminary survey of science teachers within Manitoba, the teachers felt more than moderately that sustainability issues should be taught separately from mainstream science. This could be due to the fact that the science curriculum is already overloaded (Gayford, 2002; Gayford, 2004;Tyler, 1949) and to a lack of knowledge by policymakers and practitioners (Sterling in Tilbury &

Cooke, 2005). Surely any existing overloading of a science curriculum can only become greater. Such is the nature of modern information based science.

A final risk factor found in the macrosystem is that much of EfS is outside the realm of science (Gayford, 2002; Gayford, 2004; Summers, 2005). The manner of school structure in urban Manitoba schools is that in the higher years one teacher is responsible for one or two subjects. It is easier for an elementary level teacher or a rural teacher who is expected to teach a variety of courses to integrate issues across the curriculum, but it is much more of a challenge to do so with several other teachers who have different subject matter to cover and different teaching methods. Timing and planning of this type of integration would be a challenge.

In the 2006 study by Hogan and Associates Inc (McAllister Opinion Poll, 2006) it was determined that 43% of those Canadians polled felt that a major barrier for not acting more sustainably was that they needed to know more about solutions, and 31% felt that they were unable to solve the problems alone. It is my belief that we need to capitalize on the feelings that sustainability is important and focus on overcoming the barriers of inaction and lack of knowledge. According to Hogan's study, individuals also felt that the main barrier to others not acting to promote sustainability was that they were "not really concerned" (50%), while thought leaders (Canadians in positions of influence) felt that most Canadians' greatest barrier to acting sustainably is lack of knowledge/awareness at 62%. An educational resource that will support teachers and provide basic sustainability information for students may assist in removing the barriers to EfS.

2.5.2 Protective Factors.

Because of the nature of EfS programs and the positive influence they may have on students' behaviour, individual schools can make EfS a priority. A major factor likely to influence the implementation of sustainability education programs is school culture and curriculum priorities established by schools. When schools are cognizant of the way that they are individually structured for their particular student group, protective factors can be increased. One study found that school characteristics often are associated with student behaviour, attendance, exam success, and delinquency (Centre for Mental Heath in Schools at UCLA, 2006). Many positive outcomes have occurred from school activities where students have opportunities to share ideas, provide help to others, and participate in decision making about issues of concern to them. Such activities could include peer education programs, service learning, or student advisory boards (Centre for Mental Heath in Schools at UCLA, 2006). When students are provided with the opportunities to be meaningfully involved and have responsible roles within the school and the community, positive things happen (Howard, 1999). Schools need to remember their primary goal: to educate students and assist them in developing into productive citizens.

The most effective schools are often communities that model the traits of sustainable societies:

- They know that children's ability to learn and what they learn are greatly affected by the vibrancy and health of the culture of the school and the quality of the relationships within it.

- They function as "apprenticeship communities" in which leadership is shared and members of the community see themselves and others as both teachers and learners.
- They recognize that "the curriculum is anywhere that learning occurs" (whether or not it is intended or directed by educators).

(Schools and Communities subheading, CEL Website, 2006)

There are also protective factors that are likely to promote student responsiveness to science when taught within the context of EfS. The concern mentioned earlier of a decrease in the proportion of students involved in science can be counteracted by early positive experiences. At the Organisation for Economic Co-operation and Development [OECD] Global Science Forum it was shared that educational content and curricula is imperative when trying to improve and maintain students' interest in science and technology. It was also determined that early contact with science and technology can have a lasting affect upon these students (2006). The other positive outcome of students enjoying science in school is that often their education and career choices are based upon interest. Longitudinal surveys done by the OECD suggest that this interest remains consistent from the ages of 11 and 15 (OECD Global Science Forum, 2006). By making sustainability issues within science interesting and fulfilling students will see the value of learning about and continuing to be involved with science.

According to the War Child Opinion Poll (2006) there is strong interest from the students in regard to sustainability issues. This poll determined that 59% of students recorded that they were very concerned by the spread of HIV/AIDS and environmental pollution, while 58% were listed as very concerned about hunger and famine in the

developing world. Just over one-half were also very concerned about war and conflict (53%), human rights issues (53%), and terrorism (51%).

Evidence displayed in the 2006 study by Hogan and Associates that only 5% of the general public in Canada felt that they themselves are not really concerned about sustainability issues. This would be considered a support or protective factor. The vast majority of Canadians are concerned and I believe that with an increase of knowledge individuals may begin to take more action.

2.7 The Natural Step

Often teachers lack a theoretical premise upon which to establish teaching programs. As might be expected, if a teacher has a limited knowledge of sustainability education and its foundations, this is likely to be a risk factor influencing program delivery and implementation. Thus, this background knowledge becomes an individual risk or protective factor for influencing program development and delivery. Utilizing programs like The Natural Step is a protective factor for students and sustainability. The Natural Step was created in 1989 by a Swedish oncologist, Dr. Karl-Henrik Robèrt, who noticed a connection between lifestyle and the incidence of cancer in his young patients. To facilitate this connection, The Natural Step has provided a framework to allow people to see the big picture and how the systems within it interact. It includes the root causes of the damaging impacts of our actions and also allows people to redesign for the problems of our society rather than just react to them (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002). The pathway to sustainability is very complex and may appear to be overwhelming. This may render people to a position where they do not know where to start and, as a consequence, they do nothing. The

Natural Step framework is based on the premise that, if the apparent complexity can be paired down to simple basic principles that can be understood and accepted, this will help people and organizations find solutions that will work for their particular situation.

This framework uses a science and systems-based approach to plan for sustainability. It provides a set of simple, exhaustively reviewed criteria that can be used to direct social, environmental, and economic actions. This framework will be applied to the curriculum resource, the design of which is a major component of this thesis.

The Natural Step framework is based on an integrated assessment of current economic, social and ecological dynamics, and on the implications of present trends for human society. The approach was developed in the late 1980s in response to growing concerns about the public health problems resulting from increasing toxins in the environment and current societal resource use practices.

It would appear that The Natural Step has the potential to provide a theoretical platform from which to develop EfS programs. I will be using the Four System Conditions to assist in background information for teachers and to provide a focus for the students, as well as a basis for sustainability-directed decision-making of all kinds. As simple as a purchase at the store to buy a light bulb (which to purchase? Compact fluorescent that is more costly but lasts longer or an incandescent which wastes a great deal of energy as heat?)to applying their learning when making career choices, it is the hope that students will consider these system conditions. The Four System Conditions will provide the guidance for choices students make from transportation to purchasing.

The Four System Conditions state that in a sustainable society, nature is not subject to systematically increasing

1. concentrations of substances extracted from the Earth's crust,
2. concentrations of substances produced by society,
3. degradation by physical means and, in that society,
4. people are not subject to conditions that systematically undermine their capacity to meet their needs.

(The Four Systems Conditions, ¶1, The Natural Step Web page).

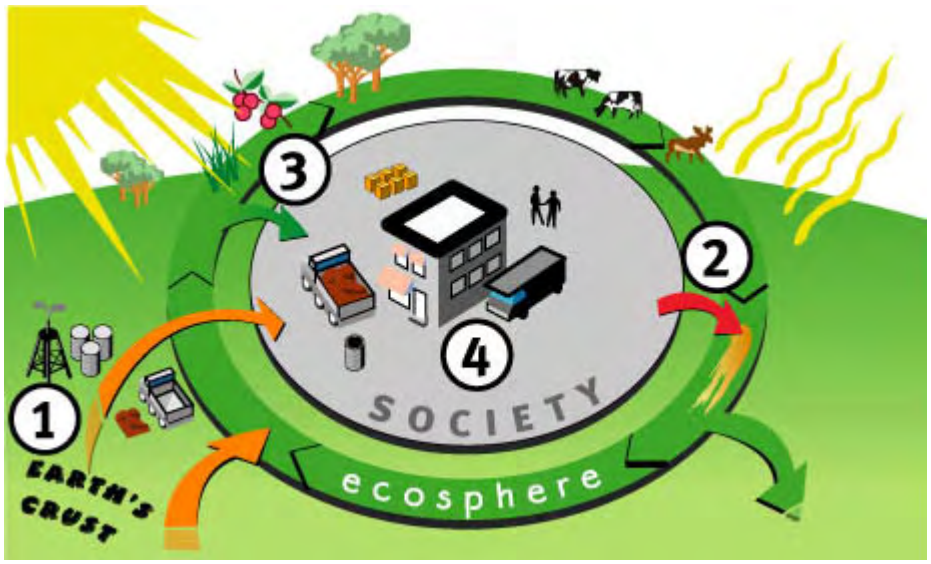

Figure 2.5. The Four System Conditions of The Natural Step. Used with permission.

Although there has been a variety of school resources developed at provincial, national, and international levels, none to my knowledge have been developed on the basis of The Natural Step or is accessible and directly related to the Manitoba Curriculum. Often teachers do not have an opportunity to view existing resources and it

has been difficult to inform teachers of new and related resources. A good example of a document that is not well known and under-used is *Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators* (2001). This was created as a guide for Manitoba teachers, was well distributed, but most teachers I know are unaware of this document.

2.8 The Role of Science in Sustainability Education

> Science in K-12 schools should be a part of the human quest and wonder for understanding the world with science offering a way of knowing and doing that can help students reach a deeper understanding of their world
>
> (Barab and Leuhmann, 2003, pp. 454-455).

One of the domains of science and EfS is ecology (environment). This is a direct link between science and EfS and there are many other science domains that are linked to EfS. This is a significant reason why science (in one form or another) seems to take on the responsibility of environmental education and now, EfS. It is true that there is a natural link, and in our current compartmentalized curriculum, it is the best fit. But will teachers be able to "fit" it in?

It is very important that our students see the value of what they are currently doing and how it affects others in different parts of our world. Traditionally it seems that global education meant that students would learn about the rainforest (that most will never see in their lifetime), or study about endangered animals that may or may not live anywhere near them. It is hard to care about or even understand something that one has never seen, and most likely not ever experience in person. The events that students must learn about have become much more that just that. According to Noddings, "In addition

to acting now to save endangered species, global citizens must be concerned about the Earth's air, water, and climate" (2005, p. 11).

In Manitoba, lakes and rivers are used for many activities including agriculture, fishing, recreation electricity generation, provision of water for domestic and non-domestic consumption, and waste removal. We also have many water-related concerns, such as local flooding and water contamination. Science provides a great opportunity to link students with their global environment, and can offer students a new way of knowing and doing that can help teach a greater appreciation of their world (Barab & Luehmann, 2003). I believe that science is not only for future scientists, but for all global citizens - people of the Earth who care to make a difference. Thus, the addition of a global focus to the current Grade 8 science cluster of Water Systems is important.

2.9 Developing Sustainability Curriculum

The literature on education for sustainability suggests that there are a number of themes, teaching strategies, and goals that should be incorporated in sustainability curricula. These include the following

- Collaboration,
- Lifelong learning,
- Interdisciplinary/thematic/integrative approaches,
- Critical thinking,
- Contextual/Experiential pedagogy,
- Utilizing systems thinking, and
- Taking action.

(Huckle & Sterling, 1996; Farrell & Papagiannis, 2002; Stapp et al., 1996a; UNESCO, 2005).

When learning about sustainability issues the learner becomes a more developed citizen ready to partake in the democratic society and able to work with others (Farrell & Papagiannis, 2002; Stapp et al, 1996a). According to Tilbury and Cooke, learning for sustainability provides the confidence for concerted educational settings which do not simply provide information but build capacity of the student (2005). Students know they can make a difference by making the world a better place to live (War Child Opinion Poll, 2006), but they need to develop the skills required to make that difference.

Sustainability is an issue that must follow students throughout their lives. There are opportunities to learning about sustainability at practically every moment and in every circumstance whether in or outside of school (Stapp et al., 1996a). When students learn about sustainability in school they see how every action they take is important. It is important for everyone to realize that EfS relates to all persons in all areas of life, and extends throughout all of their lifetimes (Huckle & Sterling, 1996). Within the Guidelines and Recommendation for Reorienting Teacher Education to Address Sustainability (UNESCO, 2005), EfS is explained as a life-long endeavour. Students must be assisted in seeing the importance of how their actions now will affect not only others but even themselves and their families in the future.

As mentioned earlier, it is difficult to teach sustainability in a discipline based manner. There are opportunities to connect the theme of sustainability across these disciplines while not reducing the parts of the different disciplines (Huckle & Sterling,

1996; Stapp et al., 1996a). It is important to have the opportunity to learn about sustainability from a holistic perspective.

The challenge of sustainability is that the problems are so complex and interwoven that a different way of thinking, a new approach to problems, is required. This approach needs to be integrative rather than analytical, and lead to synthesis rather than dissection. All of our current thinking tools will be needed, but we also must learn to see our socioeconomic-ecological systems from this much broader, integrative perspective (Nattrass & Altomare, 2002). This holistic perspective pushes the boundaries of where we need to go. People must begin to take ownership of their actions and understand the importance of their behaviours.

Sustainable development will require a change of heart, a renewal of the mind, and a healthy dose of repentance. That these are all religious terms is no coincidence; change in the fundamental principles we live by is a change so deep that it is essentially religious whether we call it that or not (Daly, 1996).

Developing students to be engaged and to have the capacity to think critically is essential to further scientific endeavour. By teaching students to think critically it allows them recognize that science does not always proclaim that it has the only answer but a possible answer that needs to be considered (Huckle & Sterling, 1996; Noddings, 2005). Critical thinking provides us the ability to allow us to recreate a greater understanding of how to move a society towards sustainability (Tilbury & Cooke, 2005).

Critical thinking does not only focus on problem-solving. Problems are something we want to eliminate, but by ridding ourselves of the problem does not necessarily lead us to where we want to be. Frequently humankind seems to create solutions to problems

that are only immediate and end up creating other problems at a later date or in another location (Cortese, 1999). Being critical thinkers and finding solutions in a creative way can lead us to where we want to be instead of just eliminating what we do not want.

Students understand better within contexts that they are familiar with. Sustainability education should be taught in a manner that is contextual. Huckle and Sterling believe that EfS should first start in an individual's local economic, social and ecological perspective and situation then include the local region, national, international and finally global perspectives (1996). People should attempt to understand a problem by putting themselves in it, i.e., "put yourself in another's shoes". Having a personalized context makes it is easier to identify the participants that can work from within the problem than from the outside. According to Stapp et al., research has shown that people are typically more interested in what impacts them in a direct manner. On a more personal level, this attention may inspire holistic learning and action that can precipitate on the individual himself and actions within the greater context (1996a).

What distinguishes a systems approach from other approaches is the focus on connections within the system. The parts of any system are connected according to core principles that define that system. Seeing those connections opens the door for exploring opportunities for change and improvement that can move the larger system in the direction of sustainability rather than unsustainability (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002). By utilizing systems-thinking students have a greater opportunity to move towards thinking and learning sustainability.

Education for Sustainability needs to employ systems thinking which is tied closely to using the interdisciplinary approach as mentioned earlier. Students who have

the opportunity to learn about sustainability though an interdisciplinary method are given a chance to expand their understanding of a systems approach and exercise integrated systems approaches to solving complex subject matter (Stapp et al., 1996a). Systems thinking is also an important skill related to critical thinking. Systems thinking challenges our current actions that may be different from the current thought of an individual. This individual may "know" about the great amount of greenhouse gases being released, but constantly idles his car. By focussing on the connections between our knowledge and how we apply it through our actions permits us to understand how things relate, how sustainability involves a complex network of interacting relationships, and the affects our actions may have (Koger & Scott, 2007; Tilbury & Cooke, 2005).

Finally, when students feel that they are making a difference they truly believe in what they are learning about and doing. Empowerment is a key to greater understanding. By including an action component students may start to take control and acquire a sense of control over their own lives (Stapp et al., 1996a). The ability to connect students with global issues is crucial, even though it is often difficult to do. Schools often work in an environment of austerity and there is little access to money in school budgets to take students to distant environments such as the rainforest to view firsthand the destruction, or to other countries to better understand other cultures. However, when the students learn to care for their own local environment they will learn that this type of commitment requires action (Noddings, 2005). As students begin to take action at home, they can more readily see the results on a larger scale.

2.10 Education for Sustainability within the Grade 8 Water Systems Cluster

The connection between global citizenship and water is clear – we all need water. We are in the midst of the International Decade for Action – Water for Life, 2005 – 2015. With increasing scarcity of water, it is not inconceivable that access to fresh water may become a source of strife. Indeed Manitoba has an international water issue with the Devil's Lake Diversion into the Red River, which drains into the already increasingly eutrophied Lake Winnipeg. The provision of water is a key ecosystem service and a great part of sustaining human health and well being both directly and indirectly and is well documented in the Millennium Ecosystem Assessment (2006).

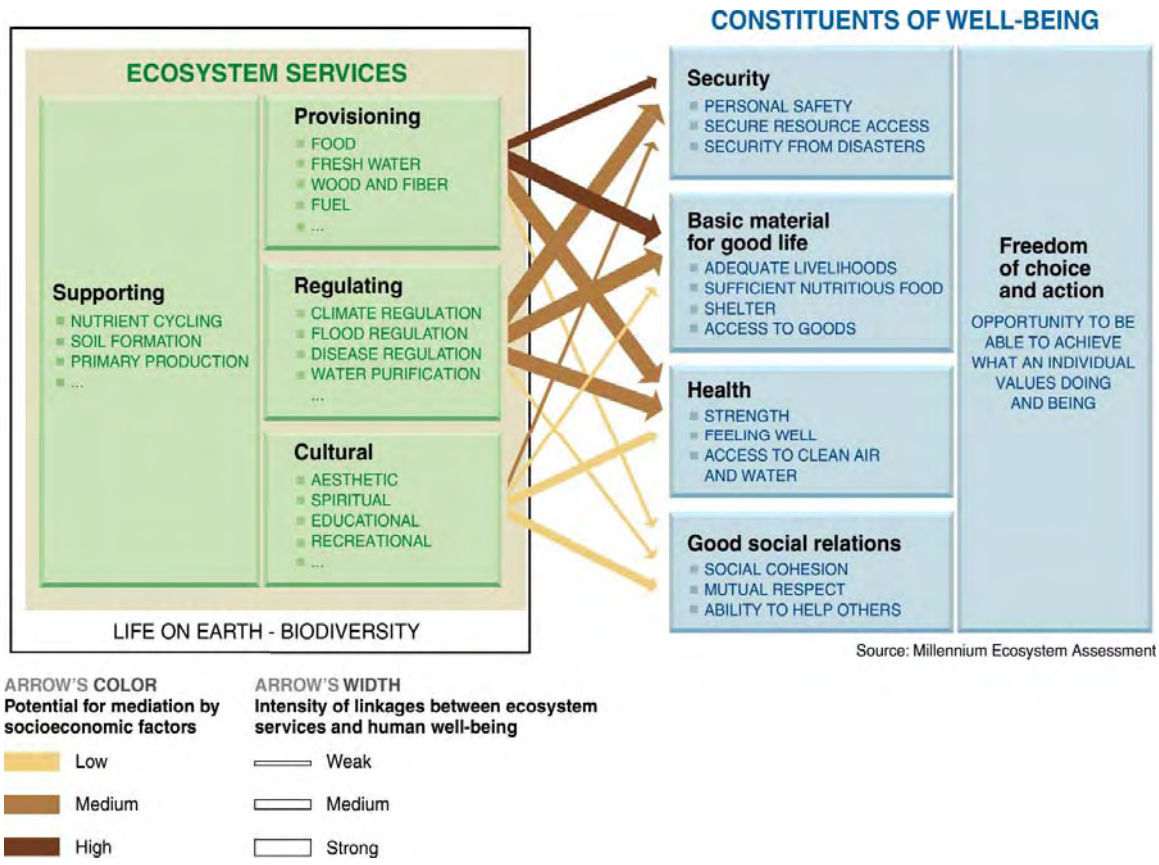

Figure 2.6. Diagram demonstrating the importance of ecosystem services, including the provisioning and regulating services water provides. Millennium Ecosystem Assessment. (http://www.maweb.org retrieved on October 20, 2006) Used by permission.

The current state of our global water is in poor shape. The most recent facts from the United Nations World Water Development Report 2, *Water, A Shared Responsibility*. (2006) speak for themselves.

- Two out of every three people will suffer moderate to severe water shortages by 2025.
- One billion people still do not have access to an adequate supply of drinking water.
- 2.6 billion people do not have access to basic sanitation. These people are among the world's poorest. Over half of them live in China or India.
- one-fifth of the planet's population still lacks access to safe drinking water and 40% lack access to basic sanitation.
- 3.1 million people died in 2002 due to diarrhoeal diseases and malaria – 90% were children under the age of five.
- The world will need 55 percent more food by 2030.

I chose to focus on water because it was the cluster of the several possibilities that focused on the Earth sciences that reflected well the world situation but also one where students can make an immediate difference with the new knowledge they will gain from the Water Systems Resource being developed.

2.11 Literature related to the Development of a Water Systems Resource

By using Bronfenbrenner's Bioecological model, The Natural Step, and a teacher's survey the Water Systems resource is founded on solid principles and information.

The content was the next aspect that needed to be developed, so specific aspects were focussed on such as the design, inclusion of essential questions, assessment strategies while basing lessons on research done in brain based learning. By first identifying the desired results such as “what are the established goals”, “student understandings”, and the “essential question being covered by any particular lesson”, the development of a teacher-friendly lesson plan was created. I began the process of “backward design” (Wiggins & McTighe, 2005). Moving onto the next step (Wiggins & McTighe, 2005). I then determined what was the acceptable evidence that students would demonstrate in order for the teacher to be sure that a student was achieving the desired results. Finally, I planned the learning experiences and instruction for the lesson, keeping in mind how the brain works. According to David A. Sousa, there are several ways to initiate brain-based learning and it is important to utilize strategies that will assist in teaching the best way a brain learns. One method that stood out is “teaching for transfer”. Use of simulation games assists the student in transferring a new skill or knowledge into a new learning situation (Sousa, 1995). It is clear that kinaesthetic activities are very important in the understanding of complex concepts as well as for modeling future student behaviour (Sousa, 1995).

Other brain-based learning strategies that were to be used in this resource were brainstorming and metacognition. Both of these strategies promote bridging for transfer. The teacher evokes transfer in students by helping provide connections from what the student already knows to the new learnings and within new contexts (Sousa, 1995). Brainstorming allows students to attempt to apply past learnings while metacognition promotes developing an approach to solving a problem, then discussing how well their

approach worked. This gives students opportunities to decide how they may change their decision to improve success in the future (Sousa, 1995). Finally, during the development of lessons it is important to remember the following points:

- Learning engages the entire person (cognitive, affective, and psychomotor domains).
- Emotions are an integral part of learning, retention and recall.
- Transfer always affects new learning.
- Lecture results in the lowest degree of retention.
- Rehearsal is essential for retention.
- Each brain is unique (Sousa, 1995).

By keeping the elements of brain-based learning within each lesson, it is the hope that these lessons could be understood and retained by the students.

Finally, assessment is a large component of any lesson. If a teacher cannot assess what the student has gained from a lesson then there may be a chance that the teacher will not use the lesson, as accountability to administration and parents is of great concern in recent times. There are three main types of assessment: Assessment for Learning, Assessment as Learning and Assessment of Learning (Manitoba Education, Citizenship, and Youth, 2006). Each form of assessment has a place in unit design and implementation. “Assessment for Learning” provides for teachers the starting point of their students, as well as the opportunity to identify prior knowledge and preconceptions that the students may have (Manitoba Education, Citizenship, and Youth, 2006). It is clear that not every student is coming from the same background or has similar learning styles, so teachers can use this information to structure their classroom on the

differentiated requirements of their students which in turn will increase productive learning and support positive student motivation. This process should be interactive and by collecting information about their students. Two main outcomes that teachers will be able to use are the ability to select and adapt appropriate learning materials and give immediate feedback and direction to their students.

"Assessment as Learning" promotes the application of new knowledge to create the student's own understanding (Manitoba Education, Citizenship, and Youth, 2006). Students must be able to critically assess this information, relate it to prior knowledge and then utilize it as new learning. This is the one type of assessment that is not done *to* or *for* students, but actually *with* and eventually *by* students themselves. Throughout this process, teachers must model in order to teach students how to self-assess and guide them into setting goals.

"Assessment of Learning" assists the teacher in the decision of whether or not the student has achieved the knowledge required for a particular lesson or unit (Manitoba Education, Citizenship, and Youth, 2006). Assessment of Learning is the assessment that becomes public and may contribute to important decisions in any student's future. Therefore, it is important that this type of assessment be credible. Teachers need to confirm that students understand the rationale behind the assessment, provide clear descriptions of the intended learning for the students and provide a range of processes and alternative mechanisms for students to demonstrate and teachers to assess the same outcomes.

The inclusion of the above elements will influence the development of the resource and in turn the affect if will have on the students and their understandings.

2.12 Other Water Education Resources

This is more of a list of potential resources and less of a critical review. The general criticism of all of these documents is the lack of connection to the Specific Learning Outcomes (SLOs) of the Manitoba Curriculum. Although teachers are familiar with the curricula, to search out these new resources takes time and to purchase them can be expensive. The following are example quotations from teachers who participated in this survey:

- Need to have more “ready-to-use” resources on the topic.
- Time is always an issue. Having well thought out and easy to use resources are always welcome. When I have to spend hours adapting or finding resources, the less likely I will be to continue to do so in the future. The more readily available resources are the ones most likely to be used.
- The closer the resource relates to curriculum the more likely it is that teachers will include it in their lessons.
- I am a big supporter of teaching sustainability issues in our classrooms. While curricular outcomes may limit some from using sustainable resources in teaching, those that have an interest in the global direction we are heading will find a way to incorporate these materials. I am fully supportive of any resource which aims to teach sustainability issues.
- I think this would be a useful resource. Everything we do now to influence students’ attitudes toward sustainability will have a positive influence on the future of our planet.

- I like Project WILD but it would be nice to have more specific activities that directly match grade outcomes (i.e., Gr. 7 Project WILD activities).
- The motivation is there. These teachers just need access to resources to use sustainability in their classrooms.

The following resources were consulted in the development of this resource. It is very important to continue to comply with the required outcomes so that teachers know they will meet expectations of the curriculum. By using a global slant and referring to The Natural Step principles, students are learning about sustainability and hopefully making better choices for their future.

- Supply, Quality and Use of Water in the Prairie Provinces, Manitoba Edition, Keewatin Publications, 2003
- Project Wet
- Planet H2O: Teacher's Guide (Toyota USA Foundation)
- Engineers Without Borders, Canada – a great single lesson plan
- GLOBE Program (Stapp et al., 1996a p. 64)
- Population Connection
- Facing the Future

Other sustainability sources not directly related to Water, but containing water related activities/information

- Green Teacher Magazine
- Project Wild
- Encouraging Students Through Global Issues: Activity Based Lessons and Action Projects (Facing the Future)

Table 2.1

A review of similar resources and the content related to sustainability.

Resource Name	Knowledge (SLO related to grade 8 curriculum)	The Natural Step	Sustainable actions	Sustainability information
Project Wet	Portions	X	Portions	Portions
Manitoba Waterways project	X	X	Option	√
Planet H2O	X	X	Portions	Portions
Project Wild	Portions	X	Portions	Portions
Water and My World	Portions	X	X	X
Red River Basin Water Systems	√	X	X	Portions
Population Connection	Portions	X	Portions	Portions
Facing the Future (various resources)	Portions	X	Portions	Portions

Table 2.1 demonstrates the four items included in the resource that are tested for. In order to see if development of this resource was actually required due to a gap in current resources, other resources were reviewed to see if and how many of the four

inclusions they contained. The check mark symbolizes that it meets or contains the requirement listed on the top of the table. For example, when reviewing for the knowledge component, the inclusion of the specific learning outcomes that are prescribed by the Manitoba government was observed. An *X* demonstrates that it is lacking in a particular area, and some resources do contain portions of the specific learning outcomes or provide some lessons surrounding sustainability. Thus providing the justification for the need of a resource specific to grade 8 Water Systems.

2.13 Summary

In this literature review I began with a description of Education for Sustainability (EfS). I provided a brief history of EfS, within the international and local context; examined the two foundations that will be used to inform the development of a science-based sustainability resource. First, Bronfenbrenner's Bioecological Theory of the Ecology of Human Development (1979) will be used to maximize the protective factors influencing the implementation of new school curricula. Second, The Natural Step (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002) will be used as the theoretical framework for the resource. Finally, I detailed how a resource might be developed for students to demonstrate to students that they are individually a part of a global solution, and that science is important for all. By reviewing other resources, I was able to identify their strengths and weaknesses from an EfS perspective.

Chapter 3: Methodology

3.1 Introduction

In this chapter I will be describing the methods used in the development, implementation and evaluation of an EfS resource for the Water Systems Cluster of Grade 8 Manitoba Science Curriculum. The chapter begins by explaining the processes informing the development of the resource. This is followed by a description of the implementation phase, which includes the use of a survey in the development of the resource and the implementation of the resource. Finally, the chapter ends by describing the processes involved in the evaluation of the resource implementation.

3.2 Processes Involved in the Development of the Water Systems Resource

Two major theoretical frameworks influenced the development of the Water Systems resource: Bronfenbrenner's Bioecological model (1979), and The Natural Step's Four Systems Conditions (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002).

3.2.1 Bronfenbrenner's Bioecological Model.

Bronfenbrenner's model and the literature pertaining to curriculum implementation would suggest that there are certain factors that are supportive of curricula delivery. Knowing what these factors are and how they occur within the classroom is the key to utilizing them in the development of a resource such as this. One factor that will affect the use of this resource is the teacher's personal attribute factors such as their methods of teaching and how they tackle a lesson. Teachers need to know exactly how they can make the Water Systems unit fit within EfS. Teachers will need to

have basic knowledge of EfS and information about the Four System Conditions of The Natural Step. Teachers need to see that the resource fits within the learning outcomes of the Manitoba curriculum. The resource must catch the interest of the teachers, and thus will be packaged in a manner that is attractive and appealing. This resource must supply teachers with the confidence to teach about EfS in a manner that makes them feel comfortable with this potentially new information within their own classrooms.

Environmental factors, such as the time required to implement the resource could impact teachers. The resource must fit appropriately into the school year, as there are four "Clusters" that must be covered by the end of the school year. These clusters contain a number of SLOs that are required by Manitoba Education, Citizenship, and Youth. The Grade 8 Water Systems Cluster contains 19 SLOs (Manitoba Education and Training, 2000), which is the most for any cluster in grade 8. Teachers are also required to teach from "Cluster 0", which focuses on overall skills and attitudes. This cluster contains six sections, which are

- initiating,
- researching,
- planning,
- implementing a plan,
- observing, measuring, recording, and,
- analyzing and interpreting.

Each of these sections contain several outcomes looking at scientific inquiry and the design process.

Keeping the length of the school year in mind, this cluster in many schools has been allotted a two month period to attain the SLO's. The important point is that there is a limited time in a school year to teach all the required outcomes and teachers are cognizant of this time limitation.

The Water Systems resource must be flexible in order to fit into the established routines of the classroom. As some schools have limited supplies for their science program, the Water Systems resource should not be too resource or supply-specialized or intensive. Furthermore, many school programs have small budgets, which is an important aspect to keep in mind.

This resource is not to be adopted without a critical eye from teachers. The flexibility of the Water Systems resource allows teachers to adapt it as required. Similarly, the Water Systems resource can also be modified to accommodate students who require adaptations or extensions due to special circumstances. Finally, due to the fact that some teachers may not be knowledgeable of the background of both water systems and sustainability issues, it provides background information that teachers may or may not be aware of. I am aware that there is a need for assistance in the advancement of a teacher's comfort level by increasing their knowledge base. The resource will contain "teacher notes" when applicable, and in addition, the researcher will provide professional learning sessions, be available for email contact, and if required there will be follow-up in the schools on request.

Taking into consideration Bronfenbrenner's Bioecological model, there are many factors that I must be aware of. By being aware of these factors, it is the hope that this resource will be accessible to a greater variety of teachers.

3.2.2 The Natural Step.

The Natural Step is the second framework to be incorporated within this resource. Within The Natural Step there are four systems conditions which essentially define sustainability. These will be taught in a specific lesson as well as applied in a final project. By allowing the students to explore the Four System Conditions and asking them to link the final project to these conditions, the students will be able to apply this framework to a practical project and should be able to see how it can assist them in decision-making. It is the hope that the application of these system conditions in an individual's decision making may extend beyond the classroom and into the students' everyday life.

3.3 Implementation of Resource Phase

This section outlines the three phases of the study (Figure 3.2). Phase One looks at the development, distribution and collection of a teacher survey. These surveys led to the development of the resource. Phase Two deals with the implementation phase of the teacher resource with five pilot classes and five control classes. Using the suggestions from Phase Two, Phase Three represents the distribution of the resource to different teacher groups through in-services and presentations.

Table 3.1

Sequence of thesis research

Teacher Survey	Phase 1
Literature Review	
Synthesis of Survey	Phase 2
Resource Review	
Development of Resource	
Pilot Resource	
Adaptations to Resource	Phase 3
Distribution to other Educators	

Phase One: The Survey

The aim of Phase One was to use the information from a survey to assist in the development of a science based sustainability resource for teachers in a middle school classroom. The purpose of the survey was to

1. Determine the risk factors as perceived by middle years science teachers related to the area of scientific sustainability education.
2. Determine the protective factors as perceived by middle years science teachers related to the area of scientific sustainability education.
3. Find teachers who may be interested in piloting a resource related to science and sustainability.

The survey was distributed to approximately 150 middle years science teachers at science-specific divisional meetings, through other teachers that were known to the researcher and through an email to teachers who attend the Faculty of Education

Graduate Program at the University of Manitoba. Each survey included a pre-stamped, self-addressed envelope. The flow of the survey is described in Figure 3.1 below.

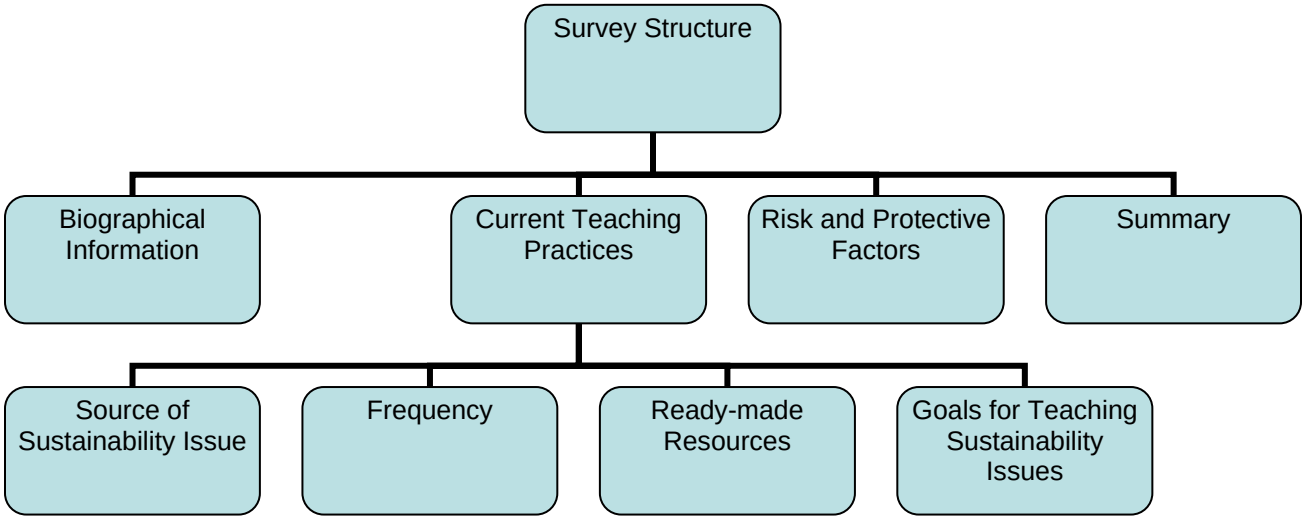

Figure 3.1. Teacher survey format

The introductory section of the survey (see Appendix 2 for entire survey) focused on biographical information of the teacher completing the survey including: gender, years of teaching experience and courses currently being taught. It also included a review of their perception of the world on a scale from 1-5, with "Anthropocentric" being 1, and "Ecocentric" being 5. A definition of both terms was provided. On the Anthropocentric end (1) of the lichert scale it explained that it:

relates to the feeling that human beings should dominate and control the earth and that plants, animals, and minerals are resources for human use,

While on the ecocentric end (5) of the scale it stated that:

humans are but one component of a complex earth and that humans must learn to live within a stable, sustainable, self-renewing ecosphere.

The teachers circled the number between 1 and 5 which they felt best corresponded to their personal worldview.

The objective of the second section was to identify where teachers get ideas related to sustainability. This section of the survey addressed the current teaching practice of each teacher completing the survey. The topics in this section were

- frequency of utilizing sustainability issues in class using a variety of sources,
- the extent which teachers are aware of certain ready-made sustainability-related resources, and,
- the importance of various goals for teaching sustainability issues.

Some examples provided by the survey in the section dealt with current new events, internet resources or guest speakers. Teachers were also asked to circle the response that best described the frequency that he or she used these sources:

- Every class
- Once/cycle
- Once/month
- Once/term
- Once/year or
- Never.

A separate section of the survey asked questions specifically about ready-made resources. The teachers were required to circle one of the following choices related to a variety of resources.

- Unaware of.
- Aware of but never used.

- Have used and found beneficial due to an increase in the students' positive attitudes.
- Have used and found beneficial due to ease of use.
- Have used and found limited due to lack of student interest.
- Have used and found limited connection to student learning outcomes.

Two examples of these ready-made resources are the Manitoba Model Forest and Project Wet.

The final question in this section inquired about the teachers' goal of using sustainability issues in their classes. Teachers were asked to address this issue on a scale ranging from very important to not necessary. A few examples of goals teachers were to identify in importance were

- affect on student attitudes (ex. How much they enjoy learning about these issues),
- increase in action-oriented behaviour (ex. If students are more likely to take action), and,
- use of science to analyze an issue (ex. a current event or topic).

The third section sought views on specific risk and protective factors and their influence on an individual's ability to teach in a sustainability manner.

Finally, teachers had an opportunity to comment on any other factors they believed might influence their ability to incorporate sustainability issues in their science course and other concerns they might have had with regard to the development of the resource.

Information from the survey was analyzed by determining the mean and range on specific questions and by any comments teachers included on the survey.

3.4 Resource Development

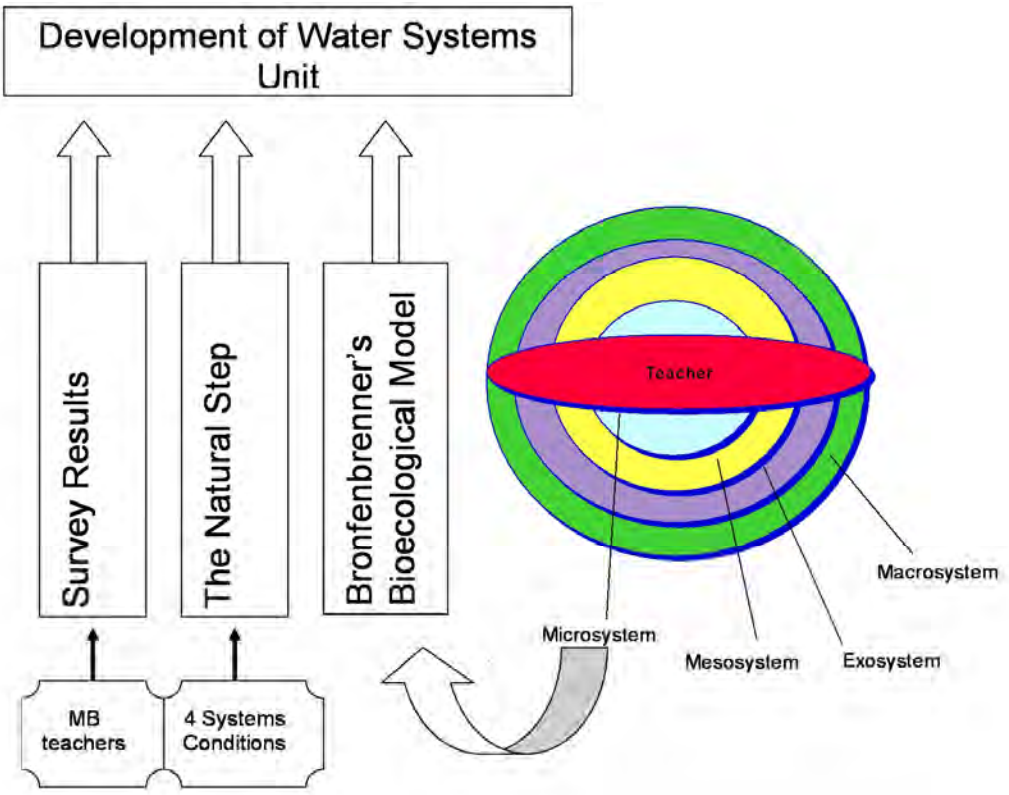

Figure 3.2. Inclusion of Bronfenbrenner's Bioecological Model, The Natural Step and MB Teacher survey in the formation of the resource.

The Bioecological model, The Natural Step and the survey results created a foundation for the development of the grade 8 Water Systems teacher resource. The actual format and content were provided by the Manitoba Education and Training Foundations Document (2000), as it supplies the specific learning outcomes (SLOs) that are mandated by the Province as items all grade 8 students must be taught. The manner in which the lessons were put together was based on Wiggins and McTighe's *Understanding by Design* (2005). This reference provided a basic lesson plan I adapted to meet the expected needs of the teachers (Figure 3.3). The basic lesson plan provides a

place to record the established goals (SLOs that will be covered by that particular lesson) as well as other measures as noted below:

- student understandings,
- assessment,
- materials provided,
- teacher background information (in order for additional information to assist the teacher with the particular lesson if required),
- the actual learning plan,
- assigned homework, and
- extension and integration with other subject areas opportunities.

Stage 1 – Desired Results	
Established Goals: (specific learning outcomes as mandated by Manitoba Education, Citizenship and Youth)	
Understandings: Students will understand that…	Essential Questions:
Students will know…	Students will be able to…
Stage 2- Assessment Evidence	
Performance Tasks:	Other Evidence:
Materials Required	
Teacher Background Information	
Stage 3 – Learning Plan	
Learning Activities:	
Homework Learning Activities	
Extension Learning Activities	
Integration Opportunities	

Figure 3.3. Lesson plan adapted and used for the Grade 8 Water Systems resource.

The activities that were chosen need to complement what has been researched on brain-based learning, taught in a manner that focuses on sustainability and can be properly assessed. Assessment is a strong component in many teacher education programs and has become a source of many professional learning opportunities in school divisions.

As indicated above, there are three main modes of assessment; assessment as learning, assessment for learning and assessment of learning, which all have their place in a unit of study, but “formative assessment” appears to be the most highly valued. Assessing for learning is vital to determine the development of the student and if he actually understands the SLOs required. The Water Systems resource provides for all three methods of assessment throughout the unit, but focuses mainly on assessment for learning. Figure 3.4 demonstrates the inclusion of these aspects within the resource and development that ensued.

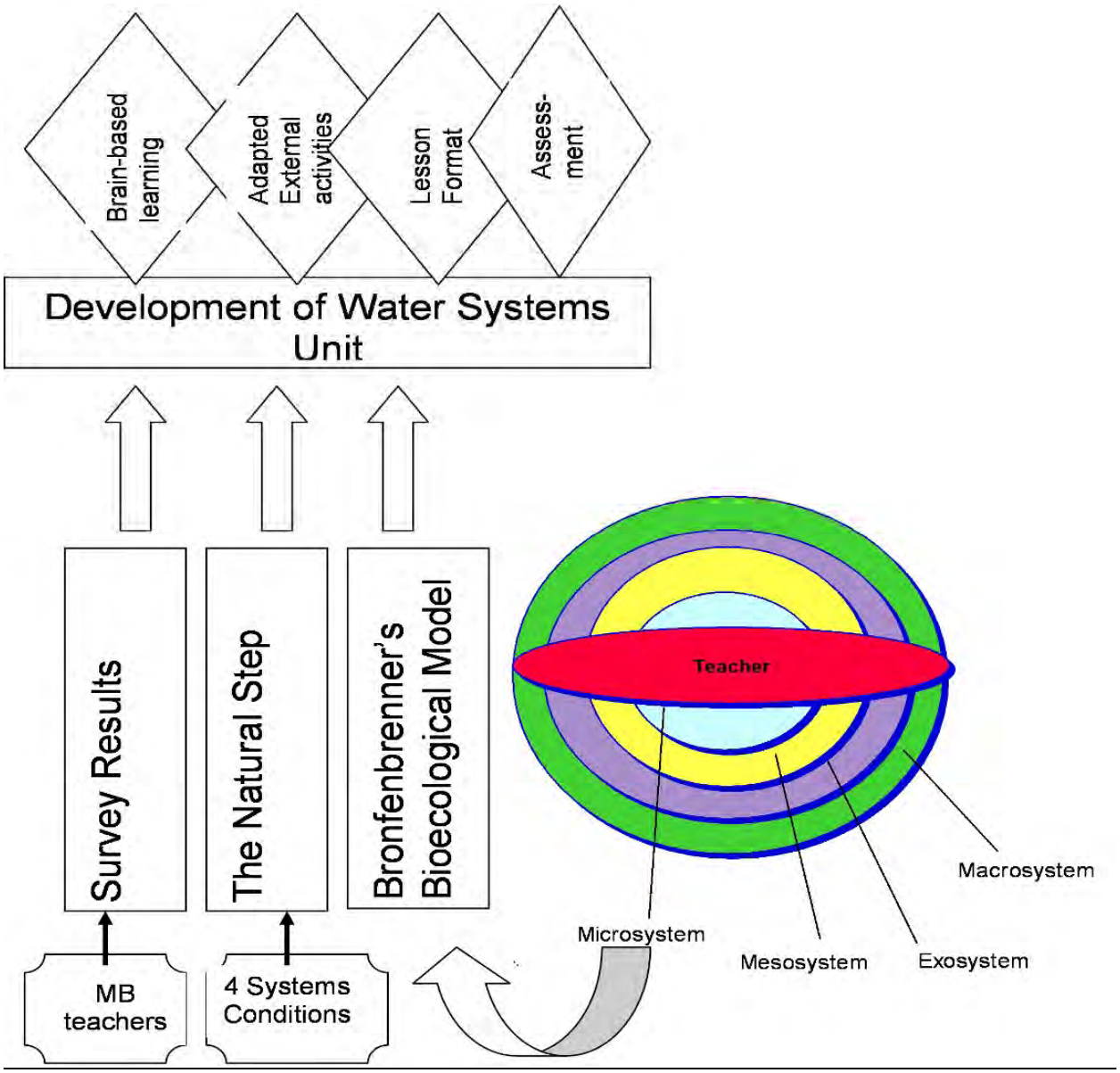

Figure 3.4. Development of the Water Systems Resource, including the creation of the lesson plan, brain-based learning and assessment.

Phase Two: Piloting the Resource

Phase Two of this study was designed as an intervention study, and contains the following components:

- Selection and assignment of participants to control and experimental groups.

- Application of the intervention to experimental groups.
- Measurement of outcomes at the end of the experiment.
- Procedures designed to address potential threats to validity.
- Statistical comparisons of different groups (Creswell, 2002).

3.5 Evaluation

The next section illustrates the methods of evaluation. It contains information regarding the experimental unit and assignment of students, extraneous factors and potential concerns that could impact the study, the desired outcome, and information regarding validity and potential threats to external validity. It also determines why this study is considered a quasi-experiment, details the development of the pre and post-test and finally will elucidate the method of teacher feedback obtained in this study.

3.5.1 The Experimental unit and assignment.

There are ten cohorts of students: five experimental cohorts and five comparative cohorts. The comparative groups received an alternative intervention e.g., a variation of the new procedure or activity, rather than no intervention so that they receive educational benefit during the experiment (Creswell, 2002). The experimental group was taught the grade 8 Water Systems unit with this Water Systems resource, while the comparative group was taught the grade 8 Water Systems unit in the same fashion the teacher has commonly taught the unit.

The classrooms were assigned by the individual participating schools and were chosen by availability and opportunity to participate, i.e., a convenience sample. It was important to find teachers through ethical methods. The teachers were chosen from the

survey participants, teaching the appropriate grades, and willingness to participate further in this study. The experimental group teachers participated in the teacher survey and had an interest in continued participation in the study. Comparative group teachers indicated their interest in continued participation on the survey or were invited by their partner teacher to take part in the survey and at that time they expressed interest through the survey.

3.5.2 Extraneous factors.

Attempts were be made to control for extraneous factors such as socio-economic factors, administrative support and divisional interest. To this end, the same pre and post-tests were used for each class. These tests can be found in Appendix 3 and 4. These tests contain predominantly quantitative questions, but provide opportunity for the students to comment and explain any issues in further detail on the post-test.

The post-test will determine the success of the Water Systems resource. It will be used to determine if there have been any significant changes in the experimental group versus the comparative group in terms of

- Students' affinity for science,
- Students' affinity for sustainability,
- Students' knowledge of water systems, and,
- Students' actions related to sustainable behaviours.

3.5.3 Potential concerns.

The major concern for this experiment is that since different teachers are involved, the results may be influenced by the teaching style/method of the teachers. This

situation simply could not be avoided. To ask one teacher to teach two different sections of classes in two different ways has more implications for problems than the "two-teacher" method. To minimize this issue, this study utilized three schools with two teachers from the each school. Two of the schools had two classes of experimental groups and two groups of control groups. Within each school one teacher served to be the "experimental" teacher (two of these teachers teach two sections) while the other teachers within the school served as the control teachers. This maintained a balance for specific concerns surrounding the socio-economics and other demographics such as availability of school resources and administrative support, between the groups in order to reduce variability.

There are many examples of other concerns that are unlikely to occur due to the manner of this experiment. For example, maturation of the students due to the short time frame between the pre and post-test will most likely not occur (approximately 2 months).

Since this is a part of their science curriculum and is mandatory, it is not expected that students who have agreed to participate would leave the study unless a family were to move away geographically from the school.

There is no concern regarding diffusion of treatments as the students may share information between classes to other schoolmates. This information should not impact the students' study or behaviour significantly as I do not imagine there will be great discussions in the school hallways as to what is occurring in two different grade 8 science classes. As for compensatory equalization, both student groupings will be meeting the same curricular outcomes; there is no inequality except for the treatment group developing more of an affinity towards the understanding of the immediacy of the need

for understanding global sustainability. Finally, it is not expected that the instrumentation will influence the students in a negative manner. The administration of the instrument used should likewise have no impact since the pre and post-tests, will be performed by the teacher in a regular classroom setting so as not to increase the chance of testing fears in the students. The procedures will be standardized and not outside the norm of the individual classroom procedures.

It is assumed that each group is homogeneous, although this cannot actually be tested as this researcher's selection depends on a convenience sample of students.

Table 3.2

The independent and dependant variables.

Independent Variable	Dependant Variables
Instruction on Water Systems (Grade 8 Science Unit) using the Sustainability Resource	• Affinity to sustainability and science • Knowledge of sustainability issues relating to science • Sustainable actions related to science curriculum

3.5.4 Desired outcome.

Significant effects of the Water Systems resource on the experimental group will be considered a positive outcome. Each section found within the pre and post-test questions will be quantitatively measured. The four sections are as follows (Figure 3.5):

- affinity for science,
- affinity for sustainability,

- knowledge of water systems, and
- actions related to sustainable behaviours.

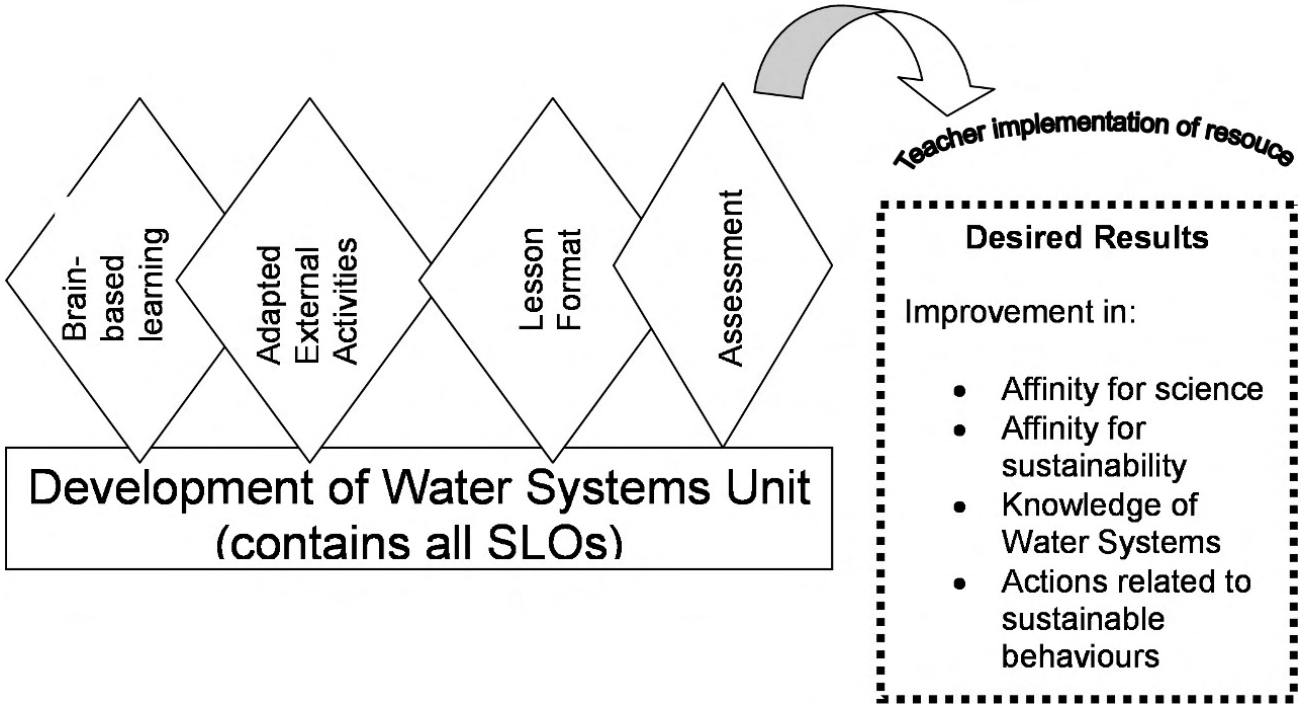

Figure 3.5. Desired results for determination of treatment

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3.5.5 Validity.

There are challenges to the validity, treatments and procedures used in the study (Creswell, 2002). A potential threat to validity is that the different styles of teaching could affect the way the information is distributed and affect the students' affinity towards the issue of global unsustainability.

3.5.6 Potential threats to external validity.

The ability to generalize this study to the greater population will be limited since the experiment will only be performed on five groups of students but due to the fact that the participating schools are spread around Winnipeg and are in different divisions the desire is that this will increase the external validity.

3.5.7 Quasi-experiment.

A quasi experiment is one type of experiment that does not contain a random assignment of participants to groups (McMillan, 2004). The current study is considered a quasi-experiment because there was no random assignment of the classes due to the nature of participating schools. This study used intact groups (individual classrooms). This method of experimentation may increase the threat to internal validity as this is not considered a true experimental design.

3.5.8 Development of the pre and post-test.

The pre and post-tests were developed based on “Children’s Environmental Attitude and Knowledge Scale” (Leeming et al., 1995), and the knowledge-based questions on the “Ozone Layer Questionnaire, General Knowledge Questions” (Groves & Pugh, 2002). The topics of affinity for science, affinity for sustainability, knowledge of water systems (the unit of study), and actions related to sustainability are separated within the pre and post-test. The ability to measure the differences between pre-test and post-test for the experimental group will be obvious while using the control group to demonstrate use of a non-sustainability focused curriculum. Each group can be separated and measured by first determining the mean of each classroom grouping and then by

measuring the mean of combined experimental and combined control groups. By determining any changes in classroom means and by using analysis of Covariance (ANCOVA) on the pre and post-tests, determination of how the experimental groups may have changed as compared to the control groups becomes possible.

3.5.9 Teacher Feedback.

Teachers were asked to keep an informal journal explaining how each lesson progressed, and to share any insight as to why the lesson was successful or how they could have improved the lesson within their specific classroom setting. This feedback will be used to assist in further adaptations made to the resource prior to sharing it through professional learning sessions.

3.6 Feedback

Using the feedback from the pre and post-test, as well as the journal comments from the participating teachers, I will adapt and publish the resource for distribution to teachers through different venues. These venues will include Special Area Groups (SAG) Teacher Professional Learning and other teacher workshops. Teachers will also place the resource on appropriate web pages such as Manitoba, Education Citizenship and Youth and the CRYSTAL web page for easy and free accessibility.

3.7 Summary

The purpose of this chapter has been to describe the methods used in the development of a resource; the application of that resource; and the evaluation of its effectiveness. The chapter has explained the processes that informed the development of the resource. Also included was a description of the implementation phase, which

demonstrated the use of the survey in the development of the resource and the implementation of the resource. Finally, the chapter concludes by describing the processes involved in the evaluation of the resource implementation. In Phase One of this study, 51 middle years science teachers completed a teacher survey to gain information about what were some educators' thoughts on sustainability issues. The survey information was used to develop the Water Systems resource. In Phase Two of the study the developed Water Systems resource was piloted in 5 classrooms in three schools. Phase Three was the evaluation of the effectiveness of the resource with respect to the four sub-systems: affinity for science, affinity for sustainability, knowledge of water systems and actions related to sustainability. Chapter 4 provides the results from the Phase One teacher survey.

Chapter 4: Quantitative and Qualitative Data from Middle Years Science Teachers regarding Sustainability Resources

4.1 Introduction

Chapter 4 will present the results of the teacher survey. Section 4.2 will illustrate the initial teacher survey findings of 51 Middle Years science teachers and what they deemed to be the risk and protective factors in teaching science from a sustainability perspective. Section 4.3 will summarize these findings and will provide the background information for chapter 5.

4.2 Teacher Surveys

There were approximately 150 surveys (to view survey in its entirety see Appendix 2) distributed. Fifty-two teachers returned the survey but one did not have the accompanying consent form so the return rate of 51 stands at approximately 34%. These are only approximate numbers as some teachers took additional surveys for colleagues when the surveys were distributed at a middle years science workshop but I have no confirmation that they were actually provided to these teachers.

4.2.1 Demographics.

Out of the 51 teachers who returned the survey, 58.8% were female (n = 30), and 41.2% were male (n = 21). There was a great range in teaching experience reported by the teachers: nearly 14 percent (13.7) were in their first two years of teaching (n = 7) while 15.6 percent have taught for more than 20 years (n = 8). The middle range was as follows:

- 19.6% have taught between 3-5 years (n =10),
- 19.6 have taught between 6-10 years (n = 10),
- 17.6% have taught between 11-15 years (n = 9) and,
- 15.7% have taught between 16-20 years (n = 8).

More than half of the teachers reported that they taught a subject other than science (n = 26), and 31% taught more than one other subject in addition to science (n = 16).

4.2.2 Current Teaching Practice: Sources of Sustainability Issues.

Table 4.1

Sources of Sustainability Issues

Source of a Sustainability Issue	Mean use by teachers in survey
Current events as they occur	Once/month (4.1)
Current new events adapted to course	Once /month (4.0)
Sustainability issues discussed in text	>Once /term (3.4)
Sustainability issues discussed in text adapted to course	<Once/term (3.6)
“Ready to Use” resources	>Once/year (2.4)
“Ready to Use” resources (adapted) to course	Once/term (3.0)
Internet resources	Once/month (4.1)
Internet resources (adapted) to course	<Once/month (3.6)
My own knowledge of sustainability issues	<Once/month (3.8)
Field Trips	>Once/year (2.5)
Borrowed materials from someone who has adapted them for my particular course	>Once/year (2.4)
Guest speakers	>Once/year (2.2)

Note. Judgments were made on a 6-point scale (1= never, 6 = every class).

Teachers were asked to choose on a scale of 1 to 6, the frequency that best represented their own professional source of information for teaching a sustainability issue (1 being *Never* and 6 being *Occurring in Every Class)*. Some examples of information sources suggested in the survey were ready to use resources, field trips, and sustainability issues found in the course textbook. Most frequently, teachers used current events and the Internet once a month as sources of sustainability issues (Table 4.1). Materials borrowed from another teacher who had already adapted them occurred just over once a year on average. Providing the opportunity to have guest speakers who are knowledgeable about sustainability issues was utilized at a rate of approximately once per school year.

4.2.3 Ready-Made Resources.

The names of eight different "ready-made" resources that are easily accessible in Manitoba were listed in the survey. Teachers were asked to identify resources they had heard of but never used, used and found to be beneficial, used and found to be limited, or resources they had never heard of.

Table 4.2

Knowledge, Use, and Benefit of Some Ready-Made Resources

	Unaware of		Aware of but never have used		Have used and found beneficial		Have used and found limited	
Manitoba Model Forest (N = 49)	37	75.5%	7	14.3%	4	8.2%	1	2%
Manitoba Waterways Project (N = 50)	22	44%	20	40%	5	10%	3	6%
Millennium Ecosystem Assessment (Internet) (N = 50)	42	84%	7	14%	1	2%	0	0
UNESCO (Internet) (N = 49)	22	44.9%	21	42.9%	6	12.2%	0	0
Project Wet (N = 49)	24	49%	17	34.7%	8	16.3%	0	0
Project Learning Tree (N = 49)	34	69.4%	12	24.5%	3	6.1%	0	0
Project Wild (N = 49)	23	46.9%	10	20.4%	13	26.5%	3	6.1%
Slow the Flow (N = 50)	11	22%	21	42%	17	34%	1	2%

Note. Not all survey respondents recorded answers for every question thus the different total number listed under the resource title.

The results illustrated that the majority of teachers have not heard of or used many of these resources. When any of these resources were used, the teachers indicated that the resources had been more beneficial than limiting. For example, even though the majority

of teachers had not heard of *Project Wild* (46.9%), of those who had used it, more found it beneficial at a rate of 26.5% as opposed to those who found it limiting at 6.1% (see Table 4.2). Provided below are some thoughts of teachers on ready-made resources such as Project Wild.

“Slow the Flow, Project Wet, Project Wild - all excellent. Most are easy to use but need to watch vocab. [*sic*] levels” (Teacher A).

“Need to have more "ready to use" resources on the topic” (Teacher D).

“I like project WILD but it would be nice to have more specific activities that directly match grade outcomes. IE/Gr. 7 Project WILD activities” (Teacher G1).

4.2.4 Goals for teaching sustainability issues.

The next section of the survey dealt with the goals for teaching sustainability issues. Teachers were asked to score each provided goal of teaching sustainability issues as very important (value of 3), important (value of 2), or not important (value of 1). The following table lists the goals provided for the teachers to rate.

Table 4.3

Means of Goals for Teaching Sustainability Issues

Goal of teaching using sustainability issues	Mean
Affect student attitude	2.6
To help students learn to live sustainably on this planet	2.6
Increase student knowledge	2.5
Affect student values	2.5
Assist in developing decision-making skills	2.5
Increase action–orientated behaviours	2.4
Use science to analyze an issue	2.4
Link issue to science and other disciplines	2.4
Learn a specific science outcome	2.2
Learn a specific science skill	2.1

Note. Judgments were made on a 3-point scale (1= not important, 3 = very important).

Even with the lowest scores of 2.1 and 2.2 out of a potential 3, teachers recorded that using sustainability to teach a specific science outcome or skill was still considered important on this scale. Teachers did note the two most important outcomes of using a sustainability resource were the ability to affect students' attitudes (2.6) and to help students to learn to live sustainably (2.6). Very close in importance was increasing students' knowledge, affecting student values and assisting in developing decision-making skills all at 2.5.

The final ranking section looked at specific risk and protective factors and the extent that the teachers perceived these factors to influence their ability to teach with a sustainability focus. The teachers were asked to circle the extent they felt a factor

influenced them on the following scale: strongly influence (4), moderately influence (3) slight influence (2), or no influence at all (1). Only the wording was listed in the survey. The values were not included on the form, they have been added to assist in the calculations of the mean value.

4.2.5 Risk and protective factors that support or constrain teachers' ability to teach from a sustainability perspective.

Teachers were asked to score several potential supports and constraints provided in the survey. The scale on which the teachers could score the items were: strongly influence (4), moderately influence (3), slightly influence (2), or no influence at all (1).

Table 4.4

Mean Values of Risk and Protective Factors Influencing the Teaching of Sustainability Issues

Risk or protective factor	Mean
• Time required to adapt sustainability issues from a source to "work" in a classroom	3.2
• Time required to adapt sustainability issue from a source to meet science outcomes	3.0
• Lack of resources	2.8
• Lack of resources for my particular course	2.8
• Lack of resources that are ready to use	2.8
• Lack of ready to use resources for this course	2.8
• Resources are not local to our area	2.8
• Internet or other resources not presented at student level	2.8

• Resources do not link sustainability issues to MB curricular outcomes	2.8
• Depth to which the resources require mastery of science concepts	2.8
• Depth to which the resources require learning from various disciplines	2.8
• Student interest in learning science this way	2.8
• External support such as professional development opportunities	2.8
• Resources are “extras” on top of curriculum	2.7
• Internet or other resources not readable at student level	2.7
• Resources take too much time away from achieving curricular outcomes	2.7
• My interest and motivation to teach science this way	2.7
• Management issues including student behaviour	2.7
• Resources are not local to our area	2.6
• Resources do not require the completion of MB Science curricula outcomes	2.5
• Using sustainability issues takes valuable time from achieving curricular outcomes	2.5
• Course does not lend itself to sustainability issues	2.4
• Support from administration	2.3
• Support from colleagues	2.2
• Using sustainability issues had no long-term effect	2.0

Note. Judgments were made on a 4-point scale (1= no influence at all, 4 = strong influence).

The results indicate that there was greater than a moderate influence when looking at time as a risk factor. Teachers appeared to find time as the greatest factor that impedes them from teaching science from a sustainability perspective. Teacher I and Teacher 01 concur with this finding.

> Time is always an issue. Having well thought out and easy to use resources are always welcome. When I have to spend hours researching resources, the less likely I will be to continue to do so in the future. The more readily available resources are the ones most likely to be used. I think using sustainability resources will empower students. They can learn how 1 person can make a substantial difference on Earth (Teacher I).

"In all honesty, I would love to enrich current sustainability issues within my existing curriculum. However, time is a huge factor" (Teacher O1).

Teachers indicated that the second most influential risk factors were lack of resources; resources in general; resources are not local and resources do not match up with a particular course. These all scored 2.8 out of a possible 4, which indicates that the teachers perceived them to be a moderate influence when looking at the risk factors. Here are some thoughts from teachers related to resources.

"The closer the resource relates to curriculum the more likely it is that teachers will include it in their lessons" (Teacher O).

"Not enough resources" (Teacher D).

4.2.6 Other factors – teacher comment section.

At the end of the risk and protective factors portion of the survey, teachers were given the opportunity to share any additional comments regarding the risk and protective factors they perceived to influence their ability to teach science from a sustainability

perspective. Many of the teachers reiterated the factors listed throughout the survey and their comments have been shared in the sections above.

4.2.7 Summarizing comments from teachers.

Teachers were provided the option to share any summarizing comments. Some of these comments were regarding other sections on the survey, whereas some comments added were in addition to what was previously discussed within the survey. Next are some quotes teachers provided as summarizing quotes on the survey.

“I think this would be a useful resource. Everything we do now to influence students' attitudes toward sustainability will have a positive influence on the future of our planet” (Teacher M1).

“The students need more relevancy in their learning and need to see the direct results of their actions. Sustainability is an excellent way to do this” (Teacher N1).

“Time & effort needs to also be devoted to other subject areas. If science was the only subject I was teaching then planning and all effort could be devoted here” (Teacher Q1).

All of the teacher comments were carefully noted and many were used to assist in the guiding of the creation of the resource document.

4.3 Summary

The results from the teacher survey provided one of the building blocks for the development of the Water Systems resource. Teachers explained that the development of a resource would primarily decrease some of the risk factors (lack of resources, time). It would also achieve the goals of impacting upon students’ attitude and increasing

students' ability to live sustainably on this planet. This is done of the intended goals of developing the resource.

The next chapter will present the results from the pilot use of the Water Systems resource in the piloting schools.

Chapter 5: Results from Resource Implementation with Grade 8 Science Students

5.1 Introduction

This chapter presents the findings from the pre and post-test given to Grade 8 science students. Section 5.2 describes the piloting teachers and school situations they teach within. Section 5.3 provides the quantitative results from the pre and post-tests obtained from the control and experimental groups. Section 5.4 will present the qualitative results acquired only from the post-test. Finally, 5.5 will summarize the results the piloting (experimental) groups and the control groups.

5.2 Piloting Schools and Teacher Background

Three schools containing 5 class groups agreed to participate in this study. The next sections will provide some background information on the participating schools and the piloting teachers.

5.2.1 Niagara School

Niagara School is located in a middle-class Winnipeg suburb. The student population has a mix of students from upper (middle) class families to working families that reside in apartments. The school contains some Korean immigrants and also serves a small number of other 'English as an additional language' students. The classes themselves are set up in a multi-age format containing a mix of both grades 7 and 8.

The teacher, Mrs. Karrie, was in her fifth year of teaching. In the past she had predominantly taught social studies. This unit was the second time in her career that she had taught science. She does not have a science degree and has limited science background. She acknowledges that the resource provided was of great help to her planning. Mrs. Karrie taught 2 of the piloting groups.

5.2.2 King Peter School

King Peter School is a diverse grade 7-9 school in an older suburb of Winnipeg. There is a wide range of middle-lower class students from around the catchment area as they have lower-income housing close to the school. A large portion of the students come from split parent homes. They also have a portion of middle-higher class students that travel in from a wealthy community outside the city to attend the German bilingual program.

The teacher, Ms. Loeb, was in her second year of teaching. She does not have a major or minor in science, and explained that it is not her comfort area. She disliked science all through her schooling and never felt the urge to take any science courses at the university level. Ms. Loeb taught 2 of the pilot classes. The classes Ms. Loeb worked with had a wide range of abilities from grade 1 reading levels and up. These students thrived with the hands-on activities.

5.2.3 Bush Middle School

At Bush Middle School, Mr. Frolek taught one of the pilot sections. Bush Middle School is located in an established suburb of Winnipeg with a fairly low socio-economic base. The majority of the students come from split families. Mr. Frolek has a Bachelor of

Science degree with a general science major and chemistry as a minor. The year he piloted the resource was his first year teaching.

5.3 Pre and Post-Test Results

As mentioned in the methodology section, all participating students were asked to complete pre and post-tests. The pre and post-tests (see Appendices 3 and 4) contained 28 multiple-choice questions addressing four themes. The themes were affinity for science, affinity for sustainability, knowledge about water systems (the grade 8 science cluster the resource was designed to teach) and actions related to sustainability. The post-test did contain 3 additional non-multiple choice questions in which students were asked to share their opinion in a qualitative fashion related to the resource.

Table 5.1

Summary of Means and Standard Deviation (SD) for Pre and Post- Tests in Control and Experimental Groupings for each Section Studied (N=111)

	Affinity for science		Affinity of sustainability		Knowledge of Water Systems		Actions related to sustainability	
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test
Control (mean value)	3.57	3.39*	3.69	3.46*	0.42	0.56	2.22	2.11**
±SD	0.62	0.83	0.43	0.81	0.26	0.24	0.71	0.83
Experimental (mean value)	3.55	3.65*	3.73	3.72*	0.33	0.59	2.23	2.74**
SD	0.47	0.53	0.58	0.56	0.20	0.21	0.76	0.65
Partial Eta Squared		0.07		0.06		0.03		0.23

Note. * p<.05. **p<.01.

The data indicate that, overall, the resource was a success in the five classrooms that it was piloted in as compared to the control classroom. There was a statistically significant improvement (Table 5.1) of the students in the pilot group in three out of the four areas targeted. The greatest improvement occurred in the area of Actions Related to Sustainability. Data from the post-test was analyzed using the eta-squared, which is more subjectively-based and addresses the practical question of whether teachers might consider this difference large enough to consider changing some aspect of their classroom instruction.

The only area that did not contain a significant difference was the Knowledge of Water Systems. There was a greater increase in the mean for the experimental group over the control, but not enough to be considered significant. There are a few possibilities that may have resulted in the lack of significant difference that will be mentioned in the discussion.

5.4 Qualitative Feedback from Students

The post-test provided students with the opportunity to share qualitative feedback on the Water Systems unit they just experienced. There were three opportunities to share this type of feedback in the format of questions.

5.4.1 Qualitative Question 1

The first question asked was “Have you done anything different since the beginning of this unit with regard to water conservation, etc.? If so, what have you done?” There were three themes that emerged from the data related to changes that students made. The fourth category was “no action”.

Many of the students from the pilot groups expressed changes in their own behaviour since they began the unit on Water Systems. Examples of these responses can be found in Table 5.2.

Table 5.2

Generalized qualitative themes emerging from pilot students' answer to question 1

Emerging themes	n	Specific examples of student comments
Taking shorter showers	26	• I have been taking shorter showers. • Yes, I have and my showers are shorter and [I have] helped the environment. • Not really, except trying to take shorter shower. I can't control what the rest of my family does. (but some of them try to conserve).
Turn off tap when brushing teeth/soaping up hands	16	• I turned the tap off while brushing my teeth. • when brushing my teeth I shut off the water. • I usually turn off the tap when I am brushing my teeth, when I do dishes and I go get the door or something I turn tap off.
Other actions related to sustainability	17	• We got a rain barrel to conserve water so we can use it for the plants instead of the hose. • Yes, I talked to my mom and brother about using less water. • I started using less water when washing the dishes and we have a low flow toilet. • We are raising money as a class for that little boy [the classes that were raising money like Ryan Hreljac in the story].
nothing	26	• As far as I can remember I don't believe that I have. • No not yet but maby [*sic*] I will do something.

Note. Some students recorded more than one action they have taken and some students left the section blank.

5.4.2 Qualitative Question 2

The second question asked of the student participants was: "Do you think people should be concerned about water? If so, why?"

The majority of students were concerned with our current water situation (Table 5.3). Many were concerned because they felt that it might affect them in the near future. Some students were concerned about other issues such as the chance of flooding or that people do not have the understanding or knowledge to reduce their own personal water consumption. There were a few students who were concerned about the immediate needs of others in a far off location, or the requirements of future generations to meet their own water needs.

Table 5.3

Generalized qualitative themes emerging from pilot students' answer to question 2

Emerging Themes	n	Specific examples of student comments
Concerned –clean water is running out (will impact these students)/we need water to survive	48	• We're running out! I think that is a good enough reason. • I think eventually, clean water is going to run out and we'll all be like "What do we do now?" We should be more concerned. • We should be concerned about our water. No other planet has water so once we wreak [sic] it, it's done.
Concerned – others far away are impacted by lack of clean water	3	• I think people should be concerned because people are dieing [*sic*] because they don't have water. • Yes because in the future the people wont [*sic*] have any water to drink.
Lack of knowledge of others	4	• Yes, because a lot of people don't care about our water. And some people don't know about how bad our water is. • Yes because if more people knew that they could be more caushis [*sic*].
Concerned about flooding	2	• People should be concerned about water because the river is already flooded enough. • Yes, because water can do a lot of bad things like flooding.
Concerned - Others waste water	2	• Yes, because people don't realize that we're wasting so much water. • I think that people should be concerned about water, because we use it for everything. If we pollute or use it all up we've put ourselves into a pickle (hopefully not the cucumber kind).
Other	7	• yes because it has life in it. • Yes, we are one of the few countries with safe water, we should help others. Stop pollution (global warming) (Ocean currents), etc.
Not concerned	6	• Well, probably. I'm sorry if this sounds mean, but honestly, I'm not that concerned. • Well, a lot of people already are, which is good, I don't see why I would, though.

Note. Not all students answered the question and some answers fall under more than one category.

5.4.3 Qualitative Question 3

The third question asked was, “What are your thoughts on this unit compared to others you have covered this year? Was there anything more/less interesting, more/less practical, and why?”

The emerging themes can be viewed on Table 5.4. The general response from the students was extremely positive. The feedback contained affirming words such as “important”, “interesting”, “valuable” and “fun”. Many of the students qualified their answers providing the word “fun” with other descriptors such as “experiments” or “hands-on” so there is a fair amount of cross over between these two categories. Based on the qualitative feedback from the students, it is evident that, overall, the resource was received well.

Table 5.4

Generalized qualitative themes emerging from pilot students' answer to question 3

Emerging Themes	n	Specific examples of student comments
Valuable info/important to learn	5	• I don't like most science units but I understand the importance of this one and appreciate it. I think it has the potential to be way more beneficial than the others we've done because it addresses SUCH a major issue. • I think the water unit will help me out more because now I know other ways to save water and why we need to save it!
Fun	15	• Most fun of all. I learned valuable info about water. • I liked the story when we mixed everything into the "Red River". It smelled funny but it was pretty fun. I thought water came from and drained into lake Winnipeg until this unit. • I thought it was fun doing all the water experiments. It was interesting.
Hands-on experiments/labs	22	• I really liked this unit because of all of the hands-on experiments (it wasn't boring). • I thought the experiments made it more interesting. • I like this unit the most cause it had hands on learning.
Learned a great deal	7	• lots, I learned a whole lot more about water. I liked how lots of it was hands on, it was the best lesson this and last year, I think. • I like this unit because the numbers were crazy unbelievable and it opened my eyes.
Related to "us"	12	• I think this unit was helpful and if enough people/students hear about this unit there could be a change. This unit compared to other units was more hands on and realistic. • I liked this unit because it taught me a lot about ways to conserve water and it was very interesting. • More practical to install a watersaver [*sic*] head.
Enjoyed the unit – other	9	• I like it cuz [*sic*] I like it.
Didn't like it/less interesting than other units or responded "no" to question 3	12	• No offense, this unit was bad. It was hard to follow lots of experiments and most of them made no sense. They had potential to be very good just not quite there yet. • It wasn't that bad, not as exciting. Less interesting

Note. Some students provided more than one sentence that falls under more than one category

while other students did not provide any qualitative feedback.

5.5 Summary

The purpose of this chapter was to provide the reader with the quantitative and qualitative results from the pilot of the Water Systems resource in 3 Schools in Manitoba. The responses by the students in both formats provides a frame that demonstrates the successes and weaknesses of the resource. The qualitative feedback indicates what individual students felt were the highlights and limitations of the resource. Chapter 6 will review the teacher feedback on any adaptations that they believe is vital for the resource to be a useful tool for other teachers.

Chapter 6: Piloting Teacher Feedback Recommendations of Resource

6.1 Introduction

The teachers piloting the Water System resource were asked to keep a journal and to email any important questions/comments to provide feedback to the researcher. The purpose of this feedback was to share the teachers' thoughts and feelings on how students engaged in and reacted to the lessons. This information proved to be invaluable. The next section of this chapter (section 6.2) will provide insight into the constructive feedback provided by the teachers. Section 6.3 reports the student reactions observed by the teacher; section 6.4 provides a summary of the qualitative feedback from the journals for each lesson that was commented upon.

6.2 Constructive Feedback

The feedback from the teachers ranged from basic grammatical/spelling errors found in the resource to providing additional support material for the resource.

6.2.1 Mr. Frolek

Mr. Frolek reported that, overall, he was pleased with the unit. There were some general themes that appeared in his comments surrounding his personal and professional thoughts regarding the resource. Through many of his journal entries he shared that he enjoyed using the resource. He used many positive expressive words and phrases to describe specific lessons throughout his journal. For example,

"Messy… but fun!" (Frolek, journal entry, Lessons 12-15)

"Awesome" (Frolek, journal entry, Lesson 21)

"Wow, what a great time" (Frolek, journal entry, Lesson 22)

Mr. Frolek also felt that he was not as prepared to teach this unit as he could/should have been. "I know that it is my partially my fault, some unfamiliarity (with the material on my part) caused some pauses. (It is always rough the first go-round!)." (Frolek, journal entry, April 16, 2007).

I would agree that the first time teaching an unfamiliar topic is generally the most difficult, and when you have not prepared the materials yourself there may be things that are not the way you would typically do them. "I have made a few changes to some things, and I find that I am not as ready as I should be on the topics. I would like to have a stronger background in this stuff. It would just make me feel better" (Frolek, email correspondence, April 16, 2007). There are many different things challenging teachers such as learning the background information, dealing with seemingly daily teenager trepidations, community and parent concerns, and being a first year teacher would really compound the issue of just trying to teach a new lesson.

6.2.2 Ms. Loeb

Ms. Loeb provided positive feedback regarding the Water Systems resource. Some of the phrases she used to describe these activities are as follows:

"Great activity" (Loeb, journal entry, Lesson 11)

"Kids loved it" (Loeb, journal entry, Lesson 21)

She noted that a few of the lessons had wording that was at a higher level then her students could fully comprehend: "I felt these questions were over their heads" (Loeb, journal entry, Lessons 3-5)

"I allowed students to use the text to help them. Had difficulty placing transpiration" (Loeb, journal entry, Lessons 10 & 11).

Under such circumstances, it is the teacher's prerogative to provide additional supports to students to successfully attain the learning outcomes of the lesson.
It is my expectation that every teacher will adapt the lessons to work for their individual classes, and Ms. Loeb did just that.

Ms. Loeb and her classrooms appeared to focus on one lesson in particular, the action lesson. Ms. Loeb extended her role as a classroom teacher and supported many of the students on a Saturday to help them hold a fundraiser that was inspired by the final lesson.

> I also am trying to get in contact with the Herald to have a reporter come out and write an article about it. I only hope my students bake as much as they said they would. I have 13 rhubarb crisps in the oven right now. Hopefully I won't be up till 5 tomorrow night baking more (Loeb, email correspondence, June 14, 2007).

This was interesting as none of the other pilot sites embraced this activity in such an enthusiastic manner.

6.2.3 Mrs. Karrie

Mrs. Karrie shared similar positive responses on the resource as the other piloting teachers. Some of the positive feedback received from her were:

"Exc[ellent]!" (Karrie, journal entry, Lessons 6 & 7)

"This was exc[ellent]! I wouldn't change a thing!" (Karrie, journal entry, Lesson 12)

Recently Mrs. Karrie contacted me to share a student comment. She was surprised when a student from last year approached her to remark on the unit he participated in last year:

> So, the grade 8's still remember the H_2O unit and out of the blue one kid last week said.... 'ya that water unit was a lot of fun!' It's amazing how those kids that participated in your unit further this year's discussions on H_2O issues (Karrie, email correspondence, November 26, 2007).

She felt that this unit really did have an impact on the students she taught and hearing feedback from a student nearly half a year later demonstrates that there was some type of impression left with at least one student.

6.3 Teacher Observations of Student Reactions to Lessons

The teachers made some observations about student reactions to some of the lessons. Some responses were generalized while some were specific. For this section I will compare the feedback from all of the teachers for the lessons they commented on.

6.3.1 Lesson 1.

This lesson described the minute amount of freshwater that is actually available for human consumption. Mr. Frolek found this lesson to be well received by his students. "So far the unit is going fine. They really enjoyed the initial demo" (Frolek, email correspondence, April 16, 2007). He also found that the students were very surprised at the world water availability. "Students were amazed @ how little fresh water was available to use. They said they were worried about people around the world… 'how could they get fresh water?'…'we use way too much'. The class was engaged, tangible lesson" (Frolek, journal entry, April 13, 2007).

Ms. Loeb also found a similar engagement level with the first lesson. “[The students were] Not engaged during the time it took to distribute the water, however they were once I began to demonstrate with their participation why the different types of water were not available” (Loeb, journal entry, no date, Lesson 1).

6.3.2 Lesson 2.

Ms. Loeb found the lesson related to teaching the students about sustainable development having unexpected results. “I was surprised with how quickly they came up the 3 topics” (Loeb, journal entry, no date). Both Mr. Frolek and Ms. Loeb found the aspect of teaching the four Systems Conditions of The Natural Step to be “a bit over their [the students’] heads” (Loeb, Journal, no date). Mr. Frolek found that even the examples I provided in brackets to make it more understandable for the student age group were still too difficult for his students to understand. “Examples were high level. I made them (a few) simpler!” (Frolek, journal entry, April 16, 2007). Ms. Loeb felt that the adaptations I did for the students were acceptable for her classes. “Students wrote only the parts in brackets in their notes.” (Loeb, journal entry, no date).

6.3.3 Lessons 3-5.

These lessons were about boiling and freezing point and heat capacity. The non-science teachers felt that they had limited experience with science equipment such as beakers and hot plates and this was a bit of a challenge for them. Mrs. Karrie shared,

> Please remember. I do not have a Sci[ence] background and am learning this as I go. So some of this may be my inexperience, not necessarily a reflection of the unit. BEAKERS…… several of ours cracked, when they went from hot to cold. (Maybe ours are just so old, that they don’t function like Pyrex should) (Karrie, email correspondence, April 22, 2007).

Ms. Loeb also had some equipment concerns. “I am a little weary about some of the things going on in the lab. Is it ok that the rubber stoppers have a hole in them besides the one for the thermometer?” (Loeb, email correspondence, May 6, 2007). This leads me to wonder if there would be other methods these teachers would be teaching the specific learning outcomes related to these topics. If the use of the “science equipment” is new or unfamiliar to them, would the teachers take the chance to try out something they were not comfortable with, if it wasn’t being provided through this resource or without the expectation to use a specific lesson created by someone other than themselves?

6.3.4 Lessons 6 & 7.

The lessons about hot and cold currents were fairly simple. Lesson 6 involved the teacher demonstrating that when ice melts, the cold water interacts in a specific way with the warmer water. This was easily shown to the students by using glass pan and an overhead projector. By having an ice cube containing red colouring and by sprinkling a bit of pepper on the surface of the water, the students were able to view the movement of the water.

In Mrs. Karrie’s class, one student suggested that the water contain blue food colouring to represent ocean water. Mrs. Karrie, as previously mentioned, felt that this was “Exc[ellent]! worked well as demo” (Karrie, journal entry, no date, Lessons 6 & 7).

Lesson 7 had the students reading different facts about ocean currents and answering some questions on a sheet supplied in the resource. Ms. Loeb felt that “This activity didn’t engage the students enough, therefore they didn’t answer/fully understand the questions.” She did provide a solution to help the students continue to acquire this knowledge. She wrote, “…maybe put each fact on a separate card and place around the

room. That way the students are more aware of what they are looking for and not overcome by facts + info. It also gets them out of their seats." (Loeb, journal entry, no date, Lessons 6 & 7). I did take this suggestion and adapted the lesson to follow her idea.

6.3.5 Lesson 8.

This lesson had the class review the water log they had been keeping for the past week and set a goal to decrease water consumption in the upcoming week by 50%. Mr. Frolek explained that he had an interesting discussion with his class.

> Discussion of water + conservation went well. It seemed to stimulate within the students interest. Most seemed to feel it was completely impossible to reduce their water consumption. I presented them with a couple of ideas. 'If its yellow let it mellow… if its brown flush it down!' (Frolek, journal entry, May 1, 2007).

He explained that he was looking forward to see if it is even possible for the students to attempt this lofty goal. "I will be curious to see who tries to reduce their water consumption" (Frolek, journal entry, May 1, 2007).

Ms. Loeb, on the other hand, didn't think it was worth the time working on this particular lesson. "I skipped filling out another booklet. Too many students didn't take the responsibility to fill out their own. Didn't want to waste the paper" (Loeb, journal entry, no date, Lesson 8).

Sometimes it can be frustrating as a teacher when students do not complete homework assignments, even those as simple as recording their water consumption. It will most definitely impact on subsequent lessons. Mrs. Karrie would probably concur with Ms. Loeb's thoughts. Mrs. Karrie recorded that her "kids didn't buy into it" (Karrie, journal entry, no date, Lesson 8).

6.3.6 Lesson 9.

Lesson 9 had students creating watersheds out of newspaper and plastic wrap in containers. They were to use spray bottles to represent precipitation falling onto the land formations (the moulded newspaper under the plastic wrap). Two of the teachers commented on the idea of providing 13 year olds with spray bottles and the chance a teacher takes doing that. For example, Mr. Frolek wrote,

"'Loaded Waterpistols [*sic*]'… a new lesson title" (Frolek, journal entry, May 2, 2007), and "kids were a little excited to be handling the squirt bottles" (Frolek, journal entry, May 2, 2007).

Ms. Loeb concurred. "Spray bottles and grade 8 students don't always go together" (Loeb, journal entry, no date, Lesson 9). A teacher must make a decision as to the ability of their classes to handle an activity such as this one. Teachers may also need to adapt lessons in a manner that their students can work within appropriate parameters.

Both Mr. Frolek and Ms. Loeb had suggestions that I incorporated into the Water Systems resource. Ms. Loeb suggested that tin foil would be more malleable than newspaper for creating and holding shapes of landforms. Mr. Frolek suggested the use of a plastic bag to place over top of the landforms instead of the plastic wrap. I agreed that both of these suggestions were good ideas and added them to the resource.

6.3.7 Lessons 10 & 11.

These two lessons provided a review of the water cycle. By this time, students should have learned about the water cycle several times during their science classes in Manitoba, most specifically in grade 2 and grade 5. Three examples of SLOs required by MECY are

- Describe evidence of water changing state, and recognize that these changes are part of the water cycle.

  Examples: puddles evaporating after a rainstorm, snow melting (Manitoba Education and Training Foundations document, 2000, SLO 2-4-07).
- Explain how the transfer of energy from the sun affects weather conditions. Include: the Sun's energy evaporates water and warms the Earth's land, water, and air on a daily basis (Manitoba Education and Training, 2000, SLO 5-4-13)
- Explain how clouds form, and relate cloud formation and precipitation to the water cycle (Manitoba Education and Training, 2000, SLO 5-4-14).

The two lessons provided for the grade 8 students are not only created as a review, but also to provide support for those who may not have taken science in Manitoba in the previous years of school.

The final product from these lessons is a story of a day in the life of a water droplet. With this lesson, all three piloting teachers took a different approach to teaching this lesson. Ms. Loeb followed the lesson that I had created and was taken aback by enjoying this activity with her students: “Great activity! Thought the kids wouldn’t be into it. Was very surprised by the results. An activity everyone could do. Definitely recommend getting involved with grade 2’s” (Loeb, journal entry, no date, Lessons 10 & 11). For those students who had created exceptional booklets, Ms. Loeb gave them an opportunity to go into a Grade 2 class (that was also studying the water cycle) and read their booklets. The overall quality of these booklets (Figures 6.1 and 6.2) was much higher than Ms. Loeb had expected and the students appeared to enjoy the time working on this small project as well as sharing it with younger students.

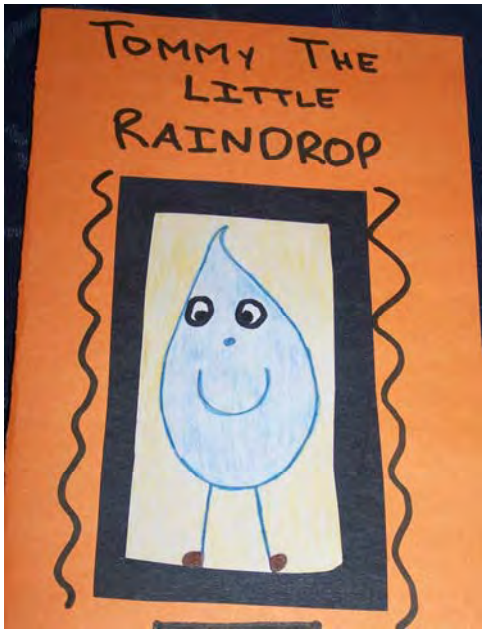

Figure 6.1. Student title page of water cycle booklet.

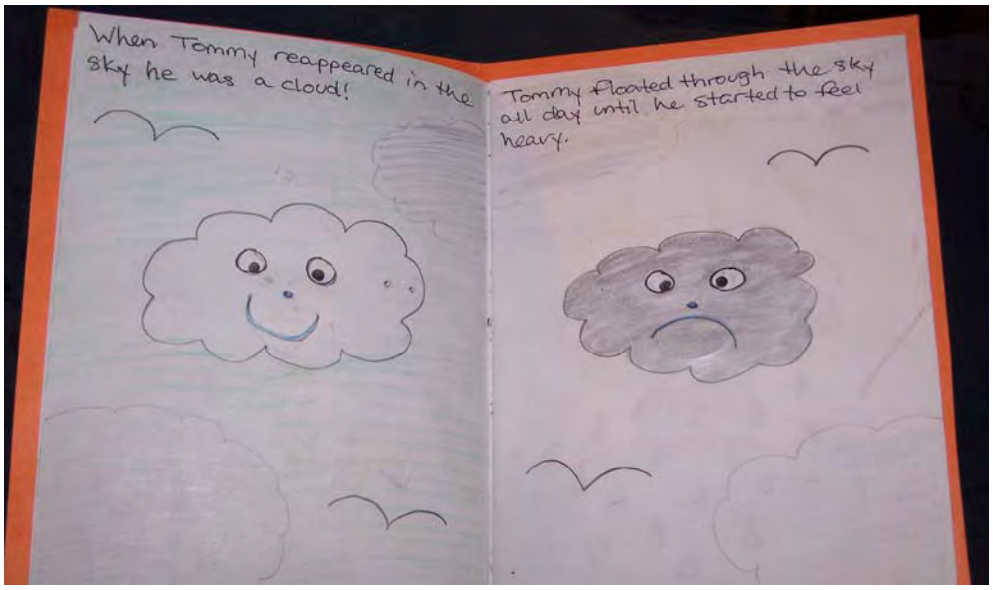

Figure 6.2. The application of the water cycle in the student's booklet.

Mr. Frolek decided to try a different version of the lesson provided in the resources. "For the children's story book (as long as you don't mind) we are using Comic

Life...making comic books of the water cycle" (Frolek, email correspondence, May 11, 2007). He reported that, "Most students found it interesting. Some were very creative". (Frolek, journal entry, May 7, 2007). Again, this resource only provided a guide and having alternative methods of distributing information is helpful for different teachers and different classes.

Mrs. Karrie deviated the greatest on these lessons. On the Internet she found a play related to the water cycle and enjoyed using that lesson with her students. I thought it was another good activity and wanted to include it in the resource as an extension activity. I attempted several times to contact the website with no response. Unfortunately due to copyright laws I could not include it in the resource.

6.3.8 Lessons 12-15.

These lessons focused on erosion, deposition and the impact of humans on riverbanks and. The students were to create stream tables and use clay and other materials to construct a variety of landforms. For Mr. Frolek's class it appeared that this activity was not exciting. He reported that, "This group seems dis-interesed!" (Frolek, journal entry, May 10, 2007). Mrs. Karrie found that her students needed more guidance for this activity and created "scenario cards" to guide her students through these lessons. I included those scenarios as an example for other teachers in the resource.

6.3.9 Lesson 16.

At this point students were to share their successes or challenges in reducing their water consumption by 50% as well as promoting water conservation to others through a poster. Ms. Loeb did not have her students record their water consumption for this

activity since many did not do this during the previous assignment. She did, however, get her students to create the posters. Again, many posters were of great quality (see Figure 6.3, 6.4 and 6.5).

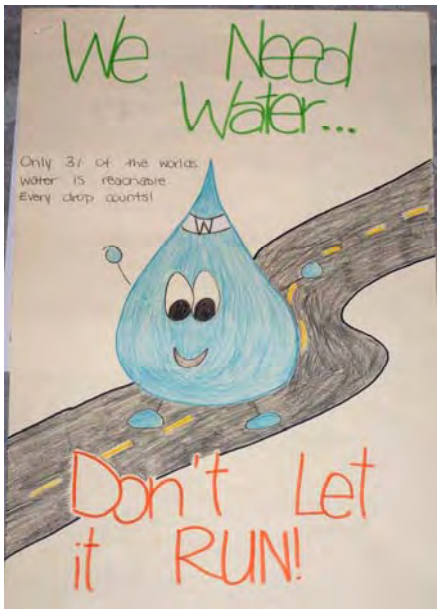

Figure 6.3. Creative student poster reminding others to not let the water run.



Figure 6.4. Creative student poster reminding others to use a bucket not a hose to wash the car.

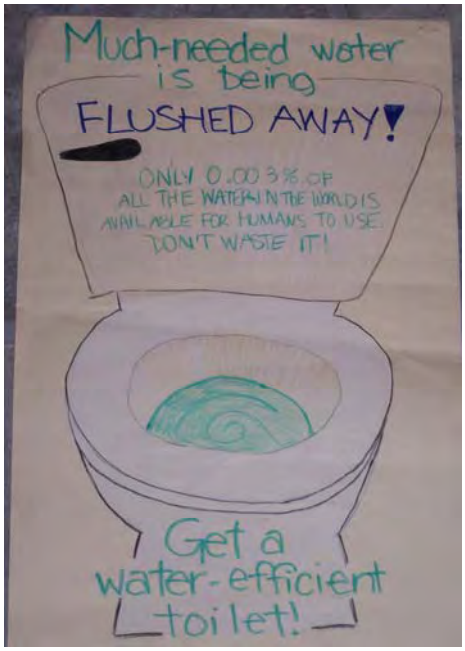

Figure 6.5. Creative student poster educating others to use water efficient toilets.

Mr. Frolek reported that he was dissatisfied in his students. According to a student self-evaluation he administered, he found that the students were generally disappointed in their lack of attempts to decrease their individual water consumption: "1 student reduced H20 use by 50%. Not very impressive. Self eval[uations] went well for most students. But some took it too far. Almost too severe on themselves" (Frolek, journal entry, May 14, 2007). Conversely, he found that the students took well to creating and distributing their posters. "Posters were a hit!" (Frolek, journal entry, May 14, 2007).

6.3.10 Lessons 17-20.

The objective of these lessons was to educate students on where and how Winnipeg residents (or local area residents) obtain and dispose of their water and waste. The City of Winnipeg had created videos many years ago that explained both of those topics. The style and quality of the videos are rather dated, but the information is still

relevant. In order to assist students in following the video information, the Water Systems resource provided a pre-test for students to predict answers to questions surrounding where Winnipeg obtains and disposes of its liquid wastes. During or after viewing the videos the students could complete a post-test.

Several teachers felt that the quality of the videos was very poor: “I wouldn’t show these videos again. Outdated” (Loeb, Journal, no date, Lessons 17 – 20). “Video quality too hard to get all answers. Kids did not like this” (Karrie, journal entry, no date, Lessons 17-20). Interestingly, Mr. Frolek’s students did not have the same reaction.

> Movies with pre + post-test worked tremendously for most students. We ran a little overtime due to short periods so this included May 16 as well. Even the lower functioning students performed well. I had to prompt the students (at first to get them into it), but after that it ran smoothly” (journal entry, May 15, 2007).

It is fascinating to see how every lesson is received differently in different classes and with different teachers.

6.3.11 Lesson 21.

This objective of this lesson was to demonstrate how human choices and actions affect water systems. The teacher read the story “Who Polluted the Red River” and provided students with “pollutants” in film canisters. The story demonstrates how often our water systems are used as a dumping grounds for our wastes. When the title that is recorded on the student’s canister was read out, they were to pour the contents of the canister into an aquarium half filled with water that represented the local river. By the end of the story, the once clean river was now cloudy and filled with “pollutants” such as septic water (water, yellow food colouring and toilet paper) and expired medication (round candies). It was important that all of the pollutants were actually non-toxic and

safe. Ms. Loeb reported that she felt it was a “great activity. Kids loved it” (Loeb, journal entry, no date, Lesson 21); Mr. Frolek concurred: “Awesome. They [the students] really enjoyed this” (Frolek, journal entry, no date, Lesson 21).

6.3.12 Lesson 22.

In Winnipeg, wastewater is cleaned at our local water treatment facility, but what happens in other places where they may have less money, technology or even literacy? To study this, the students took part in a lesson called Water for the World. They broke into small groups and were provided with country profiles that supplied various pieces of information such as literacy rate and infant mortality rate for each particular country. The students may recall that they learned some of this information in Grade 7 Social Studies, which demonstrates the interdisciplinarity of sustainability. The students were also given a certain amount of money that corresponds with the development of the country they were representing. For example, students in the group representing Sweden received $1100 to purchase water filter supplies while Afghanistan was given $18. The instructions in the package that each country received were also gauged according to the literacy rate for the particular country. Instructions for the United States where the adult literacy rate is 99% are clear, understandable and have a diagram provided (Figure 6.6), while the instructions provided to Sudan contain some familiar words interspersed between many unintelligible symbols and do not have a diagram (Figure 6.7). The symbols and representing words that are incoherent demonstrate the 61% literacy rate in Sudan. This lack of ability of many persons in this country to read or comprehend instructions will also be reflected on the students when they too cannot understand all of the directions.

Instructions – United States

1. Loosely put a cotton plug in the neck of the cut bottle, then cover the neck of the bottle with a piece of cheesecloth secured with a rubber band.
2. Pour a 1-cm layer of fine sand over the cotton plug, followed by activated charcoal, 1-cm of coarse sand, fine gravel, and coarse gravel.
3. Clean the filter by slowly and carefully pouring through 1-litre of clean water (over a bucket).
4. Place the filter over a plastic cup. Now, test your water filter by pouring half of the dirty water through the filter.



Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$5 each
Cheesecloth	$5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		

Figure 6.6. Instruction page for United States

Instructions - Sudan

1. Loosely put a µ¶{{¶§ plug in the ΣΨΘκ of the cut bottle, then º»µ{Ψ the neck of the bottle with a piece of ¥«ΘΘ¬Θ cloth ¥Ðς΢Θ§ with a rubber ¶µ´.
2. Pour a #-Ψ¬ layer of fine ¤ςÐ¥ over the cotton plug, followed by µÆΣ¥ςÐð¶ charcoal, 1-cm of ς§Θ΢Σ´ sand, fine ³#¾¿Ψ#, and coarse gravel.
3. Clean the filter by slowly and carefully pouring through 1-litre of clean ¤¾ÐΣΨ (over a Ðςלֿ¶).
4. Place the filter over a ¶Æµ©ςΨ¤ cup. Now, test your water ς⇌©¶ς¢ by pouring ³Ð÷ð of the dirty ¢±³ÐÆ through the filter.

(note: no helpful diagram provided)

Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$5 each
Cheesecloth	$5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		

Figure 6.7. Instruction page for Sudan

The students were to purchase supplies from the "World Bank" to create a filter to clean the polluted water they made in the previous lesson.

This is a challenging activity; some students may behave in a manner that they believe people from a certain country may act and react in certain situations. In Ms. Loeb's class some students got out of hand because they were unable to achieve the goal of purchasing needed equipment such as sand or gravel. "It was chaotic for me. Once the students realized they could steal they became very immature" (journal entry, no date, Lesson 22). Ms. Loeb may have failed to realize that yes, the class may have gotten out of control, but theft does occur in the real world when people cannot access required supplies. There is a great opportunity for a teachable moment here, but often when the students get very excited it is hard to bring them back to focus on importance of the activity.

Mr. Frolek's class had a positive experience with this activity. "Wow, what a great time… Awesome fun!"(Frolek, journal entry, May 21, 2007). The class attempted to re-enact the current situation in the world.

> Before the groups could get the materials I had them make a shopping list to prove they had the funds necessary. The poorer countries went for aid…hoping that U.S. and Canada would donate. Some countries did give out aid, but they first make sure they had all funds required. U.S.A. did not give aid to Afghanistan… for various reasons" (Frolek, journal entry, May 21, 2007).

Mr. Frolek's strategy would have cut down on the potential chaos, but I believe that each teacher needs to determine his or her comfort level with an activity like this.

6.3.13 Lessons 23 & 24.

Due to the time of year this unit was started (end of April, beginning of May) teachers began to experience external constraints against their unit delivery. Near the end

of the year some schools had exams and the teachers began to run out of time and, from this lesson forward, not all teachers had time to try them all in their classes. The teacher(s) who was able to try each lesson will be highlighted in this section.

Lessons 23 and 24 focused on substances that pollute the water that originate from our homes and garages. Many of these pollutants are toxic; fortunately they do have non-toxic alternatives. For these lessons, the teacher brought some empty household cleaners or paint containers from home. The students were divided into different groups to research a certain area of the home such as a bathroom or garage and the type of hazardous materials (ex. cleaning supplies) that may be found there. The students reviewed the information on the containers and recorded it on the household contaminant sheet. The students then collected data from their own homes and conducted research on different, alternative, non-toxic cleaners that could be used. Mr. Frolek thought that the students did well and achieved what he had expected for this lesson (Frolek, journal entry, no date, Lessons 23 & 24).

Mr. Frolek was concerned that the students didn't understand the consequences of adding chemicals into our water systems. "Students seemed to not really mind that there are so many products with harmful things in them… I am not sure the group quite has the grasp as to the damage that we cause" (Frolek, journal entry, no date, Lessons 23 & 24). This is an opportunity to remind students of the earlier activity when chemicals were added to the river, to discuss the water cycle and how clean water is not created quickly.

6.3.14 Lessons 25 & beyond.

The inspiration for the final activity of this unit is a story about a young Canadian boy who made a difference when he heard about people in other countries not having

access to clean water. Ryan Hreljac was just six when he began to raise money to purchase a well in Africa. The story from *Reader's Digest* (January, 2001), is touching and meant to motivate the students into trying to make a difference as well. This seemed to be the one lesson that was not well received by Mr. Frolek's class. His students felt that "This story was too long, most said" (Frolek, journal entry, no date, Lesson 25). His students were not interested in making a difference: "Most students are dis-interested. This is becoming a challenge" (Frolek, journal entry, no date, Lesson 25). This reaction is interesting compared to the situation occurring in Ms. Loeb's class:

> I didn't quite get to the final project at the end and we are now into exams. However, I made sure that I made time to read Ryan's Well to the kids. I was pretty surprised at how most of them listened so intently, it truly is an inspiring story. Anyways the kids decided that they wanted to do something, so we decided to try and raise money for a well and donate it through Ryan's well foundation. We have been collecting donations in watercans [*sic*] (we're already at $100 from the kids alone) and I am matching whatever they put in. Also we are having a bake sale on this Saturday… (Loeb, email correspondence, June 13, 2007).

The students were very motivated by Ryan's story. It was interesting that one of Ms. Loeb's math classes saw the watering cans that the other 2 classes were using to raise funds (Figure 6.8) and were interested. Ms. Loeb read them the story and they wanted to participate as well.



Figure 6.8. Student counting money they raised for building a well in Africa.

Ms. Loeb's classes' goal was to reach $500 to help build a well in Africa. In the end, the three classes raised $890. The students were very impressed at what they accomplished.

It was unfortunate that the school year was coming to an end and that all of the teachers did not have a chance to complete all of the lessons. This is a common occurrence in schools. Time is definitely a factor.

6.4 Summary

This chapter focused upon the journal entries and email correspondence from the piloting teachers. The teachers shared thoughts and feelings on how the students participated in the lessons as well as how the teachers themselves felt about the lessons. The teachers also provided thoughts on improvements to some of the lessons.

The next chapter contains the discussion and opportunities for further research on this topic.

Chapter 7: Discussion

7.1 Introduction

This study began with the underlying assumption that middle years science teachers required additional supports for the teaching of science and sustainability in the classroom. This study had two objectives: to confirm that teachers did indeed require additional supports for teaching science and sustainability in the classroom, and to create, pilot and share a resource to provide support to middle years science teachers for this purpose. This chapter will reiterate the two research questions posed and attempt to provide answers based on the evidence gathered in this study. Also examined are concerns that may exist with the resource. The following sections will summarize the pertinent findings, discuss implications for the development of sustainability resources and provide recommendations for future research on the topic.

7.2 Answer to Research Question One

Question One: What are the risk and protective factors teachers identify as constraints and contributors to the implementation of a science-based sustainability curriculum while working in a system defined by the interaction of the world at large with student engagement in the sciences?

To answer this question, the first step was to create a survey. Building on ideas derived from the literature as well as my own personal teaching experience, a list of headings and questions was derived. The generated list is provided below. Teachers were asked to consider the following questions or activities:

- Where they get their ideas for sustainability issues and how frequently they use them (Appendix 2, Survey Section A: Source of Sustainability Issues),
- To comment on whether they had used or heard of a series of local (i.e. Manitoba Model Forest) and international resources (i.e. Millennium Ecosystem Assessment) provided to them, highlighting their readiness to utilize ready-made resources (Appendix 2, Section C),
- What information would they include as to "why" teachers would teach sustainability issues (Appendix 2, Section D: Goals for Teaching Sustainability Issues),
- To share with other teachers what they felt was the influence of a list of risk and protective factors (Appendix 2, Section Three), and
- To add any other influencing factors related to supports or constraints of teaching EfS, as well as a written summary of additional information that they would like to share (Appendix 2, Section Three and Four).

It was determined from the teacher survey, and well supported by the literature, that the two strongest risk factors regarding teaching sustainability within a science class were lack of time and lack of resources (Cortese, 1999; Farrell & Papagiannis 2002; Stapp et al. 1996a; Summers et al., 2003). Teachers highlighted these two areas in many ways. One such example specified that teaching other subject areas and grades affected their ability to plan around the issue of sustainability (time). It was reiterated that there was a lack of resources that related to the curriculum outcomes and a lack of resources that were ready-made to work in an individual classroom with different factors affecting

it, such as student composition, needs and abilities. A third issue repeated frequently in the literature was the idea that sustainability related topics were highly complex (Gayford, 2002; Gayford, 2004; Groves & Pugh, 2002; Hart, 2003; Stapp et al., 1996b; Summers et al., 2003, Summers et al. 2005).

Considering these three main risk factors, I developed a resource that would:

1) Save teachers time as it contains all required information for the teacher – i.e. any complex background information, assessment strategies, detailed lessons and materials that are easily accessible, and,

2) Fit into an appropriate time frame within a busy school year (25 or more lessons that can be expanded if time were to be available), but also fulfills all of the Specific Learning Outcomes (SLOs) mandated by the Manitoba Science Curriculum.

Providing this resource within the context of the global system (Bronfenbrenner, 1979) demonstrated that concerns about water are not only local to the area that students live in, but are also of a global nature. One of the objectives of this unit was to highlight to students that they can make a difference both locally and globally.

This ready-made resource that is easily adaptable also impacts upon the systems effect upon teachers in the classroom. When first viewing the “microsystem” (Bronfenbrenner, 1979), having a resource that provides background information for teachers supports them when some teachers may not know about or understand some of the highly complex issues surrounding sustainability. According to Lewthwaite (2005), teachers also need to be ready to be willing to work towards a change in one’s knowledge about science and a positive attitude. Even though sustainability issues may be highly complex, the opportunity to learn about them and determine the most positive manner in

teaching these issues to students is there. But, if a teacher is not ready to create this change, or is not willing to try, then attempting to teach about sustainability issues may not occur.

Moving outwards to the “mesosystem” (Bronfenbrenner, 1979), having a document that can demonstrate to local school administration meet the specific learning outcomes as well as provide kinaesthetic lessons for students with not a great deal of expensive equipment may present them with the ability to support more sustainability within the school walls. Often science is associated with laboratories, microscopes and other various pieces of apparatus – often with a high cost associated with them, but if the ability to meet the SLOs can occur without this high cost, that may assist proactive approach science by using that money for other units that require it.

According to Lewthwaite (2004), the principal is extremely important when looking at science delivery and influencing the manner in which teachers deliver science. In the “mesosystem” the local administration is the “instructional leader” (Lewthawaite, 2004, p. 147) and this is a strong risk or protective factor a teacher, depending on the beliefs the principal has regarding sustainability. The principal’s support can also have an impact when funds are being disbursed for science classes. If the principal does not value science or sustainability, the opportunities for access to funds may not be as easy as schools with a supportive administration.

The “exosystem” (Bronfenbrenner, 1979) can be influenced by this resource by promoting teachers to create and share their own lessons and units. The local school and surrounding community may also be supportive when learning about the hands-on

activity that the students are pursuing. Trying to make a difference in their own community may be valued.

Finally, this resource can even have an impact related to the "macrosystem" (Bronfenbrenner, 1979). Teachers cannot do anything about the limited time they have to prepare for lessons. When using a resource that provides them with background information, exciting lessons and a variety of assessment strategies can decrease the amount of time taken to prepare every lesson. It is not to say that teachers should take all of these lessons and use them blindly in his or her own class, but to adapt as required for each student population they encounter.

7.3 Answer to Research Question Two

Question Two: What are the consequences, in terms of student knowledge, orientation and action within science and sustainability, as a result of being participants in a science-based sustainability education curriculum structured on the foundations of The Natural Step?

Using The Natural Step (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002) as a foundation for this sustainability-based science resource package provided the underpinning for teachers who have little understanding about how to incorporate sustainability into their lessons.

The results from the student pre and post-test deem that this resource may have influenced three of the four targeted areas. With respect to the *Affinity for Science* section, the pilot group had a significantly higher post-test score from the pre-test as compared to the control. It was exciting to see that this hands-on unit may have increased the affinity for science experienced by students in Grade 8. Many of the students

commented on the interactive nature of the unit and how they enjoyed learning in a kinaesthetic manner. This was also supported by brain-based research and the ideas surrounding transfer. By using simulation games such as debates and investigations, a student can practice solving complex issues (Sousa, 1995).

In the *Affinity for Sustainability* section, the pilot group also demonstrated a significant improvement on the post-test compared to the control group. I am sure that none of the students had ever heard of the Four System conditions used by The Natural Step (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002) to define sustainability, and it is my hope that they keep them in mind when making decisions. It is the hope that students can take what they learned about these Four System conditions and make them practical in nature related to the students' everyday life. Students make decisions every day and are one of the most powerful consumer groups in our country. They need to be making wise choices when exerting their purchasing power.

The questions related to *Knowledge of Water Systems* came directly from the SLOs required by the Manitoba Government. Questions regarding Manitoba's watershed (SLO 8-04-07) and flooding (SLO 8-04-12) were asked in the pre and post-test. There was no significant difference between the groups according to the pre and post-test results. There was an overall increase in *Knowledge of Water Systems* by both groups that was expected, since both groups were being taught the same unit with the same SLOs. Furthermore, since all of the students were learning about Water Systems and of meeting the same SLO, it would be expected that any method of delivery chosen by a teacher would attain these outcomes.

Another thought as to why there was not a significant change may be due to the fact that the questions posed on the pre and post-test had a right or wrong answer – thereby narrowing the range for the answers. The questions were fashioned in a multiple-choice manner (Groves & Pugh, 2002) that contained one correct answer and four incorrect answers (with the exception of question 21 where two correct answers were required). This strict correct or incorrect scale, as opposed to the range of answers in the three other categories, demonstrated a lesser degree of variability in the answers.

The fourth section of *Actions Related to Sustainability* is where the most significant difference occurred. This section was designed to see if there was an improvement in actions related to sustainability. There was a highly significant change in the experimental group over the control. Due to the relevant nature of the information shared in the experimental groups and the more interactive, hands-on approach (Sousa, 1995), the students enjoyed and, therefore, followed the lessons more closely. Overall, three of four sections demonstrated a significant difference between the improvement pilot and control groups according to the pre and post-test scores and this may be attributable to the use of the resource.

There are other factors aside from the resource that may have also contributed to the difference between the control and pilot groups. The main factor is the individual teacher. Teaching style and personality can have a vast impact on a student's ability to learn. If a student enjoys participating in the teacher's class it makes it easier to enjoy the subject matter. The method by which the teacher imparts learning (even following a resource) will impact on the student's ability to learn. The teachers who chose to pilot

the study were obviously interested in sustainability (by choosing to participate) and all appeared to be dynamic and exciting individuals.

Within the classes academic ability and socio-economic factors are randomly distributed thereby avoiding a bias in the results. It also prevents the influence of administrative support for Education for Sustainability (EfS), as both the control and experimental groups had the same administration.

Explicitly comparing this resource to other resources that are accessible to teachers one can see many differences. As noted in Figure 2.1, no other ready-made resource researched contained all of the components that were determined to be of value for teaching about sustainability in this manner. No other resource utilized The Natural Step as a foundation and decision-making tool. A few of the resources met some of the Manitoba Curricular outcomes, but again for a teacher to take the time to determine which lesson meets which outcome is time consuming, and that was one risk factor that was noted often. Many of these resources referred to sustainability, but only one was explicit with the term, and there was not a great deal of actions that promoted sustainable behaviours, which is extremely valuable when looking at changing students' everyday behaviours.

7.4 Interpretations

7.4.1 Students

The overall conclusion was that this resource was useful and that the intended goals were successfully met. Are the use of The Natural Step (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002) and Bronfenbrenner's Bioecological Theory (1979) effective in the development and

implementation of a science-based sustainability resource? The results indicate that when observing students' feelings about learning science, there was a significant increase in the pilot group over the control in this study. When looking at the mean results for the *Affinity for Science* section, post-test results were significantly greater in the pilot group ($p > .05$) with the exception of one question that stayed the same. In the control group, scores for all but one question decreased. The increase in appreciation for science was evident and it is likely that this is at least partially attributed to the use of this resource by the piloting teachers.

Similarly, in the section related to *Affinity for the Environment*, significance was present between the post-test of the pilot and control groups ($p > .05$). There was an overall decrease in the mean results by the control group, with only one question increasing slightly. In the experimental group, all but one of the mean results increased. The inference may be that learning about local water issues and employing strategies such as The Natural Step to assist in decision-making, the students are able to see that their feelings about the environment do have an impact.

The final section, *Actions Towards Sustainable Behaviours* had again, significant differences between the pilot and control groups. There was a substantial increase in the pilot groups' actions related to sustainability, and this was demonstrated by self-identifying how often or how willing a student was to take specific actions related to sustainability, such as speak to his or her parent regarding water-saving devices. The control group, however, had slight increases in the scores of three of the seven questions, but this was not even close to the large gains the pilot group made after being taught with the Water Systems resource. The largest increases were in the "easy" category of taking

action. Students learned that there were many things that could be easily done with little effort on their part. For example, question 25 asked, “To conserve water, I turn off the water when I am soaping up my hands or while I am brushing my teeth”. The scale the students had to choose from was “never” (1), “occasionally” (2), “sometimes” (3), “often” (4), or “always” (5). The pilot group pre-test mean was 3.31 while the post-test was 4.01. This difference was statistically significant with $p<.01$. Now, the majority of students “often” turn off the water when not using it directly. This is a great change that could be attributed to the basic knowledge learned through the resource and the decision-making process of The Natural Step.

A second example of changes experienced by the pilot group related to Question 23 in the Actions Towards Sustainability section, “I have talked with my parents about how to help with environmental problems”. This is an important question, as students do not often have the power to make major decisions in their homes. For this particular question the mean jumped from 2.01 to 2.51, indicating that students now sometimes speak to their parents about these types of issues. Because these students are now sharing information with their parents that may assist them in making wiser choices related to sustainability, this resource now reaches an entirely new population that might not normally be thought of as a target audience when teaching middle school.

7.4.2 Piloting Teachers

The teachers who piloted the five sections of the experimental groups stated that they enjoyed teaching the unit and have all indicated that they will be using the Water Systems resource in the future. Some of the suggestions they provided could not be used in the resource due to copyright restrictions, such as a, *Water Cycle Reader’s Theatre*

Script (found at www.enchantedlearning.com/rt/weather/watercycle.shtml). The agency that is credited with this script did not respond on several occasions. This does not stop a classroom teacher from using this, as it is accessible on the Internet and is meant to be used by teachers. Another such example was a Microsoft® PowerPoint® presentation provided by one of the teachers to assist in student understanding of how different types of deposition influence flow rates of streams and rivers. As I was unable to attain permission to use those images, it could not be used in the Water Systems resource. These are, however, excellent examples of how an individual teacher will adapt this resource to work with his or her own personal teaching style, and make it a better fit for the students.

7.5 Potential Concerns

Overall, this Water Systems resource was well received by the piloting teachers. It was attempted to make this as "teacher-friendly" as possible, keeping the resource gathering and time to put lessons together to a minimum.

The first concern is the creation of some of the materials for this unit. Two of the most popular lessons with the piloting teachers are fairly labour-intensive. *Water for the World* requires the purchase of two types of sand and gravel, cotton, cheesecloth and various other materials. It also requires cutting several two-litre bottles as the filters. The benefit to this preparation is that the bottles can be re-used and there is not a great deal of sand and soil used so the materials could last several classes (or years).

The same can be said for *Who Polluted the Red River*. The collection and labelling of film canisters may be lengthy and the purchase of all the materials to place in the canisters is more time consuming than expensive. However, if a teacher is unsure of

his or her placement the ensuing year, the amount of time it takes to prepare for these two lessons may outweigh the rewards of these hands-on opportunities.

Another concern related to *Water for the World* has to do with students who have immigrated from, or have relatives who actually live in a region represented in this activity. For example, it may be uncomfortable for a student from Afghanistan to participate in this activity due to the discussion of the extremely low literacy rate in his home country. Each teacher must assess the class and make wise choices as to the countries chosen for this activity. In addition, a prior conversation with any student who have emigrated from a country listed in the activity to gauge the comfort level of the individual would be important.

7.6 Conclusions

To conclude, I have attempted to create a resource that, by using Bronfenbrenner's Bioecological Theory (1979) and The Natural Step (James & Lahti, 2004; Natrass & Altomare, 1999; Natrass & Altomare, 2002; Robèrt, 2002) as a foundation for teaching students about Water Systems as prescribed by Manitoba Education, Citizenship, and Youth (MECY), will not only increase a student's affinity for science and sustainability, but will increase his or her knowledge about this topic and will promote actions related to sustainable behaviours. The elements in the teacher resources were to provide any necessary background information, succinct lessons that are easy to present. The lessons themselves were to be hands-on and engaging to students and focus on sustainability while still achieving the required provincial learning outcomes. With opportunities for teachers to adapt pre-made lessons to a specific classroom or teaching needs, this type of resource can assist in providing lessons related to sustainability while

providing protective factors and decreasing risk factors such as time, resources and dealing with complex issues.

The following recommendations are suggested as a result of the findings of this study. The suggestions primarily focus on supporting teachers in their development to address EfS. These suggestions will be presented under the system headings that Bronfenbrenner (1979) identifies:

Microsystem

1. It remains a challenge for teachers to fully understand the concept of EfS and how they can apply this to their classroom instruction. Personal and professional increase in interest and knowledge surrounding these issues will support the teachers' background knowledge when teaching topics related to sustainability. Teachers need to take advantage of any professional learning opportunities surrounding sustainability.
2. It is a concern that there are a lack of sustainability related resources that achieve the Manitoba curriculum SLOs. As teachers develop units for their own classrooms they should connect with other teachers to share successful sustainability-based lessons that worked well in their own classes.

Mesosystem

1. Having a supportive administration that can provide additional planning time for teachers to prepare all lessons, not just those surrounding sustainability, would be helpful. Since sustainability may be best taught in

a cross curricular manner, teacher and subject integration planning time would be valuable as teachers rarely have time to plan together.

Exosystem

1. If a school division values sustainability, then professional learning opportunities should be in place. Teachers need to have greater opportunities to learn from “expert” teachers in professional learning sessions within their own divisions and then have the chance to go back to their own schools to share new information with other teachers. An increase in these types of opportunities would be a great support.
2. More resource development and/or resource sharing needs to occur. There are resources available but it takes a great deal of time to adapt them to the SLOs of the Manitoba Curriculum as well as to focus on sustainability. Opportunities within school divisions to create and share lessons need to be provided.
3. When funding or support is provided to a group of teachers related to creation of sustainability lessons within a particular division, these lessons should be collected and posted in a place where teachers within the division can access them, such as the division web page.

Macrosystem

1. When designing new curricula, use of specific language that promotes the term sustainability and actions related to sustainability would assist in the development of our students’ leadership capacity.

2. There needs to be provision of resources directly related to the SLOs and these should be identified and possibly mandated by Manitoba Education, Citizenship and Youth (MECY),
3. There needs to be an increase in professional learning opportunities provided by MECY such an more hands-on opportunities resource materials and EfS with summer institutes.
4. More supports at the university level. Pre-service teachers have traditionally experienced a lack of information regarding sustainability as a separate entity or embedded within the core courses of science and social studies
5. Another focus at the university could be on the experienced teacher. The post baccalaureate program in Manitoba does not currently have any courses related to sustainability (although there may be one in the works), and limited graduate courses in education on this subject matter as well.

7.8 Suggestions for Future Research

This study was very informative. It demonstrated the need to fill the gap of resources that relate to sustainability by providing teachers not only with hands-on, engaging lessons, but background information and a demonstration of how they can create their own units of study. Additional resources could be created in other areas linked to sustainability for all grades. The most relevant of these would be in the Grade 6 Science unit, Diversity of Living Things, and the Grade 7 Science unit, Interactions within Ecosystems. A more comprehensive project could look at the development of a

cross-curricular unit (such as between the natural sciences and the social sciences), but the difficulties lie in the silo-like nature of the curriculum and individual school set-up.

Further research into this particular area could focus on the long-term actions taken by the students in this study. It would be very interesting to see if these students continue to make water consumption choices such as turning off the water when brushing their teeth, or if they revert to previous, non-sustainability behaviours. I think it is so very important to remember that **We Are All Downstream** from somewhere and our choices and actions affect not only ourselves, but others as well as.

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Appendices

Appendix 1

Approval Certificate

12 December 2005

TO: **Amanda Tetrault** (Advisor G. Robinson)
Principal Investigator

FROM: **Stan Straw, Chair**
Education/Nursing Research Ethics Board (ENREB)

Re: **Protocol #E2005:106**
"Utility of Science in a Globally Unsustainable Society"

Please be advised that your above-referenced protocol has received human ethics approval by the **Education/Nursing Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement**.** This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- if you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to Kathryn Bartmanovich, Research Grants & Contract Services (fax 261-0325), <u>including the Sponsor name</u>, before your account can be opened.

- if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.

APPROVAL CERTIFICATE

19 February 2007

CRYSTAL

TO: **Amanda Tetrault** (Advisor G. Robinson)
Principal Investigator

FROM: **Stan Straw, Chair**
Education/Nursing Research Ethics Board (ENREB)

Re: **Protocol #E2007:001**
"We are all Downstream: The Risk and Protective Factors for Teaching Sustainability Education in Middle School Science"

Please be advised that your above-referenced protocol has received human ethics approval by the **Education/Nursing Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement**.** This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

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- if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/ors/ethics/ors_ethics_human_REB_forms_guidelines.html**) in order to be in compliance with Tri-Council Guidelines.**

Appendix 2

Factors Contributing To and Impeding the Use of Sustainability Issues in Manitoba Science Curricula

Introduction:

This survey addresses two research questions:
In what context are teachers incorporating sustainability issues (i.e. HIV/AIDS, consumption and waste management) into delivery of Manitoba Curricula?
What are important risk factors to limit and protective factors to foster when developing sustainability-based curricular resources?
My goal is to produce a paradigm shift in students' views toward the utility of science and mathematics is necessary and important as only then can they employ scientific endeavor to move structures, organizations, communities and activities towards sustainability, as future leaders, decision-makers, and consumers. In this section you will identify risk and protective factors that impede/enhance your ability to deliver lessons that work toward this goal.

For our study, "risk factors" are those that impede your ability to deliver effective sustainability-based lessons which emphasize the utility and essential use of science.

For our study, "protective factors" are those that enhance your ability to deliver effective sustainability-based lessons which emphasize the utility and essential use of science.

Your accurate responses to the questions below will help to answer the above two questions and guide the design of the mentioned teacher resources. Leave questions unanswered if you do not wish to respond. Add information as you feel is necessary. All references to science also include the applicable mathematics content and skills as we see them as closely related.

Section One: Biographical Information

Circle the correct response or answer in the space provided that pertains to your background:

Sex: M F

Years of Teaching Experience:

1-2 3-5 6-10 11-15 16-20 more than 20.

Courses Currently Teaching:

Grade 5 Science Grade 6 Science Grade 7 Science Grade 8 Science

Other _____

How do you envision your worldview?

1	2	3	4	5
Anthropocentric (human beings should dominate and control the earth and that plants, animals, and minerals are resources for human use)				**Ecocentric** (humans are but one component of a complex earth and that humans must learn to live within a stable, sustainable, self-renewing ecosphere)

Section Two: Current Teaching Practice

A. Current Sources for Sustainability Issues

In the section that follows circle the response that describes the source(s) of sustainability issues you use to teach SLO's (student learning outcomes):

Source of sustainability issue :

1. current news events as they occur
every class once/cycle once/month once/term once/year never

2. current news events that I adapt to my course
every class once/cycle once/month once/term once/year never

3. sustainability issues discussed in text
every class once/cycle once/month once/term once/year never

4. sustainability issues discussed in text that I adapt to my course
every class once/cycle once/month once/term once/year never

5. internet resources
every class once/cycle once/month once/term once/year never

6. internet resources that I adapt to my course
every class once/cycle once/month once/term once/year never

7. "ready-to-use" resources such as Slow the Flow or Project Wet
every class once/cycle once/month once/term once/year never

8. "ready-to-use" resources that I adapt to my course
every class once/cycle once/month once/term once/year never

9. guest speakers
every class once/cycle once/month once/term once/year never

10. field trips
every class once/cycle once/month once/term once/year never

11. my own knowledge of sustainability issues (ex. poverty reduction, water issues)
every class once/cycle once/month once/term once/year never

12. borrowed materials from someone who has adapted them for my particular course
every class once/cycle once/month once/term once/year never

B. Frequency

Circle the response which most accurately reflects your actions.
How often would you use a sustainability issue to teach outcomes of your course?
every class once/cycle once/month once/term once/year never

C. Ready-made Resources

In the section that follows circle the responses that describes the extent to which you are aware of and/or have used the following resources:
Unaware of (**U**)
Aware of but have never used (**A**)
Have used and found beneficial due to an increase in positive students' attitudes (**BA**)
Have used and found beneficial due to ease of use (**BE**)
Have used and found limited due to lack of student interest (**LI**)
Have used and found limited due to limited connection to student learning outcomes (**LS**)

Resource						
Manitoba Model Forest	U	A	BA	BE	LI	LS
Manitoba Waterways Project	U	A	BA	BE	LI	LS
Internet - Millenium Ecosystem Assessment	U	A	BA	BE	LI	LS
Internet - UNESCO	U	A	BA	BE	LI	LS
Project Wet	U	A	BA	BE	LI	LS
Project Learning Tree	U	A	BA	BE	LI	LS
Project Wild	U	A	BA	BE	LI	LS
Slow the Flow	U	A	BA	BE	LI	LS

D. Goals for teaching Sustainability Issues

In the section that follows circle the response that describes to what extent each of the goals are important when using sustainability issues to teach SLO's (student learning outcomes) :
Very important (**VI**)-a critical outcome
Important (**I**) – a beneficial outcome
Not important (**NI**) – not necessary

Goal of teaching using sustainability issues:			
increase students' knowledge ex. basic science facts, cycles, principles	VI	I	NI
affect student attitudes ex. how much they enjoy learning these issues	VI	I	NI
affect student values ex. if students change their worldviews	VI	I	NI
increase action-oriented behavior ex. if students are more likely to take action	VI	I	NI
learn a specific science outcome ex. one listed in the curriculum	VI	I	NI
learn a specific science skill ex. water testing	VI	I	NI
use science to analyze an issue ex. a current event or topic	VI	I	NI
link issue to science and other disciplines ex. opportunities for integration	VI	I	NI
assist in developing decision making skills ex. critical thinking ability	VI	I	NI
to help students learn to live sustainably on this planet	VI	I	NI

Section Three: Risk and Protective Factors

The factors listed below are likely to influence your ability to teach using sustainability issues in your Science course(s). **To what extent do you perceive these factors are likely to influence you ability to teach in this manner?** Circle whether this factor would currently:
Strongly Influence (SI)
Moderately Influence (MI)
Slightly Influence (LI)
No Influence At All (NI)

Risk/Protective Factor

My particular course does not lend itself to	SI	MI	LI	NI

analyzing sustainability issues (ex. biodiversity and habitat)

Lack of resources	SI	MI	LI	NI
Lack of resources for my particular course	SI	MI	LI	NI
Lack of resources that are ready-to-use	SI	MI	LI	NI
Lack of resources that are ready-to-use for my particular course	SI	MI	LI	NI
Internet or other resources are not readable at student level	SI	MI	LI	NI
Internet or other resources are not presented at student level	SI	MI	LI	NI
Time required to adapt sustainability issues from a source to “work” in a classroom	SI	MI	LI	NI
Time required to adapt sustainability issues from a source to meet science outcomes	SI	MI	LI	NI
Depth to which the resources require mastery of science concepts	SI	MI	LI	NI
Depth to which the resources require learning from various disciplines	SI	MI	LI	NI
Resources do not link sustainability issues to MB curricular outcomes	SI	MI	LI	NI
Resources are “extras” on top of curriculum	SI	MI	LI	NI
Resources are not local to our area	SI	MI	LI	NI
Resources do not require the completion of MB Science curricular outcomes	SI	MI	LI	NI
Resources take too much time away from achieving curricular outcomes	SI	MI	LI	NI
Using sustainability issues takes valuable time from achieving curricular outcomes	SI	MI	LI	NI
Using sustainability issues has no long-term effect	SI	MI	LI	NI

Sustainability issues should be taught separately from science	SI	MI	LI	NI
My interest and motivation to teach science this way	SI	MI	LI	NI
Student interest in learning science this way	SI	MI	LI	NI
Management issues including student behaviour	SI	MI	LI	NI
Influence of my teaching colleagues to teach this way	SI	MI	LI	NI
Support from colleagues	SI	MI	LI	NI
Support from administration	SI	MI	LI	NI
External support such as professional development opportunities.	SI	MI	LI	NI

What other factors do you perceive may influence (either positively or negatively) your ability to incorporate sustainability issues into your science course(s)?

_____

_____

_____

_____

_____

_____

Section Four: Summary

Use this space to mention any concerns or comments you may have in regards to the development of a resource which uses sustainability resources to increase the utility of science in the minds of students.

_____

_____

_____

Thank-you for completing this survey. Place your survey in the self-addressed envelope supplied with this questionnaire and teacher consent form and mail at your earliest convenience.

Amanda Tetrault
xx xxxxxx xxxxx
Winnipeg, MB
xxx xxx

Appendix 3

Name: _____

Pre Test Questions

Please circle the most correct answer to each question below.

Affinity for Science

strongly disagree neutral agree strongly agree
I enjoy learning about science.

strongly disagree neutral agree strongly agree
I believe science can help our planet.

strongly disagree neutral agree strongly agree
There are more opportunities to use science in my future than only becoming a scientist.

strongly disagree neutral agree strongly agree
I think science is important for my future.

strongly disagree neutral agree strongly agree
I do not feel science has caused many of the Earth's environmental problems.

strongly disagree neutral agree strongly agree
I want to take more science courses in high school when it becomes an option.

strongly disagree neutral agree strongly agree
I feel that science is an important subject to understand.

Affinity related to Sustainability

strongly disagree neutral agree strongly
disagree agree
I care about our environment.

strongly disagree neutral agree strongly
disagree agree
I get upset when I see people waste water.

strongly disagree neutral agree strongly
disagree agree
I worry about swimming in polluted water at the lake.

strongly disagree neutral agree strongly
disagree agree
I want to help stop water pollution in Manitoba.

strongly disagree neutral agree strongly
disagree agree
I want to help others far away with their water problems.

strongly disagree neutral agree strongly
disagree agree
I get angry when I think about the damage humans have caused to our water systems.

strongly disagree neutral agree strongly
disagree agree
I am frightened to think people don't care about the water in our province.

Knowledge about Water Systems

condensation evaporation excretation precipitation run-off
Circle the word that does not relate to the global water cycle.

99.5% 85% 50% 15% 0.5%
How much water is actually available for human consumption?

oceans circulation upwelling heat capacity stirring

Which term refers to the bringing of nutrients back to the surface of the ocean?

Atlantic Ocean | Pacific Ocean | Arctic Ocean | Hudson Bay | Gulf of Mexico

Where does Manitoba's water drain?

a well | Shoal lake | Lake Winnipeg | the tap | Red River

In Winnipeg, we get our water initially from…

lack of plants | rain amount in spring | dams | Coriolis Effect | drainage systems

Which is not a contributor to flooding?

Legislation | Environment | Economics | Waste production | Human Health and Well-Being

When looking at an issue, what are the three aspects related to sustainability that should be considered?

Actions related to Sustainability

never | occasionally | sometimes | often | always

To conserve water, I take shorter showers.

never | occasionally | sometimes | often | always

I have talked with my parents about how to help with environmental problems.

thought never | would about it | have like to | have given done it | more than that

I would be willing to give $15 of my own money to help the environment.

never | occasionally | sometimes | often | always

To conserve water, I turn off the water when I am soaping up my hands or while I am brushing my teeth.

never | if it were for marks | want to but haven't done it yet | done it already | have already done it more than once

I would be willing to write letters to help inform people about the water situation in our province.

never	occasionally	sometimes	often	always

I want to tell others about the water situation in Manitoba.

not interested	thought about it	mentioned it once	mentioned it more than once	got them to purchase

I have asked my parent to purchase water saving devices like low-flow shower heads or low-flow toilets.

Appendix 4

Name: _____

Post Test Questions

Please circle the most correct answer to each question below.

Affinity for Science

strongly disagree neutral agree strongly agree

I enjoy learning about science.

strongly disagree neutral agree strongly agree

I believe science can help our planet.

strongly disagree neutral agree strongly agree

There are more opportunities to use science in my future than only becoming a scientist.

strongly disagree neutral agree strongly agree

I think science is important for my future.

strongly disagree neutral agree strongly agree

I do not feel science has caused many of the Earth's environmental problems.

strongly disagree neutral agree strongly agree

I want to take more science courses in high school when it becomes an option.

strongly disagree neutral agree strongly agree

I feel that science is an important subject to understand.

Affinity related to Sustainability

strongly disagree neutral agree strongly agree
I care about our environment.

strongly disagree neutral agree strongly agree
I get upset when I see people waste water.

strongly disagree neutral agree strongly agree
I worry about swimming in polluted water at the lake.

strongly disagree neutral agree strongly agree
I want to help stop water pollution in Manitoba.

strongly disagree neutral agree strongly agree
I want to help others far away with their water problems.

strongly disagree neutral agree strongly agree
I get angry when I think about the damage humans have caused to our water systems.

strongly disagree neutral agree strongly agree
I am frightened to think people don't care about the water in our province.

Knowledge about Water Systems

condensation evaporation excretation precipitation run-off
Circle the word that does not relate to the global water cycle.

99.5% 85% 50% 15% 0.5%
How much water is actually available for human consumption?

oceans circulation upwelling heat capacity stirring

Which term refers to the bringing of nutrients back to the surface of the ocean?

Atlantic Ocean | Pacific Ocean | Artic Ocean | Hudson Bay | Gulf of Mexico

Where does Manitoba's water drain?

a well | Shoal lake | Lake Winnipeg | the tap | Red River

In Winnipeg, we get our water initially from…

lack of plants | rain amount in spring | dams | Coriolis Effect | drainage systems

Which is not a contributor to flooding?

Legislation | Environment | Economics | Waste production | Human Health and Well-Being

When looking at an issue, what are the three aspects related to sustainability that should be considered?

Actions related to Sustainability

never occasionally sometimes often always

To conserve water, I take shorter showers.

never occasionally sometimes often always

I have talked with my parents about how to help with environmental problems.

never | thought about it | would like to | have done it | have given more than that

I would be willing to give $15 of my own money to help the environment.

never occasionally sometimes often always

To conserve water, I turn off the water when I am soaping up my hands or while I am brushing my teeth.

	if it were	want to but	done	have already
never	for marks	haven't done it yet	it already	done it more than once

I would be willing to write letters to help inform people about the water situation in our province.

never	occasionally	sometimes	often	always

I want to tell others about the water situation in Manitoba.

not	thought	mentioned	mentioned	got them
interested	about it	it once	it more than once	to purchase

I have asked my parent to purchase water saving devices like low-flow shower heads or low-flow toilets.

Have you done anything different since the beginning of this unit in regards to water conservation, etc.? If so, what have you done?

_____

_____

_____

Do you think people should be concerned about water? If so, why?

_____

_____

_____

What are your thoughts on this unit compared to others you have covered this year? Was there anything more/less interesting, more/less practical, and why?

_____

_____

_____

_____

_____

Appendix 5 Water Systems Resource

This document was created for a Masters of Education Thesis written by Amanda Freedman Tétrault.

If you have any comments, insights or suggestions, please contact me at xxxxxxx@xxx.xx or at xxx-xxxx.

The Natural Step

The Four System Conditions
In the sustainable society, nature is not subject to systematically increasing:
1. concentrations of substances extracted from the Earth's crust,
2. concentrations of substances produced by society,
3. degradation by physical means

and, in that society. . .

4. people are not subject to conditions that systematically undermine their capacity to meet their needs.

A huge thank you to the piloting teachers xxxxxxx xxxxxx, xx xxxxxxxxxxx and xxxxxxx xxxxxxx for their assistance and great teaching!
Thank you to Alphonse Tétrault for the French translations.

Draft 6
January 2008

Grade 8
Water Systems

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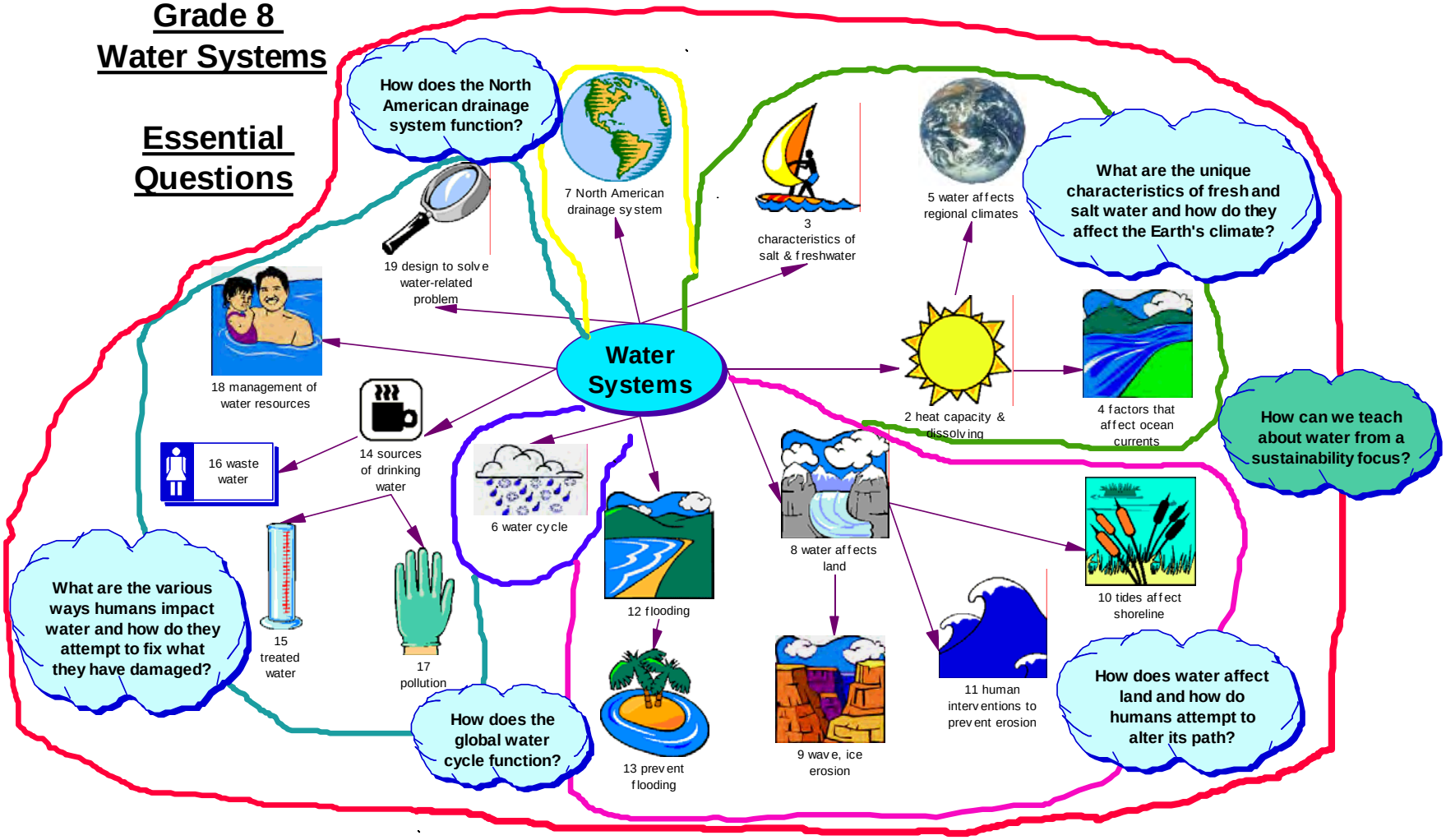
Grade 8
Water Systems

Essential Questions



Lesson 1

Stage 1 – Desired Results

Established Goals: 8-4-03 **Compare and contrast characteristics and properties of fresh and salt water.** Examples: freezing point, density, dissolved materials, **global distribution**, relative amounts, biologically diverse components of each… GLO: D3, D5, E1

Understandings:	**Essential Questions:**
Students will understand that… water is a shared natural resource and there are concerns regarding availability and distribution.	How do we learn about water from a sustainability focus?
Students will know…	**Students will be able to…**
The limited amount of water that humans actually have access to.	Estimate the amount of water as a resource they have use and compare that figure to actual .

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
Students will participate in the introductory lesson on the world's distribution of water.	Exit slip: students will hand in an exit slip that reflects on the new knowledge that only 0.03% of the world's water is actually available for human consumption.

Materials Required

7 clear containers (2 one-litre containers,	1 litre of water
5- 500 ml containers)	Salt (34 grams/approx. 2 Tbs)
1 plate	Blue food colouring
Projector	1000 ml graduated cylinder
OH BLM	One eye dropper
Masking tape	Student worksheet
Pen	

Background Information

Although 75% of the Earth's surface is covered in water, only a very small fraction is available for human use. Of the water that is available to us, some become contaminated from human actions, such as toxic run off from agriculture, factories or pollutants that we dump in the water supply from our sinks at home. Population growth over the past 30 years has caused demand for water to double in about half the countries in the world. Residents of areas with rapidly growing populations, as well as citizens of other countries often experience a water shortage. In the following activity students will gain an appreciation for the limited amount of water actually accessible and the need to conserve it.

Stage 3 – Learning Plan

Water, Water Everywhere Activity (adapted from Population Connection Student Activity 10, used with permission).

Prior to lesson:

- Fill 500 ml container with sand
- Fill a one-litre with water, add 4 drops of blue food colouring and stir
- Label the other 5 containers: one-litre= oceans, 500 ml = polar ice, 500 ml = deep groundwater, 500 ml = freshwater, 500 ml=other
- Make an overhead of attached BLM
- Have 34 grams of salt measured (just less than 2 Tablespoons)

Lesson

Set out the 7 containers

Lead a class discussion on the following questions:

- How much of the planet is made up of water? Record a prediction.
- What percentage of that water do humans have available to them for their use? Get students to write down their prediction

Use a graduated cylinder to distribute the one liter of water into the five empty containers according to the percentages indicated in the figure. (For example, 97.1 % of the water on the Earth is found in the oceans. Because one litre contains 1000 milliliters, 97.1 % of one litre is 971 milliliters. Therefore, pour 971 milliliters into the container marked "oceans." 2.2% is polar ice, .1% is other [saltwater lakes, soil &

atmospheric moisture, glaciers], 0.3% deep ground water, 0.3% freshwater [rivers, lakes, shallow ground water]).
After you have filled the empty containers with the appropriate amounts of water, continue with the demonstration as follows:
a) Add 34 grams of salt (just less than 2 Tbs) to "ocean" container; this will match the salinity of the water sample with the salinity of the earth's oceans (3.5 percent).
b) Place the plastic "polar ice" container in the freezer (or put it aside).
c) Set the "other" container aside. We do not have access to this water.
d) Pour the "deep ground water" into the container of sand.
Ask the students which of the containers represents fresh water that is readily available for human use. (They should easily see that only the jar marked "freshwater" has the readily available supply.) Initiate a discussion on the limits of fresh water supplies, the problems of population growth and distribution, and the contamination of existing supplies. Only a small part of this fresh water (.03 percent of the Earth's total water supply) is accessible. The rest is too remote (found in Amazon or Siberian rivers) to locate, too expensive to retrieve or too polluted to use. Hold a plate in front of the class and dramatically drop the usable portion of fresh water onto it (represent this portion as one drop of water).
Teacher to hand out homework – briefly explain how to fill out the water use chart daily to be used in class in one-week's time.

Exit Slip

As the students are getting prepared to leave class, they are to hand in an exit slip sharing their thoughts on the knowledge on the amount of water available for human use and the comparison of their prediction of water availability to the actual.

Homework Learning Activities

Fill out water use chart (Lesson 1 BLM 2) *make sure to make 2 copies of the first page so that the students can complete all seven days.

Extension Learning Activities

If the teacher feels the students are strong enough, the amount of water in the shower, toilet and brushing teeth can be left blank for the students to determine on their own from researching their current fixtures (ex. to figure out shower amount a student can time how long it takes to fill up a bucket, check on the back of the toilet to determine litres/flush, etc.).

Water Use Chart (1.1)

Day of Week _____	Minutes in one day or number of times/day	# litres	Total
Shower/bath (time it takes to fill tub)	X	**20** =	
Toilet	X	**12** =	
Brush teeth	X	**4** (if you leave the water running) **or** **1** (if you turn off the water while brushing) =	
Laundry	X	**200** =	
Dishwashing	X	**40** (if dishwasher) **or** **35** (if by hand)=	
Additional drinking water (found in foods)		**15** =	
Leaky plumbing		**50** =	
Total			

Day of Week _____	Minutes in one day or number of times/day	# litres	Total
Shower/bath	X	**20** =	
Toilet	X	**12** =	
Brush teeth	X	**4** **or** **1** =	
Laundry	X	**200** =	
Dishwashing	X	**40** **or** **35** =	
Additional drinking water		**15** =	
Leaky plumbing		**50** =	
Total			

Day of Week _____	Minutes in one day or number of times/day	# litres	Total
Shower/bath	X	**20** =	
Toilet	X	**12** =	
Brush teeth	X	**4** **or** **1** =	
Laundry	X	**200** =	
Dishwashing	X	**40** **or** **35** =	
Additional drinking water		**15** =	
Leaky plumbing		**50** =	
Total			

Day of Week _____	Minutes in one day or number of times/day	# litres	Total
Shower/bath	X	**20 =**	
Toilet	X	**12 =**	
Brush teeth	X	**4 =** **or** **1 =**	
Laundry	X	**200 =**	
Dishwashing	X	**1. or** **35 =**	
Additional drinking water (found in foods)		**15 =**	
Leaky plumbing		**50 =**	
Total			

	Total for 7 days
Shower/bath	
Toilet	
Brush teeth	
Laundry	
Dishwashing	
Additional drinking water (found in foods)	
Leaky plumbing	
Grand Total	(a)

Figuring out averages

Divide grand total _____(a) by 7 = _____(b) to get your household daily average

Take your household daily average and divide by # of people in your house (b)

_____(b) divided by _____(c) = _____(d) to get your personal daily average

Parent/guardian signature: _____

Due Date: _____

Questions :

1) Compare your *daily average* (d) to the following national averages (remember that we did not include watering the lawn, washing the car, filling humidifiers, fish tanks, hot tubs, or swimming pools or any water related activities like going to a swimming pool).
National Averages

Canada =350 litres/person/day,

United Kingdom=175 litres/person/day,

Bangladesh 45 litres/person/day.

What do you notice about your average as compared to these others. _____

_____

_____

_____

2) Review your water logs.

40 What changes can you make the easiest?

41 What changes are you willing to try?

42 How can you assist your family in conserving water?

_____

_____

_____

_____

_____

_____

Jour de la semaine _____	**Minutes dans une journée ou nombre de fois par jour**	**# litres**	**Total**
Douche/bain (temps nécessaire pour remplir la baignore)	X	**20** =	
Toilette	X	**12** =	
Se brosser les dents	X	**4** (si vous laissez couler l'eau) **ou** **1** (si vous fermez le robinet en vous brossant les dents) =	
Lessive	X	**200** =	
Laver la vaisselle	X	**40** (si lave-vaisselle) **ou** **35** (si à la main)=	
Eau potable additionnelle (qu'on trouve dans la nourriture)		**15** =	
Fuites de plomberie		**50** =	
Total			

Jour de la semaine _____	**Minutes dans une journée ou nombre de fois par jour**	**# litres**	**Total**
Douche/bain	X	**20** =	
Toilette	X	**12** =	
Se brosser les dents	X	**4** **or** **1** =	
Lessive	X	**200** =	
Laver la vaisselle	X	**40** **or** **35** =	
Eau potable additionnelle		**15** =	
Fuites de plomberie		**50** =	
Total			

Jour de la semaine _____	**Minutes dans une journée ou nombre de fois par jour**	**# litres**	**Total**
Douche/bain (Temps nécessaire pour remplir la baignore)	X	**20** =	
Toilette	X	**12** =	
Se brosser les dents	X	**4 ou 1** =	
Lessive	X	**200** =	
Laver la vaisselle	X	**40** (si lave-vaisselle) **ou** **35** (si à la main)=	
Eau potable additionnelle (qu'on trouve dans la nourriture)		**15** =	
Fuites de plomberie		**50** =	
Total			

<u>Calcul des moyennes</u>

Divisez le grand total _____(a) par 7 = _____(b) pour obtenir la moyenne quotidienne de votre maison

Prenez la moyenne quotidienne de votre maison et divisez-la par le # de personnes chez vous (b)

_____(b) divisé par _____(c) = _____(d) pour obtenir votre moyenne quotidienne personnelle

<u>Questions :</u>

1. Comparez votre moyenne quotidienne (d) aux moyennes nationales suivantes (n'oubliez pas que nous n'avons pas inclus l'arrosage du gazon, le lavage de voiture, le remplissage des humidificateurs, des aquariums, des bains-cuves ou des piscines, ni toute activité qui se rattache à l'eau comme la visite à une piscine).
   Moyennes nationales

Canada = 350 litres/personne/jour,

Royaume Uni = 175 litres/personne/jour,

Bangladesh = 45 litres/personne/jour.

Que remarquez-vous par rapport à votre moyenne comparée à celle des autres?

2) Faites la revue de votre journal de bord sur l'eau.

43 Quels changements sont les plus faciles à faire?

44 Quels changements êtes-vous prêts à essayer?

45 Comment pouvez-vous aider votre famille à conserver l'eau?

Lesson 2

Stage 1 – Desired Results

Established Goals:

8-0-7f: Reflect on prior knowledge and experiences to construct new understandings and apply this new knowledge in other contexts.
8-0-8f: Relate personal activities in formal and informal setting to specific scientific disciplines.
8-0-8g: Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts.
8-0-9e: Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment.
8-0-9f: Consider both immediate and long-term effects of their actions.

Understandings: **Students will understand that…** There are three aspects to Sustainable Development	**Essential Question**: How do we learn about water from a sustainability focus?
Students will know… The four systems conditions of The Natural Step.	**Students will be able to…** Incorporate SD and TNS in decision making

Stage 2- Assessment Evidence

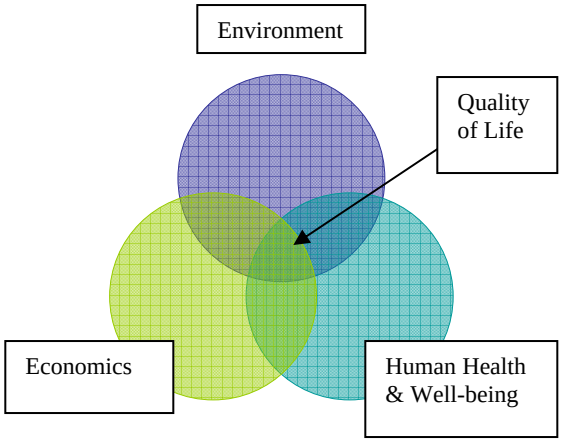
Performance Tasks: Students will participate in class discussion on Sustainable Development and The Natural Step.	Other Evidence:

Stage 3 – Learning Plan

Teacher draws a Venn diagram on the board and point to the middle of the diagram as "quality of life" to ask the students the following leading questions:

- What do we as humans need to have a positive "quality of life?" (looking for big-picture ideas)

Lead the students toward the understanding that in order to have a good quality of life (and remember that it will differ depending on where you live); we need to have a healthy environment to live in, some money (economics) and to be healthy. All of these contribute to a positive quality of life. Encourage a discussion as to the different degrees in different areas – i.e. you might need less money living in Winnipeg than Vancouver or New York City: or less in a rural area if you grow your own food. Discuss the interaction of all of these on each other – i.e. if you are poor and are ill, might it be harder to get medication to get better? If you are poor, might you live in an area that has more pollution (or a hog factory – related to the timely idea of putting the hog factory in Tuxedo versus Transcona - NIMBY).



- List some points that fit under each category – from students ideas – Here are the priority areas as designated by the United Nations (no need to mention them all):

Socio-Cultural	Environmental	Economic
Human rights Peace and human security Justice Gender equality Cultural diversity and intercultural understanding Community and culture Health HIV/AIDS Governance Demographics Equity and rights	Natural resources: 1. water 2. energy 3. agriculture 4. biodiversity 5. and habitat 6. conservation 7. fish 8. forests 9. air Climate change Rural transformation Sustainable urbanization Disaster prevention and mitigation	Poverty reduction Corporate responsibility and accountability Market economy Energy efficiency and conservation Consumption and waste management Economic performance Agricultural viability Mining Employment Education

Explain that this is called Sustainable Development or SD. Now how do we as citizens make better choices in a sustainable manner? We can use the 4 Systems Conditions created by The Natural Step. The Natural Step is a Non Governmental Organization (NGO) created by a children's cancer doctor who saw a discrepancy between how people acted in regards to their environment and how they felt about their future.

- What do you think we need to keep in mind when making choices? (Attempt to lead students into coming up with these 4 ideas)

The Four System Conditions

In the sustainable society, nature is not subject to systematically increasing:
1. concentrations of substances extracted from the Earth's crust, (stop taking things out of the earth such as oil, minerals, etc.),
2. concentrations of substances produced by society, (stop putting stuff that cannot break down in to the environment and into landfills/incinerators),
3. degradation by physical means (stop damaging the planet – over harvesting, losing topsoil, damaging ecosystems, etc), and
4. people are not subject to conditions that systematically undermine their capacity to meet their needs (make sure all humans have access to basic needs such as food, water, shelter, etc).

When we make decisions, we should keep the framework in mind and will need to do that in future lessons…Students should write these system conditions in their notebook in their own words for future reference.

Extension Learning Activities

Students can look up TNS at www.thenaturalstep.ca for more information

Lessons 3, 4 and 5

Stage 1 – Desired Results

Established Goals:

8-4-02 **Demonstrate that water, as compared to other substances, has a high heat capacity** and is able to dissolve a wide variety of solutes. GLO: C1, C2, C5, D3

8-4-03 **Compare and contrast characteristics and properties of fresh and salt water. Examples: freezing point,** density, dissolved materials, global distribution, relative amounts, biologically diverse components of each… GLO: D3, D5, E1

8-4-05 **Describe how the heat capacity of large bodies of water** and the movement of ocean currents influence regional climates. Examples: Gulf Stream effects, El Niño, **lake effect**… GLO: D3, D5, E2

Understandings:	**Essential Questions:**
Students will understand that… Life on Earth is possible because of water's unique properties. Water is the only natural substance that is found in all three states - liquid, solid (ice), and gas (steam) at the temperatures normally found on Earth. Water can absorb a tremendous amount of heat acting like a heat buffer for the Earth.	What are the unique characteristics of fresh and salt water and how do they affect the Earth's climate? How do we teach about water from a sustainability focus?
Students will know… -and describe all three states of matter - solid, liquid, and gas - within the normal temperature range at Earth's surface for fresh water and for saline water. -how the high heat capacity & abundance of liquid water makes life on Earth possible.	**Students will be able to…** Participate in three labs in a safe manner -demonstrate through experimentation, that water containing salts and minerals has different properties than fresh water. -graph data to analyze and articulate results/conclusions.

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
Lab reports (with graphs) handed in to be marked	Peer assessment of lab behaviour

Materials Required

Station 1	**Station 2**	**Station 3**
distilled water	distilled water	hot plate
Seawater(saltwater)	seawater	4 flasks (same size)
stopwatch	isopropyl alcohol	4 thermometers
hot plate	3 thermometers that can measure from -10°C to 110°C	bucket of ice water
2 flasks with rubber stoppers that hold a thermometer	3 large test tubes with a one hole fitted stoppers	stop watch
2 thermometers that can measure from -10°C to 110°C	3 Pyrex beakers	sand
graph paper	dry ice chunks*	soil
stopwatch	gloves	
	graph paper	

***you can purchase dry ice from Praxair (in Winnipeg) for about $3.00 a kg – you need to bring a small cooler to hold it. Praxair: 663-4393, 650 Nairn. An alternative to dry ice is a salt-ice mixture but with less dramatic results.**

Safety Considerations

Safety Guidelines for Using Electric Hot Plates

Use a hot plate with a smooth, clean surface.

Hot plates appear exactly the same whether hot or at room temperature. Always assume they are hot and act accordingly.

Keep the electrical cord of a hot plate away from water and the heating surface.

The cord of the hot plate should be checked periodically for frays and faults. Any hot plate with faulty wiring should

not be used. Repair or replaced immediately.

Safety Rules for All Heating Processes

When heating glassware, make sure to use only glassware made of borosilicate glass (Pyrex® brand or Kimax® brand). Common glass can break, explode or shatter very easily when subjected to heat shock.
Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.
Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
Never heat a closed container.
Any set-up should be designed to allow for fast removal of the heat source.

Background Information

Water has unique properties. About 97 percent of all water is in the oceans. Salt water or seawater has characteristics similar to fresh water with some noticeable differences because of the salts that are dissolved in water.

Prior Knowledge

The salt in seawater comes from the weathering of earth's land surface.
Water can be a liquid or a solid and can go back and forth from one form to the other.
When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point.

Common Preconceptions

Students generally do not regard freezing as taking place at a specific temperature.
Students consider heat and temperature to be the same thing, often arguing that if you increase the amount of heat you will increase the temperature.
Boiling is the maximum temperature a substance can reach.

Additional Information

Liquid water (H2O) is often perceived to be pretty ordinary as it is transparent, odourless, tasteless and ubiquitous. Water is unique in that it is the only natural substance that is found in all three states -- liquid, solid (ice), and gas (steam) - at the temperatures normally found on Earth. Earth's water is constantly interacting, changing, and in movement. 0° on the Celsius scale is water's freezing point, and 100° is water's boiling point. Water is unusual in that the solid form, ice, is less dense than the liquid form, which is why ice floats. Water has a high specific heat index or capacity. This means that water can absorb a lot of heat before it begins to get hot. This is why water is valuable to industries and in your car's radiator as a coolant. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.

Stage 3 – Learning Plan

(adapted from AQUARIUS http://www.bigelow.org/aquarius/prop_fresh_sea.html) Used by permission.

Station 1 Boiling Point

Fill one flask with distilled water and one flask with seawater. Insert the thermometers through the stoppers and cap the flasks. Make sure the thermometers are suspended in the liquids. Set both samples aside for half an hour so that they are all at room temperature

Activity – Station 1 (Boiling Point)

In this procedure, students will explore the boiling point of water, including the differences between salt water and fresh water. Ask students to hypothesize: “Which will boil first: salt water or fresh water? Why?”
Record the temperature of the distilled water and seawater in the flasks. Turn on the hot plate.
Begin with the distilled water. Check and record the temperature every 30 seconds. When the water begins bubbling and the temperature levels off, the water is boiling. Keep recording the temperature for 3 minutes after you see bubbles. Plot and graph your data. What is the boiling point of distilled water? How long did it take the distilled water to reach the boiling point?
Repeat the experiment with seawater. Record the thermometer reading every 30 seconds. Plot and graph your data. What is the boiling point of seawater? How long did it take the sea water to reach the boiling point?
Compare the results of the two experiments. Use your graphs. Are there any differences in the boiling points? How do you explain these differences?

Station 2 Freezing Point

Isopropyl alcohol works nicely because it contains water. When the water in the alcohol freezes, it should sink. There are numerous stores that sell dry ice as either chunks or cubes. Always use sturdy

gloves and / or tongs to handle dry ice. If you do not wish to use dry ice, use a salt-ice mixture instead.
In this procedure, students will explore the freezing point of water, including the differences between salt water and fresh water. Ask the students the following questions: “For pure water, the freezing point is defined as 0°C, but have you ever measured it? How can we measure it? Can we put the thermometer in a solid chunk of ice or in chopped ice? What is the temperature of ice? Which will freeze more slowly, salt or fresh water? Why?”
Fill one test tube with distilled water, the second with seawater, and the third with alcohol. Insert the thermometer through each rubber stopper and cap the test tubes. Make sure that the thermometer is suspended in the water. Record the temperature of each test tube.
Using tongs or heavy gloves, fill the bottom of three Pyrex beakers with chunks of dry ice.**STOP Review Safety Procedures** WARN STUDENTS: “DO NOT TOUCH THE DRY ICE WITH YOUR BARE HANDS!” Place each test tube in a beaker of dry ice.
Record the temperatures every 30 seconds until they level off. Observe the test tube of alcohol. What happens to the water that is in the alcohol? Compare it to the freezing point of the salt water and of the fresh water. Does the ice float or sink?
Plot and graph your data. Compare the information on the three graphs. What is the freezing point of fresh water? Seawater? Alcohol?

Station 3 Heat Capacity

In this procedure, students will examine water’s ability to store heat. Water has a higher heat capacity than almost any other liquid. This means that it takes a lot of heat to change water’s temperature significantly. We can measure and compare the heat capacities of water, air and “earth”. Ask the students: “Based on your experience, which will heat and cool more slowly: water, air, soil or sand? Why?” If your students require more guidance, please use BLM #4.
Fill one flask with water, one with soil, one with sand, and leave one flask empty. This flask is filled with air. Insert thermometers through rubber stoppers and cap the flasks.
Record the temperature in each flask at room temperature. **STOP Review Safety Procedures** Place all four flasks on top of the hot plate and start the stopwatch. Record the time it takes for the water to reach 33°C. Also record the temperature of the empty flask and the soil and sand flask at that instant.
Ask the students: “Is the temperature in the flask of air higher or lower than the temperature of the flask of water, sand and soil?”
Remove all flasks from the heat and place them in ice water. Record the time it takes for each flask to reach its original room temperature. Ask the students: “Which flask took longer to reach its original room temperature?”

Class Discussion Questions

1. What are the implications of water having a higher heat capacity than that of land when people live near a large water source like Lake Winnipeg related to climate? *Water covers about 71% of Earth’s surface. Thus its ability to store heat strongly affects our climate. The water may absorb the heat during the day and give off the heat in evenings to make for milder nights/seasons than areas further from large water sources.*
2. Why do you think that the boiling points of fresh and salt water have an effect on our local climate? How? *The boiling point of a liquid is the temperature at which it turns to gas. Water, when heated,*

evaporates and boils slowly compared to other liquids. This means that the heat of vaporization is high—the highest of all common liquids. Because of the high heat of vaporization, water evaporates slowly and absorbs a lot of heat. Water’s high heat of vaporization gives it a high boiling point (100°C). This is why much of Earth’s water is in liquid form.

3. How can you relate the results of these experiments to the three aspects of sustainable development? *Prompt students to think about how this experiment may impact on economics (climate in coastal areas) as well as environment (differences in grow seasons between Vancouver and Winnipeg) and heath.*

Homework Learning Activities

Remind students to continue to work on water use chart

Extension Activities

Each group can be assigned or choose an example of how ocean currents influence regional climates and share with the class (jigsaw). For example, the groups could research

1. Gulf Stream effects
2. El Niño
3. Lake effects

Station 1

1. Predict and record in your science notebook: "Which will boil first: salt water or fresh water? Why?"
2. Record the temperature of the distilled water and seawater in the flasks. Turn on the hot plate.
   ****STOP Review Safety Procedures****
3. Begin with the distilled water. Check and record the temperature every 30 seconds. When the water begins bubbling and the temperature levels off, the water is boiling. Keep recording the temperature for 3 minutes after you see bubbles. Plot and graph your data. What is the boiling point of distilled water? How long did it take the distilled water to reach the boiling point?
4. Repeat the experiment with seawater. Record the thermometer reading every 30 seconds. Plot and graph your data. What is the boiling point of seawater? How long did it take the sea water to reach the boiling point?

Compare the results of the two experiments. Use your graphs. Are there any differences in the boiling points? How do you explain these differences?

Station 2

1. Discuss and record answers to the following questions:
    a. For pure water, the freezing point is defined as 0°C, but have you ever measured it?
    b. How can we measure it?
    c. Can we put the thermometer in a solid chunk of ice or in chopped ice?
    d. What is the temperature of ice?
    e. Which will freeze more slowly, salt or fresh water? Why?
2. Fill one test tube with distilled water, the second with seawater, and the third with alcohol. Insert the thermometer through each rubber stopper and cap the test tubes. Make sure that the thermometer is suspended in the water. Record the temperature of each test tube.

Using tongs or heavy gloves, fill the bottom of three Pyrex beakers with chunks of dry ice.**STOP Review Safety Procedures** "DO NOT TOUCH THE DRY ICE WITH YOUR BARE HANDS!" Place each test tube in a beaker of dry ice.

Record the temperatures every 30 seconds until they level off. Observe the test tube of alcohol. What happens to the water that is in the alcohol?

Compare it to the freezing point of the salt water and of the fresh water. Does the ice float or sink?

Plot and graph your data. Compare the information on the three graphs. What is the freezing point of fresh water? Seawater?

Station 3

1. Discuss and record in your science notebook the following question: based on your experience, which will heat and cool more slowly: water, air, soil or sand? Why?
2. Fill one flask with water, one with soil, one with sand and leave one flask empty. This flask is filled with air. Insert thermometers through rubber stoppers and cap the flasks.
3. Record the temperature in each flask at room temperature. **STOP Review Safety Procedures** Place all four flasks on top of the hot plate and start the stopwatch. Use sheet to record information. Record the time it takes for the water to reach 33°C. Also record the temperature of the empty, soil and sand flasks at that instant.
4. Record whether the temperature in the flask of air is higher or lower than the temperature of the flask of water, soil and of sand?
5. Remove all four flasks from the heat and place them in ice water. Record the time it takes for each flask to reach its original room temperature.
6. Record which flask took the longest to reach its original room temperature.

Première station

1. Prédisez et enregistrez dans votre cahier de sciences: «Laquelle bouillira la première, l'eau salée ou l'eau fraîche? Pourquoi?»
2. Enregistrez la température de l'eau distillée et de l'eau de mer dans les flacons. Allumez l'élément.

Stop! Revoyez procédés sécuritaires!

3. Commencez avec l'eau distillée. Vérifiez et enregistrez la température toutes les 30 secondes. Quand l'eau commence à bouillonner et que la température plafonne, l'eau bout. Continuez à enregistrer la température pendant 3 minutes après avoir vu les bulles. Inscrivez vos données et faites un graphique. Quel est le point d'ébullition de l'eau distillée? Combien de temps a-t-il fallu pour que l'eau distillée atteigne le point d'ébullition?
4. Répétez l'expérience avec l'eau de mer. Inscrivez la lecture du thermomètre à toutes les 30 secondes. Inscrivez vos données et faites un graphique. Quel est le point d'ébullition de l'eau de mer? Combien de temps a-t-il fallu pour que l'eau de mer atteigne le point d'ébullition?
5. Comparez les résultats des deux expériences. Servez-vous de vos graphiques. Y a-t-il des différences dans les points d'ébullition? Comment expliquez-vous ces différences?

Deuxième station

1. Discutez et inscrivez vos réponses aux questions suivantes:

    a. Pour l'eau pure, on marque le point de congélation à 0oC. Mais l'avez-vous jamais mesuré?
    b. Comment peut-on le mesurer?
    c. Peut-on mettre le thermomètre dans un bloc de glace solide ou dans des éclats de glace?
    d. Quelle est la température de la glace?
    e. Laquelle gèlera plus lentement, l'eau salée ou l'eau fraîche? Pourquoi?

2. Remplissez une éprouvette d'eau distillée, une deuxième avec de l'eau salée et une troisième avec de l'alcool. Insérez un thermomètre à travers chaque bouchon en caoutchouc et refermez bien les éprouvettes. Assurez-vous que le thermomètre est suspendu dans le liquide. Inscrivez la température de chaque éprouvette.

Avec des pinces ou des gants épais, remplissez le fond de trois béchers Pyrex avec des morceaux de glace carbonique. Stop Revoyez procédés sécuritaires! Ne touchez pas la glace carbonique de vos mains nues. Placez chaque éprouvette dans un bécher de glace carbonique. Inscrivez la

température à toutes les 30 secondes jusqu’à ce qu’elle s’arrête de descendre. Observez l’éprouvette d’alcool. Qu’arrive-t-il à l’eau qui est dans l’alcool?

Comparez le point de congélation de l’eau salée et de l’eau fraîche. Est-ce que la glace flotte ou sombre?

Inscrivez vos données et faites un graphique. Comparez les renseignements des trois graphiques. Quel est le point de congélation de l’eau fraîche? De l’eau de mer?

Troisième station

1. Discutez et inscrivez dans votre cahier de sciences la question suivante : D'après votre expérience, quel élément se réchauffera et se refroidira le plus lentement : l'eau, l'air, le sol ou le sable? Pourquoi?
2. Remplissez un flacon d'eau, un de sol, un de sable et laissez un flacon vide. Ce flacon est rempli d'air. Insérez des thermomètres à travers des bouchons en caoutchouc et fermez bien les flacons.
3. Inscrivez la température de chaque flacon à la température de la chambre. **STOP Revoyez procédés sécuritaires** Placez les trois flacons par-dessus l'élément chauffant et commencez le chronomètre. Inscrivez le temps qu'il faut pour que l'eau atteigne 33°C. Au même moment, inscrivez aussi la température des flacons vide, de sol et de sable.
4. Enregistrez si la température du flacon d'air est plus élevée ou plus basse que la température des flacons d'eau, de sol et de sable.
5. Enlevez les quatre flacons de l'élément chauffant et placez-les dans de l'eau glacée. Enregistrez le temps qu'il faut pour que chaque flacon retourne à la température de la chambre originale.
6. Enregistrez quel flacon a mis le plus de temps à atteindre la température de chambre originale.

BLM #4

Name _____

Lab 3

Heating and Cooling Times

	Air	Soil	Sand	H20
Room Temperature				
Temperature (when H20 is 33 degrees)	*	*	*	Time it took for H20 o reach 33 degrees _____
		Is this temp ↑ or ↓ than air?	Is this temp ↑ or ↓ than air?	Is this temp ↑ or ↓ than air?
	Remove all from heat Put into ice			
Time it takes to get to room temperature				

Nom _____

LABO 3

Temps de réchauffement et de refroidissement

	Air	Terre	Sable	H20
Température de la chambre				
Température (quand H20 est 33 degrés)	*	*	*	Temps nécessaire pour que H20 atteigne 33 degrés _____
		Cette température est-elle ↑ ou ↓ plus que l'air?	Cette température est-elle ↑ ou ↓ plus que l'air?	Cette température est-elle ↑ ou ↓ plus que l'air?
	Enlevez tout de la chaleur Mettez dans la glace			
Temps nécessaire pour atteindre la température de la chambre				

Lessons 6 & 7

Stage 1 – Desired Results

Established Goals:
8-4-04 Identify factors that can work individually or in combination to affect ocean currents. Include: convection, Coriolis effect, prevailing winds, position of continents. GLO: D5, E2

Understandings:	**Essential Question:**
Students will understand that… Cold water and warm water move in different ways. How the Coriolis Effect works. The importance of the Antarctic Circumpolar current.	What are the unique characteristics of fresh and salt water and how do they affect the Earth's climate?
Students will know… That there are set currents that the ocean follows.	**Students will be able to…** Identify why the ocean currents move in the way that they do.

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
Students will make predictions and then apply the learning to determine what the ocean currents look like.	Completion of questions and partner work

Materials Required

Ice cubes (tray)	Overhead projector
Red food colouring	Handouts (BLM Lesson 5 #1-3)
Overhead of Ocean Currents (BLM #4)	Pepper
Clear glass baking pan	

Stage 3 – Learning Plan

Lesson 6
*Prepare ice cubes with a couple of drops of red food colouring ahead of time
Fill the baking pan with warm water.
Place baking pan on overhead so students can see what happens.
Sprinkle some pepper on the surface of the water to see how the water moves.
Ask students to predict what will happen when the red ice cube is placed in the water.
Put one red ice cube into the baking pan and observe the water movement (on BLM#1).
Empty the pan and re-fill with warm water.
Predict any changes that might occur with one ice cube at each end of the pan (on BLM#1).
Record observations.
Answer questions on handout (BLM #1).

Lesson 7
In partners, get students to review Ocean Currents Facts and The Antarctic Circumpolar Current (BLM #2).
Prep students for the Ocean Current prediction by explaining that currents move in a circular motion and that every ocean has a set current as well as in the Gulf Stream.
In partners, get students to apply the learning from the experiment and the fact sheet to answer the questions (BLM #4) and determine the Earth's Ocean Currents (BLM #3)** and use BLM #2** to assist in understandings. An engaging way to do this is to cut out each fact (see BLM 6.6) and place all around the room to get the students moving and recording their information.
Discuss answers from previous lesson and compare students predictions of the Ocean currents with that of the one on the Overhead (BLM #5)** get them to record the actual currents in a different colour than used in their predictions, and record on the map which colour is the one that accurately depicts the currents.
Discuss answers at end of class. Have students hand in answer sheets to confirm completion.

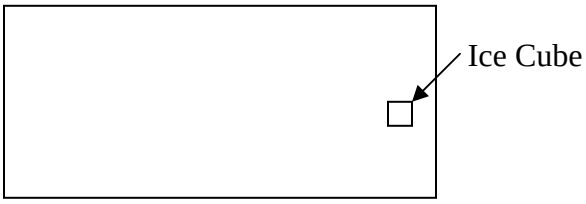
*(*adapted from* Hot and Cold Moves - http://coe.west.asu.edu/explorer/MiscUnits/team3/Hot-Cold_Moves.html)

** Source: Manitoba Education and Training. *Grades 5 to 8 Science: A Foundation for Implementation.* Winnipeg, MB: Manitoba Education and Training, 2000. Reproduced by permission All rights reserved.
Homework Learning Activities
Continue to work on water consumption chart

Hot and Cold Currents (6.1 page 1 of 2)

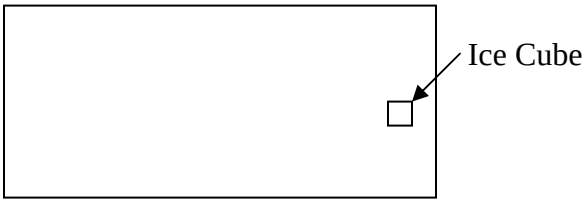
Experiment 1 – Single ice cube
Prediction of how the water will move when an ice cube is added to warm water

1. Which direction will the cold water move? _____
2. Draw a picture of how you expect the water to move in the baking pan.



After the Experiment

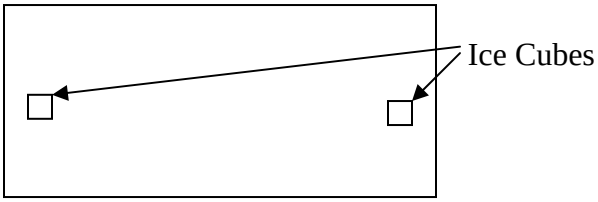
3. Which direction did the cold water move? _____
4. Draw a picture of how the water moved in the baking pan.



Experiment #2

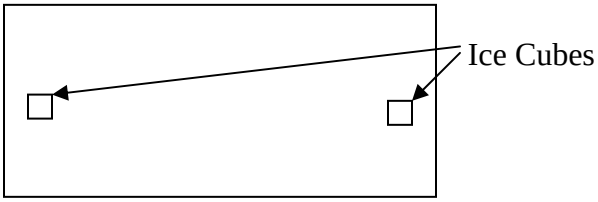
Prediction of how the water will move when two ice cubes are added to warm water

5. Which direction will the cold water move? _____
6. Draw a picture of how you expect the water to move in the baking pan.



After the Experiment

7. Which direction did the cold water move? _____
8. Draw a picture of how the water moved in the baking pan.



(6.1 page 2 of 2)

Questions

- What happened to the cold water as it warmed up?

_____

_____

_____

_____

- How did the surface water move as the cold water moved along the bottom?

_____

_____

_____

_____

- How do you think this relate to the currents in the oceans?

_____

_____

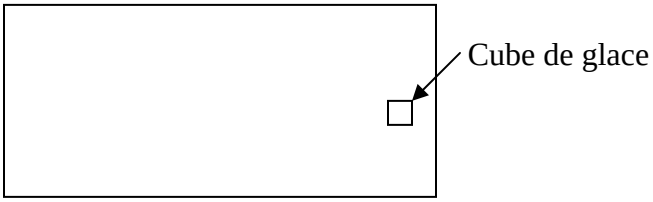
_____

_____

Courants chauds et froids (6.1 page 1 de 2)

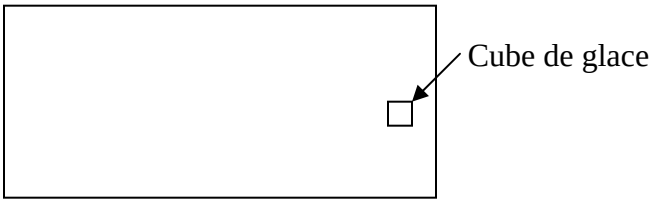
Expérience 1 – Un seul cube de glace
Prédiction sur comment l'eau bougera quand on ajoute un cube de glace à de l'eau chaude

1. Dans quelle direction l'eau bougera-t-elle? _____
2. Faites un croquis de vos attentes du mouvement de l'eau dans le plat.



Après l'expérience

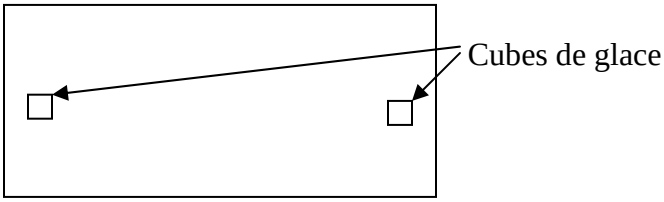
3. Dans quelle direction est-ce que l'eau froide a bougé? _____
4. Faites un croquis de comment l'eau a bougé dans le plat.



Expérience #2

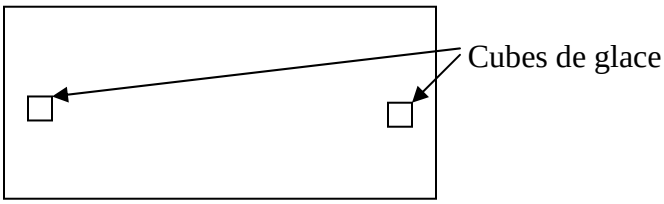
Prédiction sur comment l'eau bougera quand on ajoute deux cubes de glace à de l'eau chaude

5. Dans quelle direction l'eau froide bougera-t-elle? _____
6. Faites un croquis de vos attentes du mouvement de l'eau dans le plat.



Après l'expérience

7. Dans quelle direction l'eau froide a-t-elle bougé? _____
8. Faites un croquis de comment l'eau a bougé dans le plat.



(6.1 page 2 de 2)

Questions

1. Qu’est-il arrivé à l’eau froide à mesure qu’elle se réchauffait?

_____

_____

_____

_____

2. Comment l’eau à la surface bougeait-elle pendant que l’eau froide bougeait le long du fond?

_____

_____

_____

_____

3. Comment pensez-vous que ceci se rapporte aux courants des océans?

_____

_____

_____

_____

Facts About Ocean Currents (6.2 page 1 of 2)

Facts about Ocean Currents

• Ocean waters are constantly on the move. How they move influences climate and living conditions for plants and animals, even on land.

• Currents flow in complex patterns affected by wind, the water's salinity and heat content (density), bottom topography, the position of continents, and the Earth's rotation (Coriolis effect).

• The ocean is layered. It is cold at the bottom and warmer on top.

• Warm surface currents invariably flow from the tropics to the higher latitudes, driven mainly by atmospheric winds and the Earth's rotation.

• Cold surface currents come from polar and temperate latitudes, and they tend to flow toward the equator, driven mainly by atmospheric forces.

• Our planet's rotation produces a force on all bodies of water moving relative to the Earth. That force is greatest at the poles and least at the equator. It is called the Coriolis effect, and it causes the direction of winds and ocean currents to be deflected. Water is deflected clockwise, or to the right, in the northern hemisphere, and counterclockwise, or to the left, in the southern hemisphere.

• Ocean water at the surface is warmed at the tropics and moves toward the poles where it loses heat, becomes saltier and denser, and sinks.

• The cold bottom layer of ocean water circulates through the oceans, taking up to 1,000 years to circulate completely throughout the oceans of the Earth.

• The Gulf Stream surface current is one of the strongest currents. It is warm, deep, fast, and relatively salty.

• Organisms move from one layer of the ocean to another, and plant and animal remains containing nutrients "rain" down. Upwelling stirs the oceans and brings nutrients that have settled in deep water back to the surface, providing a rich source of nutrients for marine organisms, particularly fish. Coastal upwelling occurs against the western sides of continents in the Atlantic, Indian, and Pacific Oceans. There, colder water rises to replace

warm surface water blown out to sea by strong winds. Upwelling supports about half of the world's fisheries.

The Antarctic Circumpolar Current

• The Southern Ocean is the only ocean that circles the globe without being blocked by land. It contains the Antarctic Circumpolar current and is the world's largest ocean current.

• The Antarctic bottom water (cold, salty, and dense) sinks into the deep sea, spills off the continental shelf, and travels northward hugging the ocean floor beneath other water masses. This is a huge amount of water that pushes the warmer water out of the way, usually by flowing underneath it, causing new flows and currents in other directions. It travels as far as the North Atlantic and North Pacific Oceans. The bottom water flowing away from Antarctica has to be replaced by other water, so the warmer waters in the north tend to flow southward to fill the gap. Then they cool down and the cycle keeps going.

• The Antarctic Circumpolar current has a powerful influence on much of the word's climate as it redistributes heat, influencing patterns of temperature and rainfall.

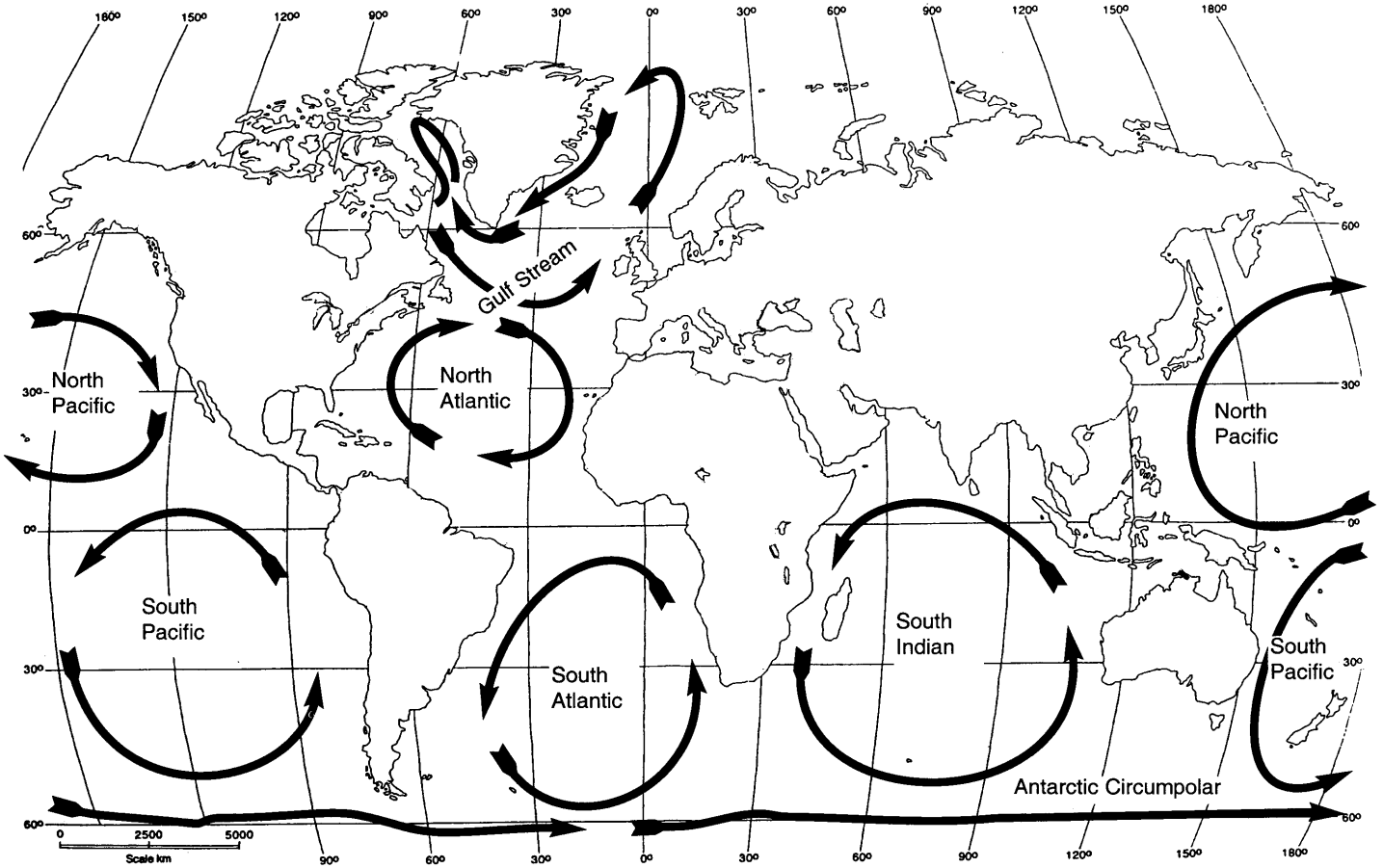
Source: Manitoba Education and Training. *Grades 5 to 8 Science: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 2000. Reproduced by permission. All rights reserved.

6.3

Name:

BLM 8-F

World Map: Ocean Currents



Source:
Manitoba
Education and Training.

Names: _____

Facts About Ocean Currents (6.4)

State the most interesting fact from the points listed	
List 3 additional pieces of information in your own words	
Draw a diagram to explain the Coriolis effect	
Answer the following questions	
How does upwelling affect the economy?	
What does density have to do with ocean currents?	
Why does the Antarctic Circumpolar current have a powerful influence on the rest of the world?	

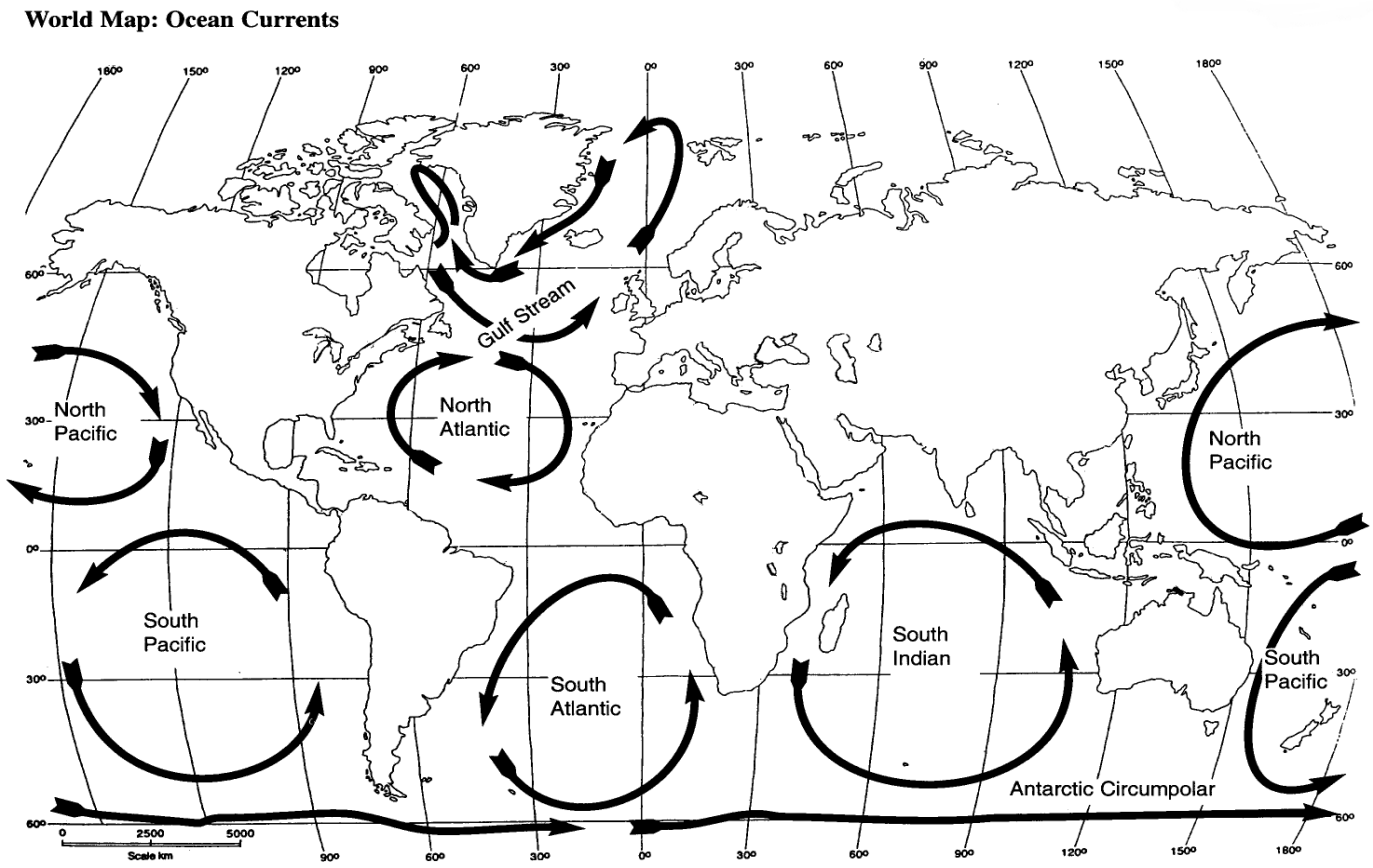
Faits au sujet des courants océaniques (6.4)

Indiquez quel fait tiré de la liste de points est le plus intéressant	
Indiquez 3 renseignements additionnels dans vos propres paroles	
Dessinez un diagramme qui explique l'effet Coriolis	
Répondez aux questions suivantes	
Comment la remontée de l'eau froide des océans affecte-t-elle l'économie?	
Quelle relation y a-t-il entre la densité et les courants océaniques?	
Pourquoi le courant qui coule autour de l'Antarctique exerce-t-il une si grande influence sur le reste du monde?	

Facts About Ocean Currents Key(6.4)

State the most interesting fact from the points listed	Dependant on student
List 3 additional pieces of information in your own words	Dependant on student
Draw a diagram to explain the Coriolis effect	
Answer the following questions	
How does upwelling affect the economy?	Upwelling stirs the ocean and brings nutrients “up” to the surface for marine organisms. It supports the fishing industry.
What does density have to do with ocean currents?	The cold dense water sinks into the deep sea and pushes great amounts of warm water up. This creates a cycle.
Why does the Antarctic Circumpolar current have a powerful influence on the rest of the world?	Due to the cycling of cold and warm water this current influences much of the world’s climate as it redistributes heat and influences temperature patterns and rainfall.

OH 6.5



Source: Manitoba Education and Training

BLM 6.6

<table>
<tr><td>Ocean waters are constantly on the move. How they move influences climate and living conditions for plants and animals, even on land.</td><td>Currents flow in complex patterns affected by wind, the water’s salinity and heat content (density), bottom topography, the position of continents, and the Earth’s rotation (Coriolis effect).</td><td>The ocean is layered. It is cold at the bottom and warmer on top.</td></tr>
<tr><td>Warm surface currents invariably flow from the tropics to the higher latitudes, driven mainly byatmospheric winds and the Earth’s rotation.</td><td>Cold surface currents come from polar and temperate latitudes, and they tend to flow toward the equator, driven mainly by atmospheric forces.</td><td>Ocean water at the surface is warmed at the tropics and moves toward the poles where it loses heat, becomes saltier and denser, and sinks.</td></tr>
<tr><td colspan="2">Our planet’s rotation produces a force on all bodies of water moving relative to the Earth. That force is greatest at the poles and least at the equator. It is called the Coriolis effect, and it causes the direction of winds and ocean currents to be deflected. Water is deflected clockwise, or to the right, in the northern hemisphere, and counterclockwise, or to the left, in the southern hemisphere.</td><td>The Southern Ocean is the only ocean that circles the globe without being blocked by land. It contains the Antarctic Circumpolar current and is the world’s largest ocean current</td></tr>
</table>

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<tr><td colspan="2">Organisms move from one layer of the ocean to another, and plant and animal remains containing nutrients “rain” down. Upwelling stirs the oceans and brings nutrients that have settled in deep water back to the surface, providing a rich source of nutrients for marine organisms, particularly fish. Coastal upwelling occurs against the western sides of continents in the Atlantic, Indian, and Pacific Oceans. There, colder water rises to replace warm surface water blown out to sea by strong winds. Upwelling supports about half of the world’s fisheries.</td></tr>
<tr><td>The Antarctic bottom water (cold, salty, and dense) sinks into the deep sea, spills off the continental shelf, and travels northward hugging the ocean floor beneath other water masses. This is a huge amount of water that pushes the warmer water out of the way, usually by flowing underneath it, causing new flows and currents in other directions. It travels as far as the North Atlantic and North Pacific Oceans. The bottom water flowing away from Antarctica has to be replaced by other water, so the warmer waters in the north tend to flow southward to fill the gap. Then they cool down and the cycle keeps going.</td><td>The Antarctic Circumpolar current has a powerful influence on much of the word’s climate as it redistributes heat, influencing patterns of temperature and rainfall.</td></tr>
</table>

The cold bottom layer of ocean water circulates through the oceans, taking up to 1,000 years to circulate completely throughout the oceans of the Earth.	The Gulf Stream surface current is one of the strongest currents. It is warm, deep, fast, and relatively salty.	

MLN 6.6

L'eau de mer est en mouvement constant. Sa façon de se déplacer influence le climat et les conditions de vie pour les plantes et les animaux, même sur terre.	Les courants se déplacent selon des modèles complexes, affectés par le vent, le montant de sel et de chaleur de l'eau (la densité), la topographie du fond, la position des continents et la rotation de la terre (l'effet Coriolis).	L'océan est stratifiée. Elle est froide au fond et plus chaude en surface.
Les courants chauds en surface coulent nécessaire- ment des tropiques aux latitudes plus élevées, poussés surtout par les vents atmosphériques et la rotation de la terre.	Les courants froids en surface viennent des latitudes polaires et tempérées, et tendent à couler vers l'équateur, poussés surtout par les forces atmosphériques.	L'eau de mer en surface se réchauffe dans les tropiques et se dirige vers les pôles Où elle perd sa chaleur, devient plus salée et dense, et coule.

La rotation de notre planète produit une force qui agit sur toutes les masses d'eau qui bougent relativement à la terre. Cette force est plus grande aux pôles et moins grande à l'équateur. Elle s'appelle l'effet Coriolis, et elle du sud. océaniques. L'eau est déviée dans le sens de l'horloge, ou vers la droite, dans l'hémisphère du nord, et dans le sens contraire de l'horloge, ou vers la gauche, dans l'hémisphère fait dévier la direction des vents et des courants	L'océan du sud est le seul océan qui encercle le globe sans être bloqué par la terre. Il contient le courant antarctique circumpolaire qui est le océanique du monde. plus grand courant.
Les organismes se déplacent d'une couche océanique à une autre, et les restes des plantes et des animaux qui contiennent des éléments nutritifs 'pleuvent' vers le fond. La remontée brasse les océans et rapporte les éléments nutritifs reposant près du fond jusqu'à la surface, fournissant une source riche en éléments nutritifs aux organismes marins, surtout aux poissons. La remontée côtière a lieu le long du côté ouest des continents dans les océans Atlantique, Indien et Pacifique. Là, l'eau froide monte pour remplacer l'eau chaude en surface qui est poussée loin en mer par des vents forts. La remontée appuie à peu près la moitié des poissonneries du monde.	

L’eau de fond antarctique (froide, salée et dense) s’abaisse dans la mer profonde, s’envole en glissant du plateau continental et voyage vers le nord en s’accrochant au fond de l’océan sous d’autres masses d’eau. Ceci représente un directions. Il voyage aussi loin que le nord de l’Atlantique de son chemin, généralement en passant dessous, ce qui énorme montant d’eau qui repousse l’eau plus chaude hors de son chemin, généralement en passant dessous, ce qui cause de nouvelles déviations et des courants dans d’autres directions. Il voyage aussi loin que le nord de l’Atlantique et le nord du Pacifique. L’eau de fond qui s’éloigne de l’Antarctique doit être remplacée par d’autre eau, alors les eaux plus chaudes du nord tendent à couler vers le sud pour remplir le vide. Puis elles se refroidissent et le cycle continue.	Le courant antarctique circumpolaire a une puissante influence sur une grande partie du climat mondial, puisqu’il redistribue la chaleur, ce qui influence les modèles de température et de précipitation.
La couche d’eau froide au fond des océans circule à travers les océans. Elle peut prendre jusqu’à 1000 ans pour circuler complètement à travers les océans de la terre.	Le courant du Golfe à la surface est un des courants les plus puissants. Il est chaud, profond, rapide et relativement salé.

Lesson 8

Stage 1 – Desired Results

Established Goals:
8-4-03 **Compare and contrast characteristics and properties of fresh and salt water.** Examples: freezing point**,** density, dissolved materials, **global distribution**, relative amounts, biologically diverse components of each… GLO: D3, D5, E1

Understandings: **Students will understand that**… In Canada, humans use an exceptionally great amount of water.	**Essential Question:** What are the various ways humans impact water and how do they attempt to fix the water they have damaged? How do we learn about water from a sustainability focus?
Students will know… That they must decrease the amount of water used.	**Students will be able to…** Figure out creative ways to decrease their water consumption.

Stage 2- Assessment Evidence

Performance Tasks: Completion of water chart. Completion of questions accompanying water chart.	**Other Evidence**: Plan of how to decrease individual consumption by 50%.

Materials Required

Students' completed water charts
New copies for each student of the water consumption chart to now decrease consumption by 50% (see BLM #2)

Stage 3 – Learning Plan

Share Water Chart results with the class – teacher to group water use amounts on board to demonstrate the range of usage in the class.
Think – Pair – Share a plan on how students will decrease their water consumption by 50% in the next 7 days.
Have students record in notebooks how they will achieve the goal of decreasing their water in realistic ways and make a prediction of if they think they will be able to do it or not.

Homework Learning Activities

Work on new chart to decrease consumption by 50%

Water Use Chart

Day of Week _____	Minutes/day times times/day	# litres	Total
Shower/bath (time it takes to fill tub)	X	**20** =	
Toilet	X	**12** =	
Brush teeth	X	**4** (if you leave the water running) **or** **1** (if you turn off the water while brushing) =	
Laundry	X	**200** =	
Dishwashing	X	**40** (if dishwasher) **or** **35** (if by hand)=	
Additional drinking water (found in foods)		**15** =	
Leaky plumbing		**50** =	
Total			

Day of Week _____	Minutes /day or times/day	# litres	Total
Shower/bath	X	**20** =	
Toilet	X	**12** =	
Brush teeth	X	**4** **or** **1** =	
Laundry	X	**200** =	
Dishwashing	X	**40** **or** **35** =	
Additional drinking water		**15** =	
Leaky plumbing		**50** =	
Total			

Day of Week _____	Minutes/day or times/day	# litres	Total
Shower/bath	X	**20** =	
Toilet	X	**12** =	
Brush teeth	X	**4** **or** **1** =	
Laundry	X	**200** =	
Dishwashing	X	**40** **or** **35** =	
Additional drinking water		**15** =	
Leaky plumbing		**50** =	
Total			

Day of Week _____	Minutes in one day or number of times/day	# litres	Total
Shower/bath	X	**20 =**	
Toilet	X	**12 =**	
Brush teeth	X	**4 = or 1 =**	
Laundry	X	**200 =**	
Dishwashing	X	**2. or 35 =**	
Additional drinking water (found in foods)		**15 =**	
Leaky plumbing		**50 =**	
Total			

	Total for 7 days
Shower/bath	
Toilet	
Brush teeth	
Laundry	
Dishwashing	
Additional drinking water (found in foods)	
Leaky plumbing	
Grand Total	(a)

Figuring out averages

Divide grand total _____(a) by 7 = _____(b) to get your household daily average

Take your household daily average and divide by # of people in your house (b)

_____(b) divided by _____(c) = _____(d) to get your personal daily average

Parent's signature & comments: _____

_____

_____

Lesson 9

Stage 1 – Desired Results

Established Goals:
8-4-07 Describe features of the North American drainage system. Include: local and regional watersheds, direction of water flow, continental divide. GLO: D3, D5, E2

Understandings:	**Essential Questions:**
Students will understand that… Bodies of water are the end product of drainage from watersheds.	How does the North American drainage system function? How do we learn about water from a sustainability focus?
Students will know… The student will see the end results of polluting within a watershed and how it impacts bodies of water.	**Students will be able to…** Predict where the water and pollutants will flow.

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
Students will work together to predict, create and record information about their watershed. Students will use peer and self assessment (BLM #1).	Students will observe the watershed in action and record observations.

Materials Required

(for each group)

One container at least 22 cm wide, 33 cm long, and 6 cm deep. A metal baking pan will work fine	One sheet of thin plastic (saran wrap) at least 20 cm larger in all dimensions than the container or plastic bags (i.e. “Safeway” style)
Two sheets of newspaper or aluminum foil	One spray bottle
One book	Baby powder (or some very fine soil will also work)
Blue food coloring	

Stage 3 – Learning Plan

Watershed modeling

Procedure

1. Divide students into groups of three or four. Each group will need a container, two sheets of newspaper, one sheet of plastic, one book, some baby powder (or soil) and one spray bottle filled with water and a few drops of blue food coloring. It is also helpful to provide students with a guide (BLM 9.4).
2. Crumple each sheet of newspaper or foil separately and place them next to each other at one end of the container. Try to vary the shape of the two. Place the sheet of plastic or plastic bag over the crumpled newspaper (or aluminum foil), causing it to form hills over the high places, and streams and rivers in the low places. Put a book under the end of the container with the newspaper, which will allow water to flow down the streams and rivers and collect in the lake at the front of the container. The sides of the plastic sheet should be placed down into the container or the land formations can be covered by a bag.
3. The plastic sheet represents the ground surface covering the watershed. Looking at the watershed model, try to guess where the main rivers will flow. Now, it's time to put the model to the test. Spray several pumps of water from the spray bottle on the model. Notice that each stream has its own watershed (the area that drains into it) and that the entire model is a larger watershed because all the water eventually flows into the pool at the bottom of the container. Count the number of small watersheds.
4. The model now represents a clean watershed. Let’s add some pollutants. Sprinkle a little baby powder over the model. The baby powder represents a variety of pollutants, including oil, road salt, animal manure, excess fertilizers, pesticides, tiny particles of soil and other harmful materials. Rapidly spray nine pumps of water over the upper portion of the watershed. Observe the way in which the pollutants are carried by the water and the end condition of the lake. Repeat if necessary.

Questions (to be put on overhead see BLM #2)

To be done in a think, pair, share method before discussing with the class.

1. Describe the relationship between small and large watersheds.

2. What are some possible solutions to keep bodies of water clean? 3. Who pollutes watersheds? 4. Think about the watershed(s) in which you live. What is the name of our watershed? Where does our water flow? What possible pollutants exist there? 5. How can you link our watershed to the three aspects of sustainable development? Using the watershed map, allow students to come up to review the local watershed. On their own map (BLM #3*) get the students to include the Red River, the Assiniboine River, the direction of water flow and discuss the continental divide. North America Watershed Map Source: Manitoba Education and Training. *Grades 5 to 8 Science: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 2000. Reproduced by permission. All rights reserved.
Extension Learning Activities
BLM 9.4 for a Water Quiz.
Homework Learning Activities
Students to continue working on 50% reduction of water consumption

Peer and Self Assessment (9.1)

All scored on a scale of 0-2
0 – below expectations **1** – adequate **2** – exceeds expectations

Activity	Self name _____	Student name _____	Student name _____	Student name _____
Participated fully in activity				
Supplied ideas/thoughts to the group				
Worked well with others				
Total	/6	/6	/6	/6

Comments: _____

Peer and Self Assessment

All scored on a scale of 0-2
0 – below expectations **1** – adequate **2** – exceeds expectations

Activity	Self name _____	Student name _____	Student name _____	Student name _____
Participated fully in activity				
Supplied ideas/thoughts to the group				
Worked well with others				
Total	/6	/6	/6	/6

Comments: _____

Auto-évaluation et par les pairs (9.1)

Tous notés sur l'échelle de 0-2
0 – en bas des attentes **1** – satisfaisant **2** – au-delà des attentes

Activité	Son nom à soi _____	Nom de l'élève _____	Nom de l'élève _____	Nom de l'élève _____
A participé à fond dans l'activité				
A fourni des idées/pensées au groupe				
A bien travaillé avec les autres				
Total	/6	/6	/6	/6

Commentaires :
_____
_____

Auto-évaluation et par les pairs (9.1)

Tous notés sur l'échelle de 0-2
0 – en bas des attentes **1** – satisfaisant **2** – au-delà des attentes

Activité	Son nom à soi _____	Nom de l'élève _____	Nom de l'élève _____	Nom de l'élève _____
A participé à fond dans l'activité				
A fourni des idées/pensées au groupe				
A bien travaillé avec les autres				
Total	/6	/6	/6	/6

Commentaires : _____
_____

Watershed Questions (9.2)

Please record your answers in point form first, then turn to your partner to share your thoughts

1. Describe the relationship between small and large watersheds.
2. What are some possible solutions to keep bodies of water clean?
3. Who pollutes watersheds?
4. What did you notice happened to the pollutants?
5. Think about the watershed(s) in which you live. What is the name of our watershed? Where does our water flow? What possible pollutants exist here?
6. How can you link our watersheds to the three aspects of Sustainable Development?

Questions sur le bassin hydrographique (9.2)

D'abord, veuillez inscrire vos réponses sous forme de points, puis partagez vos idées avec votre partenaire.

1.Décrivez la relation qui existe entre les petits et les grands bassins hydrographiques.

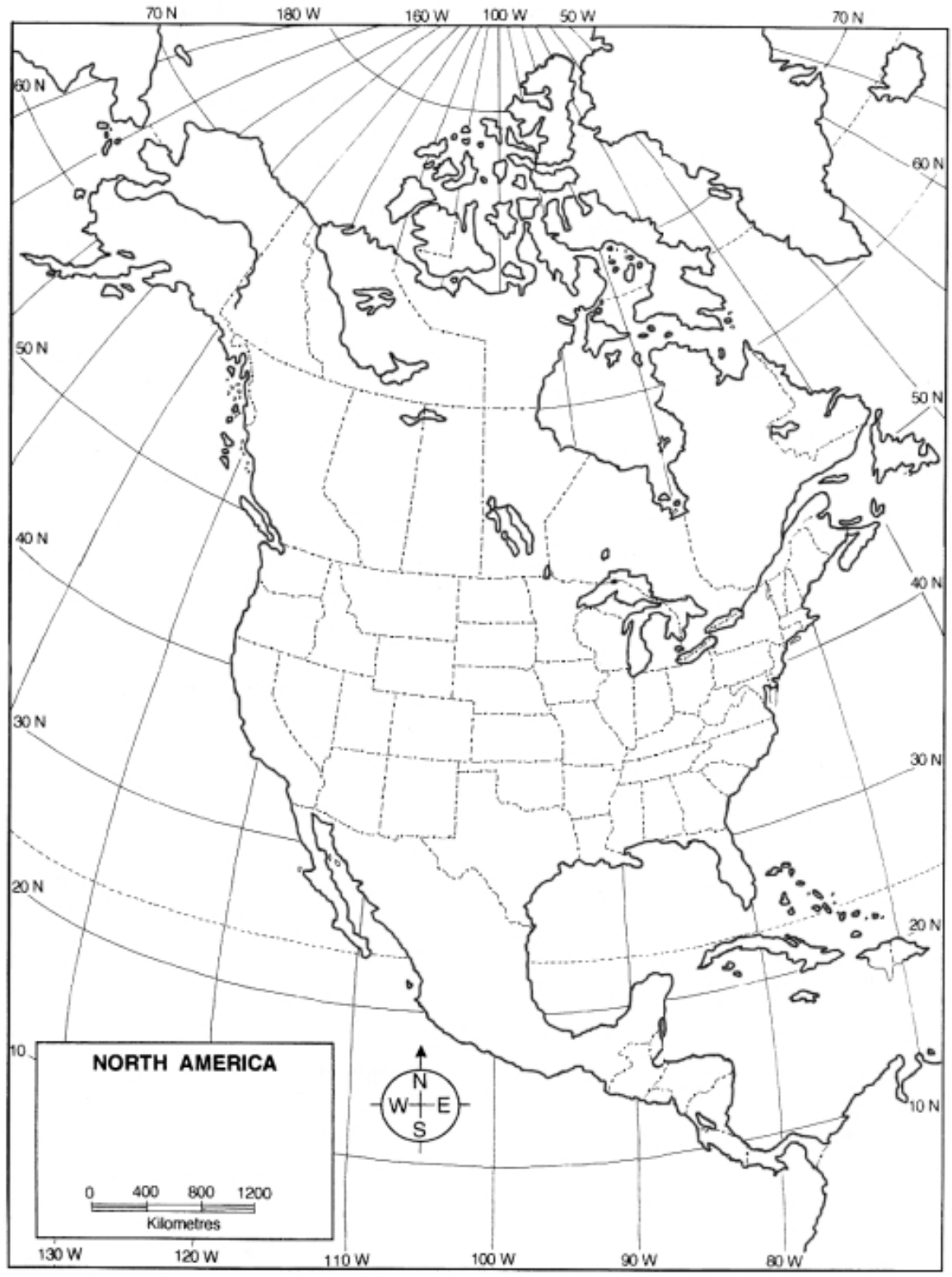
2. Quelles solutions possibles y a-t-il pour garder nos cours d'eau propres?

3. Qui pollue les bassins hydrographiques?

4. Pensez au bassin hydrographique où vous vivez. Comment s'appelle notre bassin hydrographique? Où coule notre eau? Quels sont les polluants possibles qui existent ici?

5. Comment pouvez-vous rattacher nos bassins hydrographiques aux trois aspects du développement soutenable?

Student Name _____



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Name _____ Date _____ Room _____

Watersheds BLM 9.4

1. Prepare the model. Design it so that there will be 2 “rivers”. In this box draw a quick sketch of where you think the following will be: the “rivers”, at least 3 small “streams”, the final watersheds (collection point).

2. Spray the blue water. In this box draw a quick sketch of what **REALLY** happened. Was your prediction close? _____.
What surprised you? _____

Count how many little watersheds there are. _____

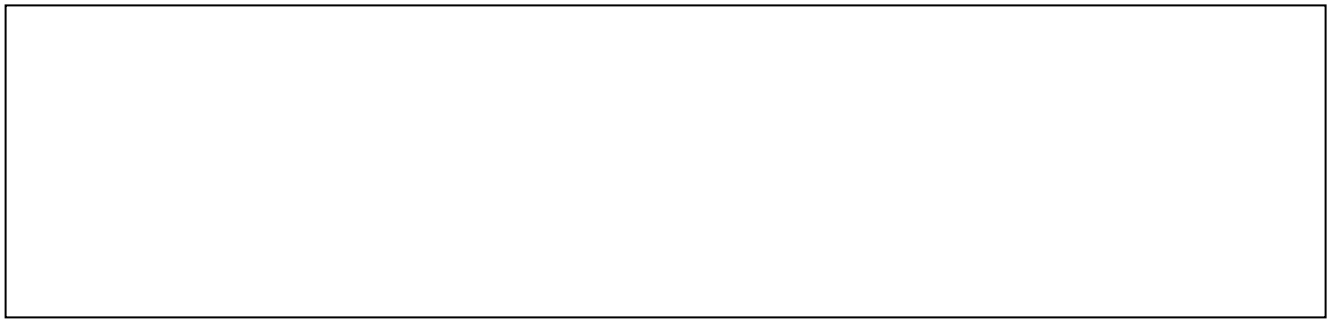
3. In the real world sometimes pollutants are added to our waterways. Discuss with your group what these could be. On the space below, list as many pollutants as you can.

_____

_____

_____

Add the pollutant to the top of the model. Quickly spray 9 pumps of water. Carefully watch how and where it travels. Wait. Pump another 6 times. Draw a quick sketch of what happens.



Describe the path of the pollutant._____

_____

_____

Where did the pollutant finish? _____

_____

⇨ CLEAN UP YOUR STATION. RETURN ALL SUPPLIES

Did you help clean? Is everything in its proper space?

⇨ Now it is time to quietly answer these questions.

A. Describe the relationship between small and large watersheds.
_____

_____

_____

B. What are some possible solutions to keeping watersheds clean?
_____

_____

_____

3. Who pollutes watersheds? _____

4. Think about the watershed in which we live. What is it called? _____

Where does our water flow? _____

What possible pollutants exist here? _____

_____

_____

5. How can you link our watershed to 3 aspects of sustainable development? _____

_____

_____

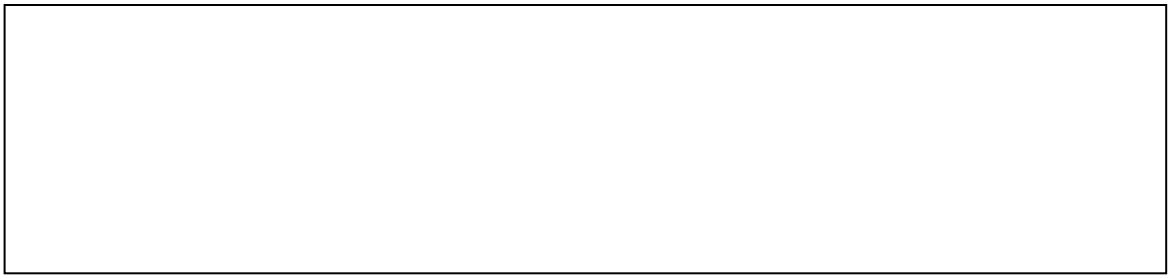
_____

QU'EST-CE QUI EST ARRIVÉ AUX POLLUANTS, SELON VOUS?

Nom : _____ Date : _____ Salle : _____

BASSINS HYDROGRAPHIQUES MLN 9,4

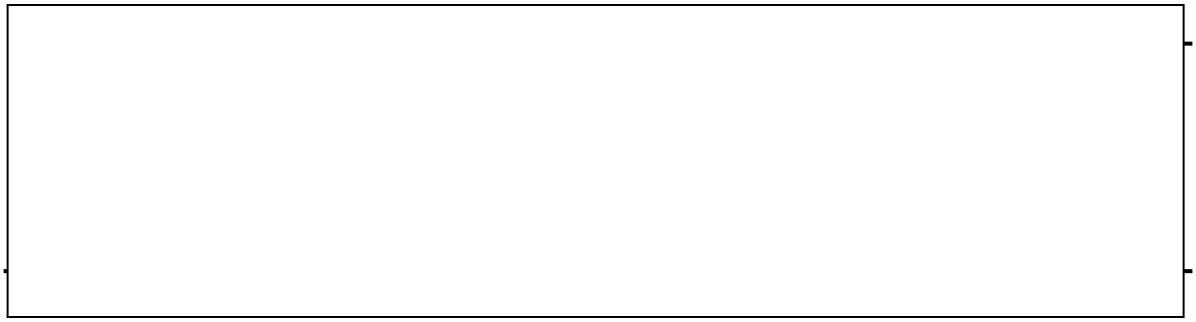
1. Préparez la maquette. Dessinez-la pour qu'il y ait 2 «rivières». Dans cette boîte, dessinez un croquis rapide où vous *croyez* que seront les objets suivants : les «rivières», au moins 3 petits «ruisseaux», les bassins hydrographiques ultimes (points de collection).



2. Arrosez avec l'eau bleue. Dans cette boîte, dessinez un croquis rapide de ce qui s'est VRAIMENT passé. Votre prédiction était-elle proche? _____
3. _____

Qu'est-ce qui vous a surpris? _____

Comptez combien il y a de bassins hydrographiques. _____



Dans le vrai monde, on ajoute quelquefois des polluants à nos cours d'eau. Discutez avec votre groupe ce que cela pourrait être. Dans l'espace ci-dessous, faites une liste d'autant de polluants que vous le pouvez. _____

_____

_____

Ajoutez un polluant au plus haut point de votre maquette. Vaporisez rapidement 9 coups de pompe d'eau. Surveillez précisément comment et où elle voyage. Attendez.
Encore 6 coups de pompe. Dessinez un croquis rapide de ce qui arrive.

Décrivez la course du polluant.

_____

_____

_____

Où s'est arrêté le polluant? _____

NETTOYEZ VOTRE STATION. RETOURNEZ TOUT LE MATÉRIEL.

Avez-vous aidé au nettoyage? Est-ce que tout est à sa place?

Maintenant il est temps de répondre à ces questions en silence.

- Décrivez la relation entre les petits et les grands bassins hydrographiques.

_____

_____

_____

- Quelles sont des solutions possibles pour garder nos bassins hydrographiques propres?

_____

_____

_____

- Qui pollue les bassins hydrographiques?

_____

- Réfléchissez au bassin hydrographique où nous vivons. Comment s'appelle-t-il? _____

Où s'écoule notre eau? _____

_____

Quels polluants possibles existent ici?_____

_____

_____

- Comment pouvez-vous relier notre bassin hydrographique à 3 aspects du développement soutenable?_____

_____

_____

Name: _____ Room: _____ Date: _____
Parent/Guardian Signature: _____ Total: ____/12

Water Quiz #1 BLM 9.5

Part 1
True or False (10 marks)

1. **_____ The Coriolis Effect causes wind and ocean currents to be deflected.**
2. **_____ The movement of oceans has no effect on world climate.**
3. **_____Surface ocean water gets warm around the tropics. It then moves towards the poles where it becomes cold, denser and sinks.**
4. **_____ Upwelling is the term that describes huge powerful waves that crash into coastal areas.**
5. **_____ Saltwater is less dense that tap water and therefore boils at a lower temperature.**
6. **_____ Ocean currents are affected by bottom topography and salinity.**
7. **_____ The cold bottom layer of the oceans takes about 1 000 years to circulate completely through the Earth's waters.**
8. **_____ The Gulf Stream can affect weather in Europe.**
9. **_____ The Antarctic Circumpolar current in the Southern Ocean is the world's largest ocean current. It is not blocked by land.**
10. **_____ Upwelling supports about 50% of the world's fisheries.**

Part B. (2 marks)
Please draw a diagram of the Coriolis effect in the northern and southern hemisphere.

Marked by: _____

Nom : _____ Salle : _____ Date : _____

Signature d'un parent/gardien : _____ Total : _____/12

Quiz sur l'eau No. 1 MLN 95

Première partie

Vrai ou Faux (10 points)

1. _____ L'effet Coriolis cause une déflection du vent et des courants océaniques.
2. _____ Le mouvement du vent n'a aucun effet sur le climat mondial.
3. _____ L'eau de mer en surface se réchauffe autour des tropiques. Puis elle se dirige vers les pôles où elle refroidit, devient plus dense et s'enfonce.
4. _____ La remontée de l'eau de mer froide est une expression qui décrit d'énormes vagues puissantes qui s'écrasent sur les régions côtières.
5. _____ L'eau salée est moins dense que l'eau du robinet et donc elle bout à une température plus basse.
6. _____ Les courants océaniques sont affectés par la topographie du fond et par la salinité.
7. _____ La couche froide au fond des océans prend environ mille ans pour circuler complètement à travers les eaux de la Terre.
8. _____ Le courant du Golfe peut affecter le temps en Europe.
9. _____ Le courant circumpolaire antarctique dans l'océan du Sud est le plus grand courant océanique au monde. Il n'est pas bloqué par des masses de terre.
10. _____ La remontée de l'eau de mer froide fait vivre environ 50% des pêcheries du monde.

Partie B (2 points)

Veuillez dessiner un schéma de l'effet Coriolis dans l'hémisphère du Nord et celle du Sud.

Noté par : _____

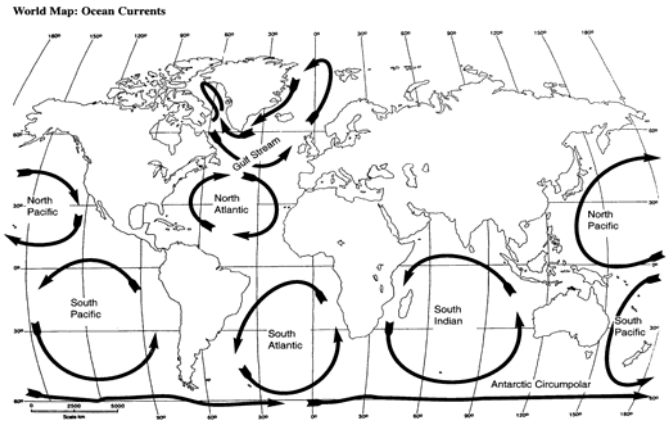
Name: _____ Room: _____ Date: _____
Parent/Guardian Signature: _____ Total: ____/12

Water Quiz #1 BLM 9.6 KEY

Part 1
True or False (10 marks)

1. **_T___ The Coriolis Effect causes wind and ocean currents to be deflected.**
2. **_F___ The movement of oceans has no effect on world climate.**
3. **_ T___ Surface ocean water gets warm around the tropics. It then moves towards the poles where it becomes cold, denser and sinks.**
4. **__F__ Upwelling is the term that describes huge powerful waves that crash into coastal areas.**
5. **__F__ Saltwater is less dense that tap water and therefore boils at a lower temperature.**
6. **___T__ Ocean currents are affected by bottom topography and salinity.**
7. **___T__ The cold bottom layer of the oceans takes about 1 000 years to circulate completely through the Earth's waters.**
8. **___T_ The Gulf Stream can affect weather in Europe.**
9. **___T__ The Antarctic Circumpolar current in the Southern Ocean is the world's largest ocean current. It is not blocked by land.**
10. **___T__ Upwelling supports about 50% of the world's fisheries.**

Part B. (2 marks)
Please draw a diagram of the Coriolis Effect in the northern and southern hemisphere.



Marked by:
_____

Lessons 10 & 11

Stage 1 – Desired Results

Established Goals:
8-4-06 Describe the component of the global water cycle and explain how it works. GLO D3, D5, E2

Understandings:	**Essential Question:**
Students will understand that… Water is not new, just goes through a variety of phases.	How does the global water cycle function?
Students will know… The various states of water and how the cycle functions.	**Students will be able to…** Demonstrate the various states of water through storytelling.

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
Students will be assessed on the children's book they will write and illustrate (see BLM #2) with the option of self-assessment.	The adaptation and application of water-cycle knowledge into a different form of sharing information.

Materials Required

Word cycle (BLM #1) Assessment (BLM #2)

Stage 3 – Learning Plan

By grade 8, students should have an understanding of the water cycle. As a method of determining that, hand out a work cycle (BLM #1) and ask the students to fill it in. In class, go through the students' answers and ask for justification if there is a difference from one student to another. If it appears that they have the main ideas, as the students to write a children's book on a water droplet. They should be as creative as possible, and it can span any time in history. It must have the water go through the various stages in the water cycle and the story could take place in any era or location.
The students can illustrate any way they want (using clip art, hand drawings, in a graphic-novel or comic book manner, etc.) or at the teacher's discretion.
The 3 best stories (or if opportunity presents itself, all of them) will be taken to the local elementary school (to be arranged by the teacher) to be shared with a grade 2 class who is learning about the water cycle.
The class will start their story during lesson 10, work on it at home and will have additional class time during lesson 11 to complete it. It will be handed in at the beginning of lesson 12.

Extension Learning Activities

Instead of illustrating a booklet, teachers could choose to use a computer program to create comic books for students to use.
See a reader's theatre script at http://www.enchantedlearning.com/rt/weather/watercycle.shtml

Homework Learning Activities

Continue to work on 50% reduction in water consumption, completion of story.

Integration Curricular Connections

English Language Arts

1.2 Clarify and Extend
1.2.3 *Combine Ideas*
Structure and restructure ideas and information in personally meaningful ways to clarify and extend understanding.
2.1 Use Strategies and Cues
2.1.1 *Prior Knowledge*
Make connections between previous experiences, prior knowledge, and a variety of texts, and apply them to new contexts.
2.3 Understand Forms and Techniques
2.3.1 *Forms and Genre*
Demonstrate appreciation for the appropriate use of various forms and genres according to

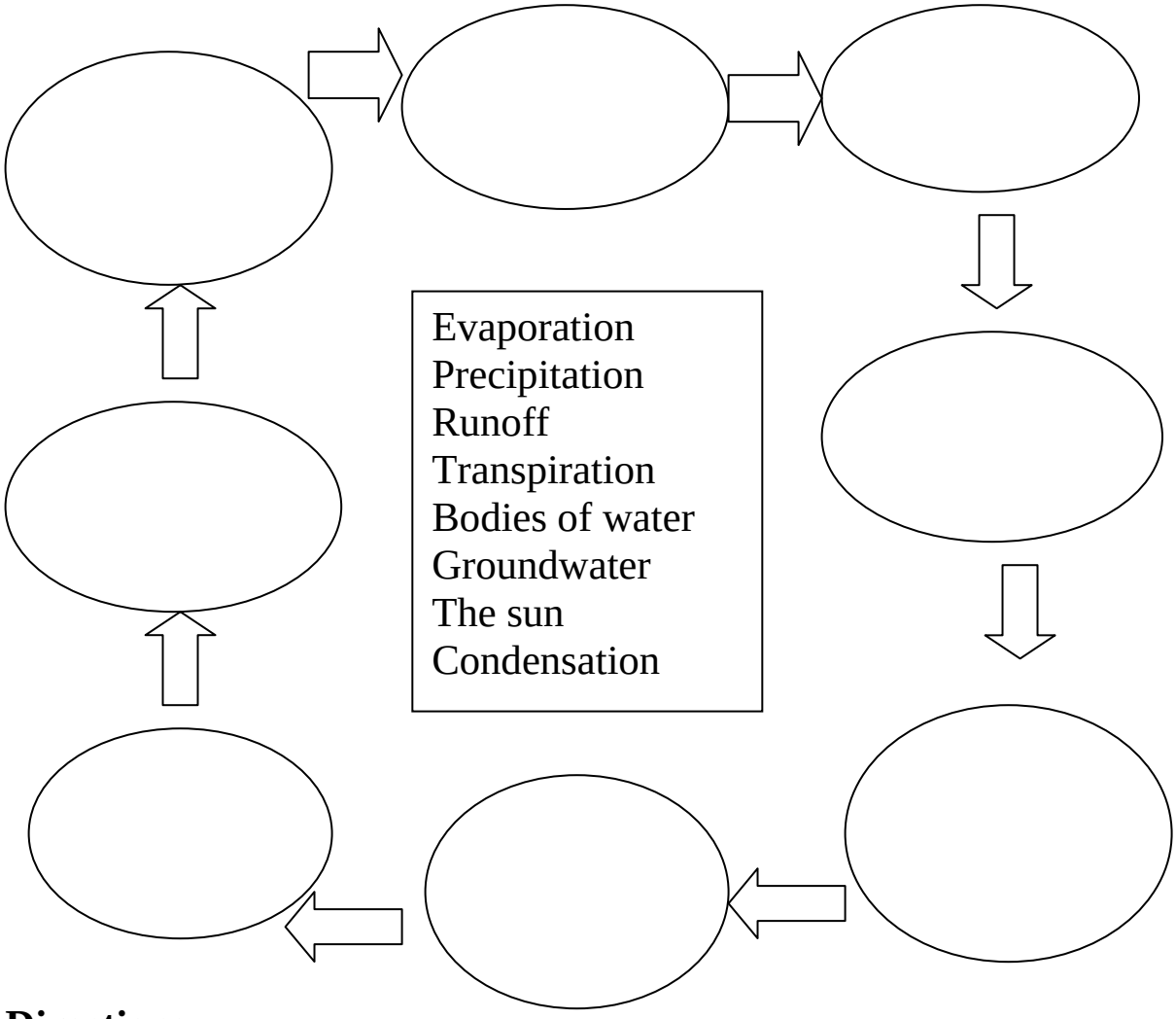
purpose, audience, and content.

2.3.5 *Create Original Texts*

Create original texts [such as descriptions, panel discussions, impersonations, collages, timelines, documentary videos, journals or diaries...] to communicate and demonstrate understanding of forms and techniques.

Word Cycle (10.1)

Name: _____

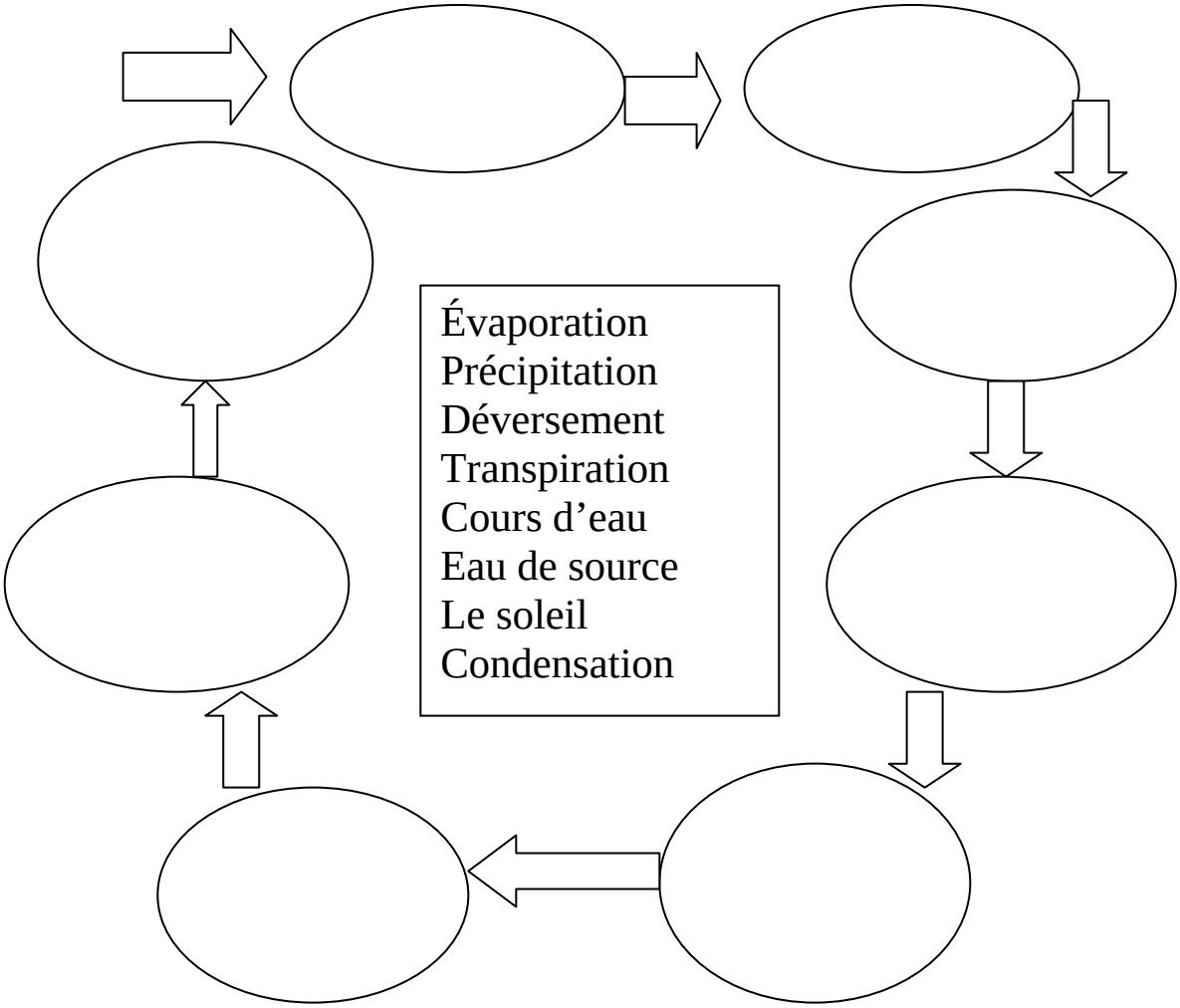


Directions

Read the list of words in the middle of the circle above. Select one word and place it in any circle. In the next circle, place another word that is related to the first. They could be synonyms, antonyms, steps in a process, examples of something, and so on. Be prepared to finish the statement**, "Word A is related to word B because…"** Write a note in between the circles of words to remind yourself of the relationship. Continue this process until you have placed all the words. Plan ahead; the last few words will be tricky to place.

Cycle des mots (10.1)

Nom: _____



Directions

Lisez la liste des mots au milieu des cercles ci-dessus. Choisissez un mot et placez-le dans n'importe quel cercle. Dans le prochain cercle, placez un autre mot qui se rattache au premier. Ça pourrait être un synonyme, un antonyme, les étapes d'un procédé, des exemples de quelque chose, etc. Soyez prêts à compléter la phrase : **"Le mot A se rattache au mot B parce que …"** Écrivez-vous une note entre les cercles de mots pour vous rappeler la relation. Continuez ce processus jusqu'à ce que vous ayez placé tous les mots. Planifiez d'avance; les derniers mots seront difficiles à placer.

Water Droplet Story Rating Scale (10.2)

Student name: _____

Write any needed comments in boxes below

Total / 30	5	4	3	2	1
Creativity					
Illustrations					
Storyline					
Include all aspects of the water cycle					
Neatness					
Grammar/ spelling					
total					

Grille d'évaluation pour l'histoire de la goutte d'eau (10.2)

Nom de l'élève : _____

Écrivez tout commentaire nécessaire dans les boîtes ci-dessous

Total / 30	5	4	3	2	1
Créativité					
Illustrations					
Trame de l'histoire					
Incluez tous les aspects du cycle de l'eau					
Propreté					
Grammaire/épellation					
total					

Lessons 12, 13, 14, 15

<table>
<tr><th colspan="2">Stage 1 – Desired Results</th></tr>
<tr><td colspan="2">Established Goals:
8-4-08 Describe how erosion and deposition are influenced by the flow rate of a stream or river, and contrast the related characteristics of young and mature streams. Examples: meanders, oxbows, alluvial deposits, sandbars, flood plains, deltas… GLO: C8, D5, E3
8-4-9 Describe how wave action and ice movement in large bodies of water cause erosion and deposition. GLO: D5, E3
8-4-10 Explain how tides are caused and describe their effects on shorelines. GLO: D5, D6
8-4-11 Explain examples of human interventions to prevent riverbank or coastal erosion. Examples: vegetation, reinforcement (concrete, boulders) piers, breakwaters… GLO: B2, B5, D5
8-4-12 Identify factors that can cause flooding either individually or in combination. Examples: heavy snow pack, quick thaw, rain in sprint, lack of vegetation to remove water, water through transpiration, frozen ground preventing absorption, agricultural drainage systems, dams, diversions… GLO: C8, D5
8-4-13 Provide examples of the way in which technology is used to contain or prevent damage due to flooding, and discuss related positive and negative impacts. Examples: floodway, diversion, dike, levee… GLO: A5, B1, D5</td></tr>
<tr><td>Understandings:
Students will understand that…
Water causing erosion and deposition can create land features.
Some floods have the potential to be controlled.
Different types of soil have different capacities for retaining rainwater.
If the soil in an area will not hold enough rainwater, flooding problems will ensue.
Soil can be tested for its water-retaining capacity
Tides affect shorelines.</td><td>Essential Question:
How does water affect the land and how do humans attempt to alter its path?</td></tr>
<tr><td>Students will know…
How the slope, flow of water and land features affect erosion and deposition.
Which type of soil is best at preventing flooding and which contributes the greatest to flooding.</td><td>Students will be able to…
Communicate the steps and results from an investigation in written reports.</td></tr>
<tr><th colspan="2">Stage 2- Assessment Evidence</th></tr>
<tr><td>Performance Tasks:
Use a model to investigate the movement of water and how it shapes land.
Describe land features formed by water erosion and deposit of sediment.
Label a Winnipeg map of the different landforms (i.e. meanders, oxbow, etc.).
Recreate tide movement and describe the effects it has on shorelines.
Complete assigned activity data sheets, landforms sheet and final group engineer assignment.</td><td>Other Evidence
Activity 2
Assessment
You can evaluate your students on their lab reports using the following three-point rating scale:
Three: accurate and complete description of each soil test; clear explanation of how tests would be used; careful and error-free writing
Two: satisfactory description of each soil test; explanation of how tests would be used lacking in clarity; some writing errors
One: weak description; unclear or no explanation; numerous spelling and grammatical errors
You can ask your students to contribute to the assessment rubric by determining what information should be included in the description of each soil test.</td></tr>
</table>

Materials Required

1 stream table per group (dishpan or rectangular aluminium baking pan with drainage holes drilled)	Modeling clay
sand & clay (For each stream table, 2 parts sand to 1 part clay– approx. 6 lbs needed total)	1 cup per group
Watering can per group	Buckets with water
Drainage basin per group	Textbooks/encyclopaedia/online access with info about land/river formations
Laminated Winnipeg map per group	1 stream table per group (dishpan or rectangular aluminium baking pan without drainage holes drilled)
Closed spatula for each group	Gravel/small rocks
Three soil samples: sand, agricultural soil (potting soil), and clay	Foliage (leaves, branches etc.)
Funnel per group	Filter paper per group
Three graduated cylinders per group	Blocks or books

Stage 3 – Learning Plan

Activity 1:

For additional student support, see BLM 9 to provide student groups with stream table scenarios ***(courtesy of Kirsten Morris).***

Prior Knowledge

Students should be aware that
- erosion is the process by which weathered rock and soil, or sediment, are transported
- models simulate the real world but are not exactly like it
- models help us to understand natural processes
- landforms change over time

Materials Set-up

1. Mix sand and clay in drainage basin. Dampen mixture with some water.
2. In the stream table, pour out the sand and clay mixture. Pack the sand and clay mixture evenly into the upper half of the stream table (do not cover the end with the drainage hole).
3. Set the ruler over the top part of the stream table. Balance the water source cup on the edge of the stream table and the ruler.
4. Set the stream table on a flat surface such as a table. Place the wooden block under the upper end of the stream table to increase the slope.
5. Place the drainage basin directly below the drainage hole of the stream table to catch water and sediment exiting the stream table.
6. Fill bucket with water.

Procedures

Teacher asks students how they think the local landforms were created. What caused the hills/mountains to be shaped the way they are? Why are there flat areas? What forces shaped the land? How did water play a part in the process? Introduce the river model and its purpose. Teacher explains to students: You will create a river model to help you understand a river system and the land features created by water moving downhill. Remember that models are used in science to help us understand natural processes. For the river model, imagine you are the size of a small ant. The sand represents the earth and the watering can represents the precipitation, such as rain or snow. Observe what happens to the land as the water flows down the stream table.

Students observe their river model and complete the accompanying data sheet. Teacher leads discussion of land features created by the river model and lists student responses on poster paper to create a list of land features that will be covered in this lesson.

Teacher questions might include: If you could not see the water source, how would you know which way the water is flowing? What seems to influence the course that the river takes? What features did you observe in the stream tables that remind you of real land features you have seen before? What happens to

the earth that is pushed out of the way when the water cuts a river into your model? What happens to the sediment carried by your model rivers? What would happen to all the mountains and hills in the world if weathering, erosion, and deposition were the only forces shaping the land? Why does this not happen? Why is the Earth not flat?
Teacher scaffolds discussion with new vocabulary (meanders, oxbows, alluvial deposits, sandbars, flood plains, deltas), using transparencies (see BLM #5, 6, 7) to show visuals of each part of the river system, highlighting the land features.
Students read about the land features identified in the stream table model in the textbook, encyclopedia, or additional teacher provided resources. Students complete the Land Feature chart (OH 12.2).
The slope of the first river model was not very steep. How might a steeper slope cause the river to flow differently and create different land features? Students create an investigation to study the effect of slope on water flow. To increase the slope of the river model add more wooden blocks. Discuss with students how to conduct a controlled experiment which fairly tests the effects of slope on river model. Students observe the difference in water flow and land features and collect and analyze data for a brief lab report.

Activity 2 Lessons 13 & 14
Materials Set-up
1. Use the modeling clay to build levees along the river's banks and to form a canal leading from the river to a reservoir.
2. Set the stream table on a flat surface such as a table. Place the wooden block or textbook under the upper end of the stream table to increase the slope.
3. Place the drainage basin directly below the drainage hole of the stream table to catch water and sediment exiting the stream table.
4. Fill bucket with water.
Procedures
Students have previously investigated the effects of an increase of slope on the riverbed. Ask students what might happen if water flow, instead of slope, increases on a gently sloping riverbed. Have students make a prediction and share with the class.
Students run the flood stream table and observe how material is eroded and deposited.

- Present the following scenario to your students. The class is a team of "consulting engineers" for a new housing development to be built in the next county. Many of the county's citizens are protesting the development. They are saying that the soil in that area will not hold the rain and there will be flooding problems for all dwellings in that area. But others believe this is just an excuse to delay and block the development.
- Tell students that their challenge is to aid in the decision-making process by testing different samples of soil to see how much water the soil will absorb.
- Divide your class into small groups, distributing materials to each group.

- Students should first test each type of soil in its dry state by measuring the same amount of each soil, in turn, into a funnel lined with filter paper, and then pouring a measured amount of water through it. They should use the same amount of water for each type of soil. The water that drains through each type of soil should be collected in another graduated cylinder and the amount recorded.
- Have students repeat the test using the same types of soil in their saturated states.
- Discuss with the class which soil held the most water when dry and which saturated soil held the most water. Which type of soil would be most likely to cause flooding problems?
- Perform the same experiment again, but this time mix in different foliage such as branches and leaves to represent trees, roots and other plants.
- Have each student record on a separate paper answers to the overhead (BLM #1) describing the soil tests, and a final discussion of how communities and developers would use such tests.

Students complete the accompanying data sheet - Activity 2 – Data Sheet and Flood Lab (BLM#4).
Teacher leads discussion of student observations of the flood model. A connection is made between the Red and Assiniboine River and the flood model. Questions include: Where is the eroded material being deposited? Where are the largest sediment particles being deposited? The smallest sediment particles? Is a delta forming? Where? Why is it forming there?
Students observe the "controlled flood" river model and apply their knowledge of river systems and their study of how the human have modified their environment to deal with floods. Students complete the

accompanying data sheet.
Students to make predictions as to what would happen in regards to erosion and deposition in large bodies of water related to wave action and ice movements.

Performance Task Assessment:
Students look at a Winnipeg map. In groups, label the rivers with the new vocabulary. Then the students take the role of engineers and attempt to create an intervention for erosion and flooding. They are to determine where is needed the most along the two rivers and give reasons (see BLM#8). Then also need to discuss the positive and negative impacts of flooding and erosion related to the three aspects of Sustainable Development?

Activity 3 Lesson 15
Discuss with students how tides are caused. Get students to predict what they think happens to the shoreline due to tides.
Have students create a shoreline of the sand/clay mixture in the stream table without holes drilled in it. Gradually add water and using a closed spatula move the water to the shore. Gradually get students to record what happens to the shoreline. Allow students to be creative and put a variety of things on the shoreline, such as rocks (gravel) or paper or "Monopoly" style houses.

Lesson 15
Go through written assignments and discuss answers.

Teacher Background Knowledge

Activity 2
A diversion is a channel constructed across the slope to divert excess concentrated and sheet surface water, and possibly subsurface water, from areas under construction or development, to sites where it can be used or disposed of. This practice applies to sites where:
· A diversion is required to control erosion and runoff on construction sites.
· Concentrated runoff from higher lying areas is potentially damaging to a developing area.
· Overland (sheet) surface flow and shallow subsurface flow caused by seepage is potentially damaging to areas under construction.
· Runoff is in excess and a diversion is required as part of a pollution abatement system.
· Diversions shall not be substituted for terracing or land grading where such practices are more appropriate for erosion control.
Levee – is an embankment for preventing flooding or a continuous dike or ridge (of earth) for confining the irrigation areas of land to be flooded *http://www.m-w.com/cgi-bin/dictionar*

1997 Flood Facts
99.9 % of Winnipeggers are protected by the four major flood control works (Shellmouth Dam & Reservoir, Assiniboine River Diversion, Red River Floodway and Primary Diking System).
At the flood crest, the flow in the Red River approaching Winnipeg was 138,000 cubic feet per second, enough water to fill Winnipeg's Pan Am Olympic Pool once every second. Approximately half that flow was diverted around Winnipeg by the Red River Floodway.
More than 3,000 City staff were involved in the flood effort for a 2 1/2 week period starting April 21st.
800 properties were protected by secondary dikes: 750 by sandbags and 50 by earth fill.
Approximately 8.1 million sandbags were filled and delivered in the City. If you placed the sandbags end to end in a straight line, they would run roughly from Winnipeg to Vancouver. The City's four sandbag machines produced 4.4 million sandbags and volunteers hand filled 3.7 million sandbags.
Sandbag removal was essentially complete by the end of June, 1997.
Over 800,000 cubic yards (600,000 cubic meters) of clay was excavated for earth dike construction. This was approximately 45,000 truck loads. This earth would fill the Winnipeg Football Stadium to a height of 200 feet or a 20 storey building.
The primary diking system was raised with earth fill in 25 locations an average of three feet.
50 temporary earth dikes were modified to become permanent structures. Of these, 10 were primary dikes and 40 were secondary dikes.
All the City's 34 flood pumping stations were operated and a total of 131 flap and positive gates were checked and/or operated in the sewer systems.
The Flood Hotline handled 126,000 calls (peak day was 12,600 calls on April 30th). At the peak there were

60 operators and a 24 hour operation.
The City's Flood Information page on the Internet was accessed over 143,000 times with a maximum of 14,800 hits on May 1st.
There were 74 printed news releases and 24 live daily news conferences.
For 16 consecutive days and nights, Videon and Shaw Cable TV covered the flood, including the daily news conferences. It is estimated that 77% of Winnipeggers watched the cable channels.
City council members and staff conducted more than 2,000 media interviews.
City staff placed more than 70,000 volunteers.
It is estimated that sandbag diking required over 200,000 volunteer days, where one day is an eight hour shift.
Almost 1,000 citizens attended the City's sandbag dike building demonstrations.
Over 600 media personnel were covering the flood, including 150 national and international media from as far away as Germany, Holland and Japan.
Over 9,000 city residents representing 3,000 homes, were evacuated during the flood, primarily in the south end of the City. By mid-May, 97% were returned home.
More than 23,000 individuals received social services including shelter, food, clothing and personal services.
The original scenario of the potential Z-dike failure meant the potential evacuation of 125,000 City residents.
http://www.winnipeg.ca/Services/CityLife/HistoryOfWinnipeg/flood/flood_facts_1997.stm used with permission.

Activity 3

What causes the tides?

It is the gravitational attraction of the sun and moon that cause waters of the ocean to raise and lower at different parts of the earth. Tides occur in oceans, and to a much smaller extent, tides also occur in large lakes, in the atmosphere, and within the solid crust of the earth. There are also non-astronomical factors, such as the configuration of the coastline, the local depth of the water, the ocean-floor topography, and other hydrographic and meteorological influences that play an important role in altering the range and interval between high and low water.

Why tides are important to humans?

The knowledge of the times, heights, and the extent of inflow and outflow of tidal waters is of importance in a wide range of practical applications for humans such as the following:

1) Commercial and recreational Navigation through coastal waterways, and within estuaries, bays, and harbours.
2) The establishment of chart datums for Hydrography, which are then used for demarcation of a base line or "coastline" for fixing offshore territorial limits, both on the sea surface and on the submerged lands of the Continental Shelf.
3) For the furnishing of data useful to fishing, recreational boating, surfing, and a considerable variety of related water sport activities and tourism activities.
4) Work on harbour engineering projects, such as the construction of bridges, docks, breakwaters.
5) For the provision of information necessary for underwater military engineering uses.

Where are the largest tides in the world? What causes them to occur there?

The largest tidal ranges in the world occur in the Bay of Fundy (more exactly Minas Basin) and in Ungava Bay (more exactly Leaf Basin) on the East Coast of Canada, where you can observe a 16 metre (53 foot) tide range. Tidal range varies during the month according to phase of the moon. They are largest at the new and full moons, and smallest at the quarter phases. Tidal ranges in the Bay of Fundy and Ungava Bay are the highest in the world because of an unusual combination of resonance (or seiche) and the shape of the bay. The Bay of Fundy and Ungava Bay are "V" shaped, so that water entering at their wide mouth at the open ocean end is funneled into less and less space as it moves into the head of the bays and the water can only pile up and form a large tide. The water in the Bay of Fundy and Ungava Bay also has a natural rocking motion called a seiche. You could compare this to the movement of water in a bathtub. Although the water in a bathtub sloshes from one end to the other and back again in a few seconds, it takes about 13 hours for the water in the bays to rock from the mouth of the bays to the head of the bays and back again. The Atlantic ocean tide rising and flooding into the bay every 12 hours and 25 minutes reinforces the rocking motion. The seiche in the Bay of Fundy and Ungava Bay are therefore sustained by a pulse from the ocean tides.

Activity 3 background information is reproduced with the permission of the Canadian Hydrographic Service.

Homework Activities

Completion of flooding questions if not finished in class.
Finish 50% water use reduction chart.

Activity 1: Observing a River Model
Data Sheet (OH 12.1)

You will make 3 observations: before, during, and after the water flow.

For each observation do the following on your stream table diagram:

- draw and label any changes you observe
- draw and label the land features you observe

Include the following on your stream table diagram:

- draw and label any changes you observe
- draw and label the land features you observe

Describe what you observe about the stream table.

Première activité : Observer une feuille d'information sur un modèle de rivière (OH 12.1)

Vous ferez 3 observations : avant, pendant et après la coulée de l'eau.

À chaque observation, faites ce qui suit sur votre schéma de coulée d'eau :

1. Dessinez et étiquetez tout changement que vous observez
2. Dessinez et étiquetez les aspects physiques du terrain que vous observez
3. Décrivez ce que vous observez au sujet de la coulée d'eau.

Land Features Chart (OH 12.2)

Land/River Feature	Written description	Diagram
Meanders		
Oxbows		
Sandbars		
Flood plains		
Deltas		

Tableau des aspects physiques du terrain (OH 12.2)

Trait de terre/rivière	Description écrite	Diagramme
Méandres		
Virages en U		
Bancs de sable		
Basse-terres inondables		
Deltas		

Activity 2: Flood
Data Sheet (OH 12.3)

You have observed river models that vary in the steepness of slope. Now you will see what happens when the flow of water changes from normal to a flood.

Run 3 cupfuls of water through the water source cup.

For the observation do the following on your stream table diagram:

1. draw and label any changes you observe
2. draw and label the land features you observe

Describe where the eroded material is being deposited.

How is this model the same/different from the previous model you have observed?

Activity 2: Flood
Feuille de données (OH 12.3)

Vous avez observé des modèles de rivières qui varient dans le degré de la pente. Maintenant vous verrez ce qui arrive quand l'écoulement d'eau change de la normale à l'inondation.

Faites passer 3 tasses d'eau à travers la tasse d'eau source.

Pour l'observation, faites ce qui suit sur votre schéma de coulée d'eau :

3. dessinez et étiquetez tout changement que vous observez
4. dessinez et étiquetez les traits du terrain que vous observez

Décrivez où se dépose la matière érodée.

Comment ce modèle est-il semblable/différent du modèle précédent que vous avez observé?

Name : _____

Flooding lab (OH 12.4)

	Amount of water added		Amount drained out	
	1st attempt	2nd attempt	1st attempt	2nd attempt
Soil				
Sand				
Clay				
Adding of foliage				
Soil				
Sand				
Clay				

Answer the following questions on a separate piece of paper. If any questions are not completed in class it will be for homework.

1. Explain why a river can flood even if there was no recent rain in that section of the river valley?
2. Why are sediments found in rivers? Discuss how rivers carry sediments and explain how this impacts the land during a flood.
3. What characteristics determine how much water soil can hold?
4. Debate the merits of building dams upstream to prevent flooding that can make former floodplains available for development.
5. Discuss why hydrologists (scientists who study the water cycle) track snow accumulation as a part of long-term flood forecasting. What other data would help them make more accurate flood predictions?
6. What happens to the water capacity of each soil when foliage is added?
7. How does growing trees and other plants with significant root systems affect flooding?
8. Discuss with your group whether or not people should be allowed to rebuild homes in an area prone to serious flooding.
9. As the soil engineer, would you recommend the development if the soil in the area was mainly sand? If it were mainly regular soil? If it were mainly clay?
10. What are the positive and negative impacts flooding has on all three aspects of sustainable development?

Nom : _____

Laboratoire d'inondation (OH 12.4)

	Montant d'eau ajoutée	Montant d'eau drainée
Sol		
Sable		
Glaise		
Addition de feuillage		
Sol		
Sable		
Glaise		

Répondez aux questions suivantes sur une feuille de papier séparée. Toute question non complétée en classe deviendra un devoir.

1. Expliquez pourquoi une rivière peut inonder même s'il n'y a pas eu de pluie récente dans cette section de la vallée de la rivière.
2.Pourquoi trouve-t-on des sédiments dans les rivières? Discutez comment les rivières transportent les sédiments et expliquez l'effet que cela a sur la terre durant une inondation.
3.Quelles caractéristiques déterminent combien d'eau la terre peut contenir?
4. Débattez les mérites de la construction de barrages en amont pour empêcher les inondations, ce qui permet le développement de terres anciennement inondables.
5. Discutez pourquoi les hydrologues (scientifiques qui étudient le cycle de l'eau) tiennent compte des accumulations de neige pour pouvoir prédire de loin les inondations. Quelles autres données pourraient les aider à prédire plus précisément les inondations?
6. Qu'arrive-t-il à la capacité d'eau de chaque sol quand on y ajoute du feuillage?
7. Quel effet cela a-t-il sur les inondations quand on fait pousser des arbres et d'autres plants aux systèmes de racines importants?

8. Discutez avec votre groupe si oui ou non on devrait permettre la reconstruction de maisons dans une région portée à de sévères inondations.
9. Comme ingénieur de terrain, recommanderiez-vous le développement si le sol dans la région était surtout du sable? Surtout un sol régulier? Surtout de la glaise?
10. Quels sont les effets positifs et négatifs de l'inondation sur les trois aspects du développement soutenable?

Group Members
_____ _____

_____ _____

Winnipeg Rivers 12.8

Where are the top three areas as an engineer you would protect Winnipeg from either flooding or erosion? Please include which river and cross streets of importance.
1. _____

2. _____

3. _____

What methods might you use to protect those areas from flooding or erosion?
_____

_____

_____

How does flooding/erosion affect (think of potentially both positive and negative):
The local economics: _____

_____

The local environment: _____

_____

Human health and well being? _____
_____

Rivières de Winnipeg 12.8

En tant qu'ingénieur, quelles trois régions de Winnipeg protégeriez-vous contre l'inondation ou l'érosion? Veuillez indiquer quelle rivière et quel carrefour important.

1. _____

2. _____

3. _____

Quelles méthodes utiliseriez-vous pour protéger ces régions contre l'inondation ou l'érosion?

_____

_____

_____

Quel effet l'inondation/l'érosion a-t-elle (pensez aux possibilités positives et négatives) sur :

L'économie locale : _____

_____

L'environnement local : _____

_____

La santé et le bien-être des humains?

_____

_____

BLM #12.9

Stream table scenarios

These are assigned to groups after they have done the first stream table activity. This can be part of lessons 12, 13, 14, 15.
OPTIONAL . Clay for rocks and boulders, trees (Christmas decorations or foam stickers), people (foam decorations or whatever works), houses (*Monopoly* houses .. or small banks of staples work too) and anything else you can think of to represent a human and nature presence.

Scenario #1 Start with a "fresh" stream table.

Using your observations and the information you gathered in your first stream table, spray or carefully pour water to recreate the Red River around Scotia Street.
In your design, include people, houses, trees… etc

Scenario #2 Start with a "fresh" stream table.

Increase the slope of your stream table. B spraying or pouring water form as many of these as you can: delta, sandbars, watershed, oxbow, floodplain…. etc
In your design, include people, houses, trees… etc

Scenario #3 Start with a "fresh" stream table.

Use clay to build banks that would best protect the people, houses, work places, vegetation etc. Then, by pouring water very quickly, create a flash flood.
What happened? Did the banks give the needed protection?
In your design, include people, houses, trees… etc

Scenario #4 Start with a “fresh” stream table.

Using your observations and the information you gathered in your first stream table, spray or carefully pour water to recreate the Red River around Kingston Crescent.
In your design, include people, houses, trees… etc

Scenario #5 Start with a “fresh” stream table.

Create a very wet spring. Slowly and gently spray water along the entire top of the stream table. This represents many days of rain. Observe the changes in rivers, tributaries water sheds, etc.
In your design, include people, houses, trees… etc

Scénarios de tables d'écoulement MLN 12,9

Ceux-ci sont assignés à des groupes après qu'ils ont fini leur première activité de table d'écoulement. Ceci peut faire partie des leçons 12, 13, 14, 15.

FACULTATIF : De la glaise pour les roches et les grosses pierres, les arbres (des décorations de Noël ou des collants en mousse), les gens (décorations en mousse), les maisons (des maisons de Monopoly … ou des petits paquets d'agrafes peuvent servir aussi) et n'importe quoi d'autre qui vous vient à l'esprit pour représenter une présence humaine et naturelle.

Scénario No. 1 Commencez avec une table d'écoulement «vierge».

Selon vos observations et les informations garnies dans votre première table d'écoulement, vaporisez ou versez doucement de l'eau pour recréer la rivière Rouge autour de la rue Scotia. Dans votre maquette, incluez gens, maisons, arbres … etc.

Scénario No. 2 Commencez avec une table d'écoulement «vierge».

Augmentez la pente de votre table d'écoulement. En vaporisant ou en versant de l'eau, formez autant des choses suivantes que possible : un delta, des bancs de sable, un bassin hydrographique, un virage en U, une plaine d'inondation … etc. Dans votre maquette, incluez gens, maisons, arbres … etc.

Scénario No. 3 Commencez avec une table d'écoulement «vierge».

Avec de la glaise, construisez des rives qui offriront la meilleure protection aux gens, aux maisons, aux lieux de travail, à la végétation, etc. Puis, en versant de l'eau très rapidement, créez une inondation éclair.
Qu'est-ce qui est arrivé? Est-ce que les rives ont offert la protection nécessaire? Dans votre maquette, incluez gens, maisons, arbres … etc.

Scénario No. 4 Commencez avec une table d'écoulement «vierge».

Selon vos observations et les informations garnies dans votre première table d'écoulement, vaporisez ou versez doucement de l'eau pour recréer la rivière Rouge autour du croissant Kingston. Dans votre maquette, incluez gens, maisons, arbres … etc.

Scénario No. 5 Commencez avec une table d'écoulement «vierge».

Créez un printemps très pluvieux. Vaporisez lentement et gentiment de l'eau tout le long du haut de votre table d'écoulement. Ceci représente plusieurs jours de pluie. Observez les changements dans les rivières, les affluents, les bassins hydrographiques, etc. Dans votre maquette, incluez gens, maisons, arbres … etc.

Lesson 16

Stage 1 – Desired Results	
Established Goals: 8-4-03 **Compare and contrast characteristics and properties of fresh and salt water.** Examples: freezing point**,** density, dissolved materials, **global distribution**, relative amounts, biologically diverse components of each… GLO: D3, D5, E1	
Understandings: **Students will understand that…** They can make a choice to decrease the amount of water they use.	**Essential Question**: What are the various ways humans impact water and how do they attempt to fix the water they have damaged?
Students will know… How to decrease their individual water consumption	**Students will be able to…** Make choices for their own consumption of water
Stage 2- Assessment Evidence	
Performance Tasks: Students to share ability to decrease water consumption by 50% Students to share methods of decreasing water consumption.	**Other Evidence:** Students design an eye-catching poster to share with others.
Materials Required	
Water use chart competed Poster paper Pencil crayons/markers	
Stage 3 – Learning Plan	
Teacher to record how many of the students were able to decrease their water consumption amount by 50% on the board. Students will share with the class creative ways they have reduced their water use. Students will create posters to put up either within the school or other places (home, community centre, arenas) to share methods of decreasing water.	
Homework Learning Activities	
Minimum of 1 poster per student to be completed by the following class. Poster to be evaluated by student (see BLM#1). Evaluation to be written on the back of the poster.	

Poster Self-Assessment (OH 16.1)

Did I clearly explain why water is important (either visually or with text)

3 2 1

Did I clearly explain how to decrease water use?

3 2 1

Is the poster creative?

3 2 1

Where will I hang up this poster?

_____

Will I actually hang it up?

1.0

Total ____/10

Auto-évaluation de l'affiche (OH 16.1)

Est-ce que j'ai expliqué clairement pourquoi l'eau est importante (soit visuellement ou textuellement)

3 2 1

Est-ce que j'ai expliqué clairement comment diminuer l'usage de l'eau?

3 2 1

Est-ce que l'affiche est créatrice?

3 2 1

Où est-ce que je vais poser cette affiche?

_____

Est-ce que je vais vraiment l'afficher?

1 0

Total ____/10

Lessons 17, 18, 19, 20

Stage 1 – Desired Results

Established Goals:
8-4-14 Identify sources of drinking water and describe methods for obtaining water in areas where supply is limited. *Examples: desalination, melting of ice, condensation*… GLO: B1, B2, B3, D5
8-4-16 Compare the waste-water disposal system within their communities to one used elsewhere. Include process involved, environmental impact, cost. GLO: B2, B5

Understandings:	**Essential Question:**
Students will understand that… In different regions of the world water is accessed and disposed of in different ways.	What are the various ways humans impact water and how do they attempt to fix what they have damaged? How do we learn about water from a sustainability focus?
Students will know… Winnipeg gets its drinking water from Shoal Lake Winnipeg's wastewater gets treated at one of three facilities in Winnipeg and is then discharged into the Red River.	**Students will be able to…** Share how other countries get their water and/or dispose of their waste.

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
View City of Winnipeg videos (can be rented from local library) and complete pre/post test. Students in small groups to create a public service announcement as to where other countries get their drinking water and where their wastewater goes.	Students will work together to create an engaging and information-sharing product.

Materials Required

2 City of Winnipeg videos (At the Turn of the Tap [11 minutes] & Down the Drain [13 minutes])
Internet access – for additional information if required

Stage 3 – Learning Plan

Lesson 17
*** Get students to do self-evaluation of poster due this class and tell teacher for recording***
Teacher gets students to do pre-test (BLM # 1) on Winnipeg's water supply and treatment. Then students to watch 2 videos about the city of Winnipeg (approximate time: At the Turn of the Tap 11 minutes, Down the Drain 13 minutes) and briefly go over their post-test.
In small groups of 4, students will be given an article on a region to do additional research and either video tape a 3 minute PSA or act out in front of the class (see BLM #2) – students are given article to read for homework prior to next class and should come with some ideas of how to proceed (all articles courtesy of UNICEF. Used by permission.)
Lessons 18 & 19
Students are given time to plan the PSA.
Students should find their country on a map prior to starting to get an idea of where it is in the world.
Lesson 20
Students are to present their PSAs.

Homework Learning Activities

Read article on country.
Work on any additional research or presentation at home

Extension Learning Activities

The best announcements can be shared at a school assembly

Pre & Post Test for Water Supply and Treatment in Winnipeg (OH 17.1)

- Where does Winnipeg's water originate from?
- What year was Winnipeg's water system built?
- How does the water get to Winnipeg?
- How much did the water system cost?
- How long does it take 7 thousand million litres of water to be used up by the City of Winnipeg?
- Which water reservoir do you think services our area?
- On average, how many litres of water per person is used in the City of Winnipeg each day?
- Is the water from our taps safe to drink?
- How many pollution control centres are there in Winnipeg?

10. Where does the water go after it has been treated?
11. What year did Winnipeg open up its first water treatment facility?
12. Which pollution control centre do you think services our area?
13. What does the North End Treatment Facility do with the methane gas it produces?
14. Why is it important to fix leaks in regards to the water treatment facilities?
15. How do you feel about the quality of your drinking water?

Pré & Post Test pour l'approvisionnement et le traitement de l'eau à Winnipeg (OH 17.1)

1. D'où vient l'eau de Winnipeg?
2. En quelle année le système d'eau de Winnipeg a-t-il été construit?
3. Comment l'eau parvient-elle à Winnipeg?
4. Combien le système d'eau a-t-il coûté?
5. Combien de temps faut-il pour que Winnipeg utilise 7 mille millions de litres d'eau?
6. Selon vous, quel réservoir dessert notre région?
7. En moyenne, combien de litres d'eau sont utilisés par personne à Winnipeg chaque jour?
8. Peut-on boire l'eau de nos robinets en toute sécurité?
9. Combien de centres de contrôle de pollution y a-t-il à Winnipeg?
10. Où va l'eau après avoir été traitée?
11. En quelle année Winnipeg a-t-elle ouvert son premier centre de traitement de l'eau?
12. Selon vous, quel centre de contrôle de pollution dessert notre région?
13. Qu'est-ce que le centre de traitement de la région Nord fait du gaz méthane qu'il produit?
14. Pourquoi est-il important de réparer les fuites quand il s'agit d'un centre de traitement d'eau?
15. Comment vous sentez-vous par rapport à la qualité de votre eau potable?

Public Service Announcement Assessment (17.2)

Group members

_____ _____

_____ _____

Total ___/20	5	4	3	2	1
Water supply					
Waste disposal					
Creativity					
Organization					

Public Service Announcement Assessment

Group members

_____ _____

_____ _____

Total ___/20	5	4	3	2	1
Water supply					
Waste disposal					
Creativity					
Organization					

Évaluation des annonces du service public (17.2)

Group members

_____ _____

_____ _____

Total ___/20	5	4	3	2	1
Approvisionnement d'eau					
Disposition des déchets					
Créativité					
Organisation					

Évaluation des annonces du service public (17.2)

Group members

_____ _____

_____ _____

Total ___/20	5	4	3	2	1
Approvisionnement d'eau					
Disposition des déchets					
Créativité					
Organisation					

Small water purifiers make a major difference in keeping Ethiopian children healthy

(17.3 page 1 of 2)

Dereje Abdeta dips a bucket into the polluted waters of the Awash River to take a sample just a few metres from where a group of young herders have brought their cattle to drink.

“The water is highly contaminated with organic material. We have tested it, and a there is a lot of bacteria,” says Mr. Abdeta, a consultant working for UNICEF’s Water, Environment and Sanitation [WES] section for the central and southern regions of Ethiopia.

But help is at hand. As part of its emergency water response, UNICEF is bringing safe drinking water to the people of Awash-Malkasa, Ethiopia using water purification equipment received as a contribution from the Norwegian government.

Since June 2003, 10 units have arrived in Ethiopia. Five have already been installed and are up and running in Oromia, Somali, Afar and Southern Nations, Nationalities and Peoples regions.

Ten more units, which cost about $17,000 each, are scheduled to arrive early this year.

“We will put this equipment where there are high health risks and diarrhoea in emergency areas and where there are highly polluted ponds and rivers,” says Mr. Abdeta.

The same water purification technology has been used all over the world from Afghanistan and Mozambique to the former Yugoslavia in the aftermath of natural disasters like floods, earthquakes and volcanoes, or man-made ones like war.

“The Norweigan government asked our company, Plastec AS, to assist after UNICEF said there was a need for clean water in Ethiopia,” explains Steinar Langedahl, who is overseeing the installation of purification equipment.

“These are small units, easy to handle, even for unskilled personnel, and they work for nearly every kind of water source. If used properly, you can run them for about 10 years,” he adds. “Minor repairs can be done here. For bigger repairs, Plastec AS can supply the parts.”

The metallic hum of the pump powered by its diesel engine fills the air and can be heard over the mooing of the nearby cows. Water from the river is pumped through tubes into a chamber where water purification tablets are added. These bind to the sediment particles, making them bigger and easier to separate from the liquid.

The water flows through two filters where the sediment is filtered and the water is chlorinated. The purified water is then channelled into two large tanks, which provide safe drinking water for nearby villages.

This area of Awash-Malkasa was selected for the project after a joint water supply assessment was conducted by the Ethiopian Zonal Water Bureau and UNICEF between May and July 2003.

“If we get more units, we can increase water supply coverage and reduce water-borne diseases, as purification saves a lot of lives during drought or flood emergencies,” says Haile Gashaw, Assistant Project Officer for UNICEF Ethiopia’s WES section. “We face a lot of diarrhoea and cholera in such areas, and with this equipment we can reach people immediately.”

(17.3 page 2 of 2)

The system can process an average of 4,000 litres of water per hour. Highly polluted water takes longer – 2,000 to 3,000 litres per hour. Each unit can provide for between five and 10 litres of drinking water for 5,000 people per day.

“Safe water can really change people’s lives. I’ve talked to many women who say it makes a big difference. They say they have less waterborne diseases and diarrhoea,” says Lillian

Wikstrom, an advisor for the Norwegian Ministry of Foreign Affairs, as she inspects the purification system equipment in Awash-Malkasa.
“It’s inspiring to see our efforts taking off on the ground. People are really satisfied, and it’s sustainable. It’s the best payback anyone can have.”
www.unicef.org

Les petits purificateurs d'eau jouent un grand rôle dans la bonne santé des enfants éthiopiens
(17.3 page 1 de 2)

Dereje Abdeta plonge son seau dans les eaux polluées de la rivière Awash pour prendre un échantillon à quelques mètres de jeunes bouviers qui ont mené leur bétail à boire. «L'eau est très contaminée de matières organiques. Nous l'avons testée et il y a beaucoup de bactéries», dit M. Abdeta, un conseiller qui travaille pour la section d'eau, d'environnement et d'aménagement sanitaire [EEA] de l'UNICEF dans les régions centrale et sud de l'Éthiopie. Mais l'aide est là. Avec sa solution pour les urgences d'eau, l'UNICEF apporte une bonne eau potable au peuple d'Awash-Malkasa, en Éthiopie, grâce à l'équipement de purification d'eau reçu comme contribution du gouvernement norvégien. Depuis juin 2003, 10 unités sont arrivées en Éthiopie. Cinq ont déjà été installées et sont utilisées régulièrement dans les régions d'Oromie, de Somalie, d'Afar et des Nations, Nationalités et Peuples du Sud.
Dix autres unités, coûtant environ 17 000$ chacune sont sensées arriver tôt cette année. «Nous installerons cet équipement là où il y a d'énormes risques de santé et de diarrhée dans des régions urgentes et où les rivières et les étangs sont extrêmement pollués,» dit M. Abdeta. On se sert de cette technologie de purification d'eau à travers le monde, depuis l'Afghanistan et la Mozambique à l'ancienne Yougoslavie suivant des désastres naturels comme des inondations, des séismes et des volcans, ou encore les guerres produites par l'homme.
«Le gouvernement norvégien a demandé à notre compagnie, Plastec AS, de les aider après que UNICEF eut déclaré le besoin d'eau propre en Éthiopie,» a expliqué Steinar Langedahl, qui surveille l'installation de l'équipement de purification. «Ces unités sont petites, faciles à manier, même pour un personnel non qualifié et elles fonctionnent pour presque toutes les sources d'eau. Si on s'en sert correctement, elles peuvent servir pour une dizaine d'années,» a-t-il ajouté. «Les réparations mineures peuvent être faites sur place. Pour des réparations majeures, Plastec AS peut fournir les pièces.»
Le vrombissement métallique de la pompe actionnée par un moteur diesel remplit l'air et on peut l'entendre au-dessus du beuglement des vaches tout près. L'eau de la rivière est pompée à travers de tuyaux dans un réservoir où on y ajoute des comprimés de purification. Ceux-ci se rattachent aux particules sédimentaires, les rendant plus grosses et plus faciles à séparer du liquide. L'eau passe à travers deux filtres où le sédiment est filtré et l'eau est javellisée. L'eau purifiée est ensuite canalisée vers deux grandes citernes qui fournissent une eau potable saine aux villages environnants.
Cette région d'Awash-Malkasa fut sélectionnée pour le projet après qu'une évaluation combinée de l'approvisionnement d'eau fut menée par le Bureau de la zone éthiopienne de l'eau et UNICEF entre mai et juillet 2003. «Si nous avons plus d'unités, nous pouvons augmenter le montant d'eau disponible et réduire les maladies portées par l'eau, puisque la purification sauve beaucoup de vies pendant les urgences de sécheresse ou d'inondation,» dit Haile Gashaw, Officier adjoint de projet pour la section EES éthiopienne de l'UNICEF. «Nous faisons face à beaucoup de diarrhée et de choléra dans ces régions, et avec cet équipement nous pouvons rejoindre les gens immédiatement.»
Le système peut traiter une moyenne de 4 000 litres d'eau par heure. L'eau extrêmement polluée prend plus de temps – 2 000 à 3 000 litres par heure. Chaque unité peut fournir entre cinq et dix litres d'eau par jour à 5 000 personnes. «Une eau saine peut vraiment changer la

(17.3 page 2 de 2)
vie des gens. J’ai parlé à bien des femmes qui ont dit que ça faisait une grande différence. Elles ont dit qu’elles avaient moins de maladies portées par l’eau et de diarrhée,» a dit Lillian Wikstrom, conseillère au Ministère des affaires étrangères norvégien, en inspectant l’équipement du système de purification à Awash-Malkasa. «C’est inspirant de voir nos efforts prendre leur envolée sur le terrain. Les gens sont vraiment satisfaits, et c’est soutenable. C’est le meilleur retour sur investissement que n’importe qui pourrait avoir.»
www.unicef.org

Guinea worm causes physical pain for people, economic pain for countries

(17.4 page 1 of 2)

John Jal Youl pulls up a pant leg and points to a faded scar on his ankle. "That is where he came out," he says, brushing his hand over a pink circle on his weathered black skin. "The wound burned like a fire."

The 52-year-old man from the town of Malakal in Upper Nile State in southern Sudan sounds like a possessed man speaking about exorcising a demon. Which is just how most victims of guinea worm describe their horrible ordeal in the grips of "the fiery serpent," as the disease has been called.

Guinea worm is a painful, debilitating and gruesome disease that is contracted when a person consumes stagnant water contaminated with microscopic fleas carrying infective larvae.

The larvae mature and grow inside a person's body, with worms sometimes growing to be over a metre long. The worm winds through the body and after a year, slowly emerges through an agonizingly painful blister in the skin. There is no cure.

"In the beginning, it started like a fever," recalls Mr. Youl. "After that, my body started to swell. Then I had pain around the hips and legs. It took about one month for the whole thing to come out."

"Guinea worm disease affects productive people. It's very painful and people can't work. Then it becomes an economic hazard," explains Dr. Emmanuel Baya, UNICEF Resident Project Officer in Malakal.

"Children just become bedridden. If the rest of the family has the disease, there is no one to care for them. So it affects the whole productive capacity of the community."

A global campaign is underway to eradicate guinea worm disease (also known as dracunculiasis) by 2005. The effort is being led by UNICEF, the World Health Organization (WHO), and the Carter Center (a humanitarian organization founded by former President Jimmy Carter), along with other partners.

Enormous strides have been made: there has been a 98 per cent reduction in new cases from some 3.2 million cases in 1986. Guinea worm and polio may become the first diseases since smallpox to be wiped off the earth.

Sudan is the world's largest reservoir of guinea worm disease, with 70 per cent of the 35,000 cases provisionally reported in 2003. Ghana and Nigeria are the next largest endemic countries.

Traditional beliefs have also sustained the disease. "There are two beliefs about how you get it," says Mr. Youl who supervises the guinea worm eradication programme in the state of Jonglei, one of the worst affected areas in Sudan..

“The first is that if someone has it and you step on his urine, you will contract it. The second is that if someone has guinea worm and you touch them, you can get it."

Mr. Youl and teams of health workers educate villagers about the real sources of the disease. They teach people about using safe sources of clean water, and distribute simple filters — clay or metal tubes with cloth screens over one end — that can strain out the larva-carrying insects. They instruct those infected with the disease not to bathe in communal water sources so they don't spread the disease.

(17.4 page 2 of 2)

"I also go to schools and talk to children about the danger of guinea worm, and I go to talk to people in church," he says. "In the beginning, people don't usually believe me. But after

seeing how people who use the filter are not affected by the disease, they begin to ask questions."

The ultimate cure for guinea worm disease is not a pill or a filter. It is peace. Dr. Baya has seen proof of this first-hand.

"In East Equatoria State [in Sudan] there was a village where almost everyone had guinea worm," he recalls. During a lull in fighting, "UNICEF sank one borehole that delivered clean water to the community. In one year, all the guinea worm cases were gone."

UNICEF has linked its guinea worm eradication efforts in Sudan to local peace building initiatives. In 2001, the organization helped broker a peace agreement in the states of Jonglei and Upper Nile between two ethnic Nuer groups that had been warring for years, at a cost of thousands of lives.

The mediators offered the warring parties a universally appealing incentive to make peace: the promise of boreholes, which meant, among other things, that guinea worm disease might vanish from the area.

The peace compact was signed in 2001, and the worm, John Jal Youl hopes fervently, "is in retreat."

www.unicef.org

Le ver de Guinée cause une douleur physique aux gens et une douleur économique aux pays

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John Jal Youl remonte un côté de son pantalon et indique une cicatrice fanée sur sa cheville. «C'est là qu'il est sorti,» dit-il, frôlant sa main sur un cercle rose sur sa peau noire vieillie. «La blessure brûlait comme un feu.» L'homme de 52 ans de la petite ville de Malakal dans l'État du Nil en Amont au sud du Soudan semble être un homme possédé qui parle d'exorciser un démon. Voilà comment la plupart des victimes du ver de guinée décrivent leur horrible épreuve aux prises du «serpent enflammé», comme on appelle cette maladie.
Le ver de guinée est une maladie douloureuse, débilitante et horrible qui est contractée quand une personne boit de l'eau stagnante contaminée de puces microscopiques qui portent des larves infectieuses. Les larves se développent et grandissent à l'intérieur du corps de la personne, avec des vers qui grandissent parfois à plus d'un mètre. Le ver s'insinue à travers le corps et, après un an, en sort lentement par une ampoule dans la peau dans une douleur agonisante. Il n'y a aucun remède.
«Au début, ça a commencé comme une fièvre,» se rappelle M. Youl. «Après ça, mon corps a commencé à s'enfler. Puis, j'ai eu des douleurs autour des hanches et des jambes. Cela a pris environ un mois pour que toute la chose sorte». «La maladie du ver de guinée affecte les gens productifs. C'est très douloureux et les gens ne peuvent pas travailler. Alors, ça devient un hasard économique,» explique le docteur Emmanuel Baya, Officier de projet en résidence pour l'UNICEF à Malakal. «Les enfants sont cloués au lit. Si le reste de la famille est atteint par la maladie, il n'y a personne pour s'occuper d'eux. Alors, cela affecte toute la capacité productive de la communauté». Une campagne globale est en voie pour déraciner la maladie du ver de guinée (nom scientifique : dracunliasis) dès 2005. L'effort est mené par l'UNICEF, l'Organisation mondiale pour la santé (OMS), le Centre Carter (une organisation humanitaire fondée par l'ancien président Jimmy Carter) et d'autres partenaires.
De grandes avances ont été faites : il y a eu une réduction de 98% dans les nouveaux cas à partir des 3,2 millions de cas en 1986. Il se peut que le ver de guinée et le polio soient les premières maladies depuis la variole à être effacées de la surface de la terre.
Le Soudan est le plus grand réservoir mondial pour la maladie du ver de guinée, avec 70% des 35 000 cas provisoirement rapportés en 2003. Le Ghana et le Niger sont les prochains plus grands pays endémiques. Des croyances traditionnelles ont aussi maintenu la maladie.
«Il y a deux croyances sur comment on peut la contracter,» dit M. Youl qui surveille le programme d'éradication du ver de guinée dans l'état de Jonglei, une des régions les plus affectées du Soudan.
«La première, c'est que si quelqu'un l'a et vous marchez dans son urine, vous la contracterez. La seconde est que si quelqu'un a un ver de guinée et que vous le touchez, vous pouvez l'attraper.»
M. Youl et des équipes de travailleurs pour la santé instruisent les villageois sur les vraies sources de la maladie. Ils enseignent aux gens comment utiliser des sources d'eau propre en toute sécurité, et distribuent de simples filtres – des tuyaux en glaise ou en métal avec un tamis en étoffe à un bout – pour filtrer les insectes porteurs de larves. Ils avertissent ceux qui sont atteints de la maladie de ne pas se baigner dans les sources d'eau communes pour ne pas répandre la maladie.

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«Je vais aussi dans les écoles parler aux enfants au sujet du danger du ver de guinée, et je vais en parler aux gens dans les églises,» dit-il. «Au début, les gens ne me croient généralement pas. Mais après avoir vu comment les gens qui se servent du filtre ne sont pas affectés par la maladie, ils se mettent à poser des questions.»

Le remède ultime pour la maladie du ver de guinée n'est ni une pilule ni un filtre. C'est la paix.

«Dans l'État équatorial est [au Soudan] il y a un village où presque tout le monde avait le ver de guinée,» se rappelle-t-il. Durant une accalmie pendant la guerre, «l'UNICEF a creusé un trou de sondage qui a livré de l'eau propre à la communauté. En un an, tous les cas de ver de guinée étaient partis.»

L'UNICEF a lié ses efforts d'éradication du ver de guinée au Soudan aux initiatives pour bâtir une paix locale. En 2001, l'organisme a aidé à forger un accord de paix dans les états de Jonglei et du Nil Supérieur entre deux groupes ethniques Nuer qui se faisaient la guerre depuis des années, au prix de milliers de vies. Les médiateurs ont offert aux deux parties guerrières un stimulant universellement attrayant pour faire la paix : la promesse de trous de sondage, ce qui voulait dire, entre autres, que la maladie du ver de guinée pourrait disparaître de leur région.

Le pacte de paix fut signé en 2001, et le ver, John Jal Youl espère fervemment, «qu'il est en voie de disparition.»

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Bringing water, bringing life to people in the most remote areas of Turkmenistan

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People in Turkmenistan equal water to something precious. "A drop of water is a grain of gold," says the old Turkmen proverb. It is especially true for more than a million citizens of Dashoguz province in the north of the country which represents one fifth of Turkmenistan's population. Dashoguz province is where people struggle ever day to have access to safe drinking water.

With the territory twice as big as Belgium, Dashoguz is located in the desert Kara Kum, which covers more than 80% of Turkmenistan's territory. The shortage of water resources in this region is caused by the widespread desert landscapes and saline soils. The region is a big producer of wheat, rice, cotton and vegetables, thus, the situation with water resources is aggravated by high water intake for irrigation and soil leaching and low efficiency of irrigation systems.

An environment and people's health in Dashoguz are also affected by the Aral Sea dry out. Once a glowing oasis, the Aral Sea territory is now occupied by vast amount of saline that is spread by the winds to the air and causes acute respiratory illnesses among children.

The only rescue is the Amu Darya river, the most vital water resource in the country. But Amu Darya is also saline because upstream countries discharge their drainage effluent into river systems. Water becomes successively more saline as it goes towards lower areas. And unfortunately, Turkmenistan is located much downstream.

Until 2000, families in Gurbansoltan Edje district (formerly Yylanly) in Dashoguz province had no choice but to drink saline, often bitter tasted unsafe water that served as a major cause of diarrhea and other waterborne diseases among children. Since UNICEF has established the desalinization plant in this district in 2000, people have better access to safe drinking water.

"The plant filters and chlorinates about 30-40 tonnes of water daily and that is enough for Gurbansoltan Edje district with population of more than 20,000. This year UNICEF has upgraded our plant and now the capacity has tripled, and we are able to produce up to 120-130 tonnes per day," says Gochmuhammet Amanov, Director of the Desalinization Plant. "This will allow us to serve the drinking water needs and, thus, contribute to the improvement of health condition of thousands of people in our district as well inhabitants of neighbouring districts," Mr. Amanov says in excitement.

Provision of safe water supply and sanitary facilities, particularly in schools, and promoting hygiene education in basic schools, health facilities and at the community level are the main focus of UNICEF's Water and Sanitation programme in Turkmenistan.

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In the sweaty summer season requirement for safe drinking water increases in many folds – exception is not in Dashoguz velayat. Citizens of Gurbansoltan Edje district have advantage

of using the desalinized safe water, but many more in the region suffer from inadequate provision of safe water. The next available desalinization plant is 130 km away from Gurbansoltan Edje district making it difficult for many families to have access to safe drinking water.

“We wish people in our districts also had an access to safe water,” voiced their concern the representatives of the Drinking Water Association of other districts. “Establishment of desalinization plants in our districts could dramatically improve the health of our people and we wish UNICEF to come forward to help us as well.”

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L’EAU TRÈS SALÉE, APPORTER LA VIE AUX GENS DANS LES RÉGIONS LES PLUS ÉLOIGNÉES DU TURKMÉNISTAN

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Les gens du Turkménistan équivalent l’eau à quelque chose de précieux. «Une goutte d’eau, c’est un grain d’or», selon un vieux proverbe turkmène. C’est surtout vrai pour plus d’un million de citoyens de la province de Dashoguz au nord du pays qui représente un cinquième de la population du Turkménistan. C’est dans la province de Dashoguz qu’on trouve des gens qui luttent chaque jour pour avoir accès à de l’eau potable sécuritaire.

Comprenant un territoire deux fois plus grand que la Belgique, Dashoguz est située dans le désert Kara Kum qui couvre plus de 80% du territoire du Turkménistan. La pénurie de ressources d’eau dans cette région est causée par des paysages désertiques répandus et des terres salines. La région est un grand producteur de blé, de riz, de coton et de légumes, donc l’état des ressources d’eau est aggravé par la prise d’eau élevée pour l’irrigation, ainsi que la dissolution du sol et le peu d’efficacité des systèmes d’irrigation.

L’environnement de Dashoguz et la santé des gens sont aussi affectés par le dessèchement de la mer Aral. Jadis un oasis luxuriant, le territoire de la mer Aral n’est plus qu’un vaste salinage qui se répand par le vent dans l’air et cause des maladies respiratoires aiguës chez les enfants.

La seule rescousse, c’est la rivière Amu Darva, la ressource d’eau la plus importante au pays. Mais l’Amu Darva est aussi saline parce que les pays en amont déchargent leurs effluents dans les systèmes de rivières. L’eau devient progressivement plus saline à mesure qu’elle descend vers les régions basses. Et malheureusement, le Turkménistan est situé loin en aval.

Jusqu’à l’an 2000, les familles dans la région Gurbansoltan Edie (autrefois Yylanly) de la province de Dashoguz étaient forcées de boire de l’eau saline amère, source de diarrhée et d’autres maladies portées par l’eau chez les enfants. Depuis que l’UNICEF a établi une installation de dessalage dans cette région en 2000, les gens ont un meilleur accès à une eau potable sécuritaire.

«L’installation filtre et javellise environ 30-40 tonnes d’eau chaque jour et ça suffit pour la région Gurbansoltan Edie avec une population de plus de 20 000. Cette année, l’UNICEF a amélioré l’installation et maintenant la capacité est triplée, et nous pouvons produire jusqu’à 120-130 tonnes par jour», dit Goshmuhammet Amanov, directeur de l’installation de dessalage. «Ceci nous permettra de remplir les besoins d’eau potable et ainsi de contribuer à l’amélioration des conditions de santé de milliers de personnes dans notre région ainsi que des habitants des régions avoisinantes», dit M. Amanov, tout excité.

La disposition d’un approvisionnement d’eau sécuritaire et de facilités sanitaires, surtout dans les écoles, et la promotion de l’éducation sur l’hygiène dans des écoles fondamentales

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et d'installations pour la santé au niveau communautaire forment la direction centrale du programme d'eau et d'installations sanitaires de l'UNICEF au Turkménistan.

Durant les étés chauds, les besoins d'une eau potable sécuritaire augmentent maintes fois – avec peu d'exceptions au Dashoguz. Les citoyens de la région de Gurbansoltan Edie ont l'avantage d'avoir de l'eau dessalée sécuritaire, mais il y en a bien d'autres dans la province qui souffrent d'un approvisionnement insuffisant d'eau sécuritaire. L'installation de dessalage la plus proche est à 130 km de la région de Gurbansoltan Edie, ce qui rend bien difficile à nombre de familles l'accès à une eau potable sécuritaire.

«Nous aimerions bien que les gens de notre région aussi aient accès à de l'eau sécuritaire», ont plaidé les représentants de l'Association d'eau potable d'autres régions. «L'établissement d'installations de dessalage dans nos régions pourrait améliorer dramatiquement la santé de notre peuple et nous aimerions que l'UNICEF vienne nous aider aussi.»
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Mozambique: children lead the way

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Throughout the outlying area of Beira City in central Mozambique, young people are transforming dank and dirty schools into healthy, inviting places of learning. Children as young as seven are the messengers, educating their peers, their families and their communities about the importance of safe water, good hygiene and private, separate sanitation facilities.

In this peri-urban area there are 54 schools, serving 34,000 pupils. Because of classroom shortages, children go to school in shifts — normally from 6:30a.m. until 10:30a.m., 10:30a.m. until 1:30p.m. and 1:30p.m. until 5:30p.m. This schedule has left children with idle time without teacher supervision.

In 2000, a UNICEF study found that 80 per cent of all primary schools here had no toilets for boys or girls, and no hand-washing facilities. Few schools promoted hygiene and those that did focused on teacher lectures with no student participation. To rectify this situation, UNICEF supported the construction of latrines for boys, girls and teachers, and hand-washing facilities for hygiene practice. But the most potent tools in improving the school and community environment were the children themselves.

UNICEF initially trained 17- to 24-year-olds as facilitators to bring the message about children's role in improving their school and community to primary school students. Child-to-child sanitation clubs sprang up in 15 primary schools with about 18,000 students.

"The benefits of child-to-child sanitation clubs combined with latrine construction and hand-washing facilities have exceeded all expectations."

These clubs promoted hygiene practices and healthy school environments. The young people pushed for central refuse collection spots so that they no longer had to share their play spaces with garbage. Through theatre, song, dance and games, the children warned of the dangers of unhygienic environments, especially for children. They emphasized how proper disposal of syringes and other medical material would help prevent the spread of HIV/AIDS.

Irene Luisa da Costa Tivane, a 10-year-old child-to-child club member, is certain that she is making a difference.

"Participating in hygiene promotional activities is fighting diarrhoeal diseases," says Irene. "That is why everybody should drink chlorinated water and know how to use a latrine."

Flávo Varela de Araújo, 14, is an active member of a child-to-child radio programme that supports the school sanitation clubs. He boasts about the transformation within the classroom walls.

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“With the creation of the club the school environment is changing,” said Flávo. “And the students’ behaviour is changing too. We will continue supporting safe practices.”

These after-school clubs are instruments of learning for the adults in the community as well. The students’ exemplary behaviour is catching on.

“The process of adopting safer practices is slow,” says Flávo. “But we see positive steps in our communities as they implement our recommendations and advice.”

The parents are listening to their children and are practising hygienic behaviour at home. After witnessing the benefits of good hygiene and the necessary enabling environments, the adults have begun pressing local authorities to provide better hygiene education and services in all schools.

The success of the initial programmes has encouraged inter-school discussion in which teachers share with pride the accomplishments of their schools. Encouraged by the cost-effectiveness of these

programmes, three other municipalities have begun fund-raising so they too can bring this participatory methodology to their schools.

UNICEF is working closely with the Ministry of Education to see how this can be replicated in other communities. In its national reform of the curriculum, Mozambique has committed 20 per cent of the school term to reflect local issues. UNICEF is pressing for hygiene promotion activities to be part of that 20 per cent.

"For a relatively small investment in child-to-child clubs, the dividends have been great."

The benefits of child-to-child sanitation clubs combined with latrine construction and hand-washing facilities have exceeded all expectations. Not only have these initiatives provided safer, healthier learning environments, they have also encouraged girls’ education. Whereas older girls used to drop out of school for lack of privacy, they are now remaining in school to complete their basic schooling. The improved hygienic conditions have given girls back their books and their dignity.

For a relatively small investment in child-to-child clubs, the dividends have been great: healthy schools and communities, more girls remaining in schools and leadership skills for the next generation.

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Mozambique: les enfants montrent le chemin

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Partout dans la région environnant Beira City, en Mozambique centrale, des jeunes gens transforment des écoles humides et sales en lieux d'apprentissage sains et accueillants. Des enfants même au bas âge de sept ans en sont les messagers, instruisant leurs pairs, leurs familles et leurs communautés sur l'importance d'une eau saine, d'une bonne hygiène et de facilités sanitaires privées et séparées.

Dans cette région autour de la ville, il y a 54 écoles desservant 34 000 élèves. À cause du manque de salles de classe, les élèves doivent aller à l'école en rotation – généralement de 6h30 à 10h30, de 10h30 à 13h30 et de 13h30 à 17h30. Cet horaire donne aux élèves beaucoup de temps libre sans surveillance des professeurs.

En 2000, une étude de l'UNICEF a trouvé que 80% de toutes les écoles primaires n'avaient de toilettes ni pour les garçons ni pour les filles, et rien pour se laver les mains. Peu d'écoles encourageaient l'hygiène et celles qui le faisaient s'en tenaient à des conférences pour les professeurs sans la participation des élèves. Pour corriger cette situation, l'UNICEF a appuyé la construction de latrines pour les garçons, les filles et les professeurs, et des lavabos pour se laver les mains pour pratiquer l'hygiène. Mais l'outil le plus puissant dans l'amélioration de l'environnement scolaire et communautaire fut les enfants eux-mêmes.

L' UNICEF a d'abord entraîné des jeunes de 17 à 24 ans comme agents pour porter le message sur le rôle des enfants dans l'amélioration de leur école et leur communauté aux élèves des écoles primaires. Des clubs d'amélioration de l'hygiène enfant à enfant ont commencé dans 15 écoles primaires avec environ 18 000 élèves.

«Les bienfaits des clubs d'amélioration de l'hygiène enfant à enfant combinés avec la construction de latrines et de lavabos ont dépassé toutes les attentes.»

Ces clubs encourageaient la pratique de l'hygiène et d'un environnement scolaire sain. Les jeunes gens ont fait pression pour qu'on désigne des endroits pour la collecte centrale des déchets, ainsi ils n'auraient plus à partager leurs terrains de jeu avec des ordures. Par le théâtre, la chanson, la danse et les jeux, les enfants ont averti les gens des dangers des environnements non-hygiéniques, surtout pour les enfants. Ils ont accentué qu'il est important de se débarrasser correctement des seringues et autre matériel médical pour empêcher la propagation du SIDA.

Irène Luisa da Costa Tivane, un membre du club enfant à enfant âgée de 10 ans, est sûre qu'elle fait une différence.

«Participer aux activités de la promotion hygiénique, c'est combattre les maladies associées à la diarrhée,» dit Irène. «Voilà pourquoi tout le monde devrait boire de l'eau javellisée et savoir utiliser les latrines.»

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Flavo Varela de Araujo, 14 ans, est un membre actif d'un programme radiophonique enfant à enfant qui appuie les clubs d'amélioration de l'hygiène scolaires. Il se vante de la transformation dans la salle de classe.

«Avec la création du club, l'environnement scolaire est en train de changer,» dit Flavo. «Et le comportement des élèves change aussi. Nous allons continuer à appuyer les pratiques sécuritaires.»

Ces clubs para-scolaires sont des instruments d'apprentissage pour les adultes dans la communauté aussi. Ils pigent le comportement exemplaire des élèves.

«Le processus pour adopter des pratiques sécuritaires est lent,» dit Flavo. «Mais on peut voir des étapes positives dans nos communautés à mesure qu'elles adoptent nos recommandations et nos conseils.»

Les parents écoutent leurs enfants et pratiquent le comportement hygiénique à la maison. Après avoir été témoins de la bonne hygiène et des environnements nécessaires pour la soutenir, les adultes ont insisté auprès des autorités locales pour qu'on fournisse une meilleure éducation et de meilleurs services en hygiène dans toutes les écoles.

Le succès des programmes initiaux a encouragé une discussion entre les écoles où les professeurs partagent avec fierté les accomplissements de leurs écoles. Encouragées par l'efficacité à peu de frais de ces programmes, trois autres municipalités ont commencé un prélèvement de fonds pour pouvoir, elles aussi, apporter cette méthodologie participante à leurs écoles.

L'UNICEF travaille de très près avec le Ministère de l'éducation pour voir comment ceci peut être copié dans d'autres communautés. Dans sa réforme nationale du curriculum, la Mozambique a assigné 20% du trimestre scolaire à l'étude des questions locales. L'UNICEF insiste pour que les activités de promotion de l'hygiène fassent partie de ce 20%.

«Pour un investissement assez minime dans les clubs enfant à enfant, les dividendes ont été superbes.»

Les bienfaits des clubs d'amélioration d'hygiène enfant à enfant, combinés avec la construction de latrines et de lavabos, sont allés au-delà de toutes les attentes. Ces initiatives n'ont pas seulement fourni des environnements d'apprentissage plus sains et sécuritaires, ils ont aussi encouragé l'éducation des filles. Là où les filles plus vieilles quittaient l'école parce qu'il n'y avait pas de facilités privées, maintenant elles restent à l'école pour compléter leur éducation de base. Les conditions hygiéniques améliorées ont redonné aux filles leurs livres et leur dignité.

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Pour un investissement assez minime dans les clubs enfant à enfant, les dividendes ont été superbes : des écoles et des communautés saines, plus de filles qui restent à l'école et des habiletés de leadership pour la prochaine génération.

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Rural Angola urgently needs clean water

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By Macarena Aguilar

Luanda, March 2005 - World Water day celebrations normally mean absolutely nothing to 38 year old Mariana Preciosa. Yet, this year, water day will become an unforgettable one. “The electricity has just come back after an entire month without it and they tell us we are going to have running water in our houses.” Some how skeptical, Mariana adds “I still fail to believe that we are going to open a tap in our houses and get water we can give our children.”

Mariana is mother to four children aged between 20 and 4. For the past two years she lives in Cabiri, a small rural community of 2,000 inhabitants located some 45 kilometres north of Angola’s capital, Luanda. The primary source of livelihood of Cabiri’s inhabitants is growing maize, sweet banana, mango and cassava as well as river fishing. For as long as Mariana recalls, running water has never been available in Cabiri. “During the rainy season we fill our buckets with rain water. In the dry season we need to walk over two kilometres to get to the river to find water, which we still have to boil before drinking,” she says.

Mariana’s daily struggle to secure the needed amount of water is well known across Angola. Only half of the 14 million inhabitants of the oil-rich country have access to safe drinking water. From the estimated 7 million persons that live in the rural areas barely 40% can claim access to potable water compared to 71% of the urban population. The result is an appalling child death rate with one in every 4 Angolan children dying before they reach their fifth birthday mainly due to water and sanitation related diseases like malaria and diarrhoea. As for Angolan girls, especially those living in remote locations, the laborious daily trek to find water leaves them little time to attend school.

But today, Mariana is optimistic. With the support of UNICEF, the Angolan National Directorate for Water has rebuilt and upgraded the old water supply system constructed in the early 60s to serve Cabiri and the neighbouring communities of Camuteba and Mbanza Kitele. The system constitutes pumping water from the nearby Bengo river into a water tank. After treatment, the water is channelled to the settlements through a distribution network. As UNICEF’s Assistant Officer for Water and Sanitation, Manuel Eduardo explains, “the system served its purpose for a few years but during the war both the tank and the pipelines were shelled several times, to the point where they were totally destroyed…Uncertainty about the course of the conflict contributed to just leaving things the way they were.”

The six kilometre-long brand new distribution network and the two huge reservoirs equipped with the latest technology to purify the water extracted from the river, will benefit 3,000 persons. Like Mariana, Cabiri’s inhabitants will have access to running water from the houses. In Camuteba and Mbanza Kitele, considerably less urbanised than Cabiri, the

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population will collect their water from the newly installed stand posts located in the centre of the villages. With the establishment of a network of laundries in the settlements, women

will no longer need to wash the cloths in the river or the lagoon. “Even if it may seem inadequate to you, to us, having potable water so near our homes is almost a dream,” says Paulo Adao, an elderly community leader in Mbanza Kitele. “Since the end of the colonial period in 1975 we haven’t had water in this village. We get our water from an artificial lagoon across the road, the same place where our pigs go drink.”

Existent schools and health centres in the communities have also benefited from the reconstruction of the badly needed water supply system. “Every day in our health centre I see at least 25 children in a space of four hours badly ill with multiple diarrhoeal diseases, acute skin infections and typhoid fever, all due to the lack of safe water.” says Francisca Martinez, one of Cabiri’s nurses.

The race to decrease child mortality in Angola has made UNICEF boost its efforts to bring improved water supply facilities to rural areas. With the support of the Governments of Norway, Sweden, Netherlands, and the private sector including the Italian firm COOP, and the UNICEF National

Committees of Germany, the UK and Spain, the goal by 2008 is to increase rural and peri-urban water and sanitation coverage from 40% to 55% and from 25.5% to 36% respectively.

“An additional critical role that UNICEF plays in Angola is to ensure that the most vulnerable, the schools and the health centres are taken into account and not left aside from key ongoing government development plans,” says Dauda Wurie, Head of UNICEF´s Water and Sanitation section in Angola. “With some 44 million USD per year during the next decade, we believe that all of rural Angola could be served with safe water and sanitation facilities…this is by all means an achievable goal in this country.”

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L’ANGOLA RURAL A UN BESOIN URGENT D’EAU PROPRE

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De Macarena Aguilar

Luanda, mars 2005 - Les célébrations de la journée mondiale de l’eau ne veulent absolument rien dire à Mariana Preciosa, 38 ans. Cependant, cette année, la journée de l’eau sera inoubliable. «L’électricité est revenue après l’absence d’un mois entier et l’on nous dit qu’on aura bientôt l’eau courante dans nos maisons.» Quoique douteuse, Mariana reprend, «Je ne peux pas croire qu’on pourra ouvrir un robinet dans nos maisons et recevoir de l’eau qu’on pourra donner à nos enfants.»

Mariana est mère de quatre enfants qui ont de 20 à 4 ans. Depuis deux ans, elle habite à Cabiri, une petite communauté rurale de 2000 habitants située à quelque 45 kilomètres au nord de la capitale d’Angola, Luanda. La source principale de subsistance des habitants de Cabiri est la culture du mais (2 dots on the i in mais), de la banane douce, de la mangue, du manioc, ainsi que de la pêche à la rivière. De toute la longue mémoire de Mariana, on n’a jamais eu d’eau courante à Cabiri. «Pendant la saison des pluies, nous remplissons nos seaux d’eau douce. Pendant la saison de sécheresse, il nous faut marcher deux kilomètres à la rivière pour trouver de l’eau, qu’il nous faut encore faire bouillir avant de la boire», dit-elle.

La lutte quotidienne de Mariana pour trouver le montant d’eau nécessaire est fort bien connue à travers l’Angola. Seulement la moitié des 14 millions d’habitants de ce pays riche en pétrole ont accès à de l’eau potable sécuritaire. Des environ 7 millions de personnes qui habitent les régions rurales, à peine 40% peuvent dire avoir accès à de l’eau potable comparé au 71% de la population urbaine. Résultat : un taux déplorable de mortalité enfantine où un sur quatre enfants angolais meurt avant d’avoir cinq ans surtout à cause de l’eau et des maladies rattachées aux facilités sanitaires, tels que le malaria et la diarrhée. Quant aux filles angolaises, surtout celles qui habitent dans des endroits éloignés, la marche laborieuse quotidienne pour trouver de l’eau leur laisse peu de temps pour assister à l’école.

Mais aujourd’hui Mariana est optimiste. Avec l’appui de l’UNICEF, le Directorat national angolais pour l’eau a reconstruit et amélioré le vieux système d’eau construit au début des années ’60 pour desservir Cabiri et les communautés avoisinantes de Cambuteba et Mbanza Kitele. Selon le système, on pompe de l’eau de la rivière Bengo tout près dans un réservoir. Après avoir été traitée, l’eau est canalisée aux agglomérations par un réseau de distribution. En tant qu’officier adjoint de l’UNICEF pour l’eau et les facilités sanitaires, Manuel Eduardo explique : «Le système a été utile pendant quelques années, mais pendant la guerre on a bombardé à maintes reprises le réservoir et les tuyaux, au point où ils ont été complètement détruits… L’incertitude rattachée au prolongement du conflit a contribué à laisser le tout exactement tel quel.»

Le tout nouveau réseau de distribution long de six kilomètres et les deux vastes réservoirs équipés de la plus récente technologie pour purifier l’eau tirée de la rivière seront salutaires pour trois mille personnes. Tout comme Mariana, les habitants de Cabiri auront accès à l’eau courante dans les maisons. À Cambuteba et à Mbanza Kitele, beaucoup moins urbanisés que

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Cabiri, la population ira recueillir son eau à de nouveaux poteaux avec robinets situés au centre des villages. Avec l'établissement d'un réseau de buanderies dans les petites agglomérations, les femmes n'auront plus besoin de laver les vêtements dans la rivière ou dans la lagune. «Même si ça vous paraît insuffisant, pour nous, l'eau potable si près de nos maisons, c'est presque un rêve», dit Paulo Adao un leader communautaire d'un certain âge, à Mbanza Kitele. «Nous n'avons pas eu d'eau dans ce village depuis la fin de la période coloniale en 1975. Nous obtenons notre eau d'une lagune artificielle de l'autre côté du chemin, là où vont boire nos cochons.»

Les écoles et les centres de santé existant dans les communautés ont aussi profité de la reconstruction du système d'approvisionnement d'eau extrêmement nécessaire. «Chaque jour dans notre centre de santé, je vois au moins 25 enfants dans une période de quatre heures atteints de multiples maladies de diarrhée, d'infections aiguës de la peau et de la fièvre thyphoïde, tout cela dû au manque d'eau sécuritaire», dit Francisca Martinez, une des infirmières de Cabiri.

La course pour réduire le taux de mortalité enfantine en Angola a poussé l'UNICEF à augmenter ses efforts pour améliorer les établissements d'approvisionnement d'eau en région rurale. Avec l'appui des gouvernements de la Norvège, de la Suède, des Pays-Bas, et du secteur privé comprenant la compagnie italienne COOP, et les comités UNICEF nationaux d'Allemagne, du Royaume-Uni et de l'Espagne, le but est d'augmenter dès 2008 l'étendue rurale et péri-urbaine de l'eau et des facilités sanitaires de 40% à 55% et de 25,5% à 36% respectivement.

«Un rôle critique additionnel que joue l'UNICEF en Angola, c'est de s'assurer qu'on n'oublie pas les plus vulnérables, les écoles et les centres de santé dans les plus importants plans de développement gouvernementaux», dit Dauda Wurie, directeur de la section d'eau et de facilités sanitaires de l'UNICEF en Angola. Avec quelque 44 millions de dollars américains par année durant la prochaine décennie, nous croyons qu'on pourra desservir tout l'Angola rural avec de l'eau sécuritaire et des aménagements sanitaires …
ceci est sûrement un but atteignable dans ce pays.»
www.unicef.org

Drought plagues Uzbekistan as Aral Sea dries up

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Aymuratov Uzak is 22. When he was a small boy, he visited the town of Myinak, the Aral Sea's principal resort and fishing town in the far north of Uzbekistan. He watched as Uzbek men competed in horse races in honour of a wedding. Such races had taken place since their Mongol ancestors rode across the central Asian lands and settled permanently to graze their animals.

Uzak saw the riders dash across the sands, their colourful pennants a splash of colour against the burnished sands and white skies and strange, decaying ships that were strung across the desert. Uzak asked a goatherd what the rusting hulks were doing there, stuck fast in a perpetual list as though they were forever trying to sink through the vast plates of hardened salt. "They were for the sea, but the sea has gone." Uzak: "We deceived nature"

"You see," says Uzak, referring to the drought that is consuming Central Asia. "We deceived nature, and now nature is deceiving us." When Uzak was eleven, his father died of kidney cancer (a disease attributed to a prevalence of salt in the drinking water). Six years later, his brother's 31 year-old wife died in her sleep, and doctors refused to perform an autopsy "because it was a waste of time, they said."

In despair, his brother committed suicide and Uzak was left at 17 to provide for his mother, two sisters, and two small nieces, in the Karl Marx collective farm that lies east of the Aral Sea in the district of Takhtakupir. He cannot attend college, and his youthful dreams seem to have disappeared. He hopes to marry, to be able to support the education of the children, to continue to provide for his mother, and to improve his skills on the dombra, a long-necked string instrument he plucks at while we talk.

We deceived nature

Most of Uzbekistan is lowland desert with little rainfall. The country relies for water on the snow-fed rivers of the Amu Dar'ya (the ancient Oxus) and the Syr Dar'ya flowing from their mountainous easterly neighbours Tajikistan and Kyrgyzstan. As late as the 1920's families of nomadic herdsmen roamed its sparsely vegetated lands in search of pasture for their animals.

The drying of the Aral sea began in the 1930's with the large-scale agricultural policies of Stalin's Soviet Union. Huge tracts of unsuitable land in Central Asia were turned over to agriculture, and sustained with massive irrigation schemes, forcible population transfers, and fertilizers and pesticides. Today's drained rivers, dried aquifers, poisoned water-tables, and large populations subsisting on exhausted lands, are the direct results of those policies. As are the mysterious illnesses, low life expectancy, and high infant mortality rates of a number of central Asian populations.

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As the unsustainable agricultural policies foundered, planners compensated with large scale chemical intervention and the sluicing of even greater quantities of water from the Aral's 'feed' rivers onto the land. They transformed a balanced pastoral and fishing paradise into an ecological disaster The fishing industry, once one of the world's most abundant, has completely disappeared, and the shore has receded up to 120 kilometers at some points. Communities which once lived just kilometres from its shores know of the Aral Sea only by hearsay (villagers we speak to have heard of, but have never seen the sea because it is "too far.").

As the sea receded, it exposed 27,000 square kilometres of dry seabed. The river basins began snaring up to 25 million tonnes of salt each year from their upper reaches that would once have been carried into the saline-balanced sea. Huge dust storms of salt and pesticide are now driven by prevailing winds hundreds of kilometres across the fields of Uzbekistan and Kazakhstan, further eroding the limited capacities of the soil, destroying forests, and poisoning the population.

The Aral Sea shores are home to 3.5 million people. In Uzbekistan's region of Karakalpakia there are high rates of child mortality, illness amongst women of child-bearing age, maternal mortality, anaemia, typhoid, respiratory and intestinal infections, cancer, hepatitis, DDT poisoning (especially notable in breast milk), and diminished life-expectancy. All drinking water is chemically contaminated to dangerous levels, and most bacteriologically, to levels characterized as "catastrophic." Malnutrition is commonplace

As the U.S.S.R. crumbled and constituent republics opted for independence, the social services in the cotton and wheat fields of the southern republics were withdrawn overnight. And this year, for the first time, the mighty Amu Dar'ya river withered a record 150 kilometers back from the Aral Sea, denied what water that escapes diversion by the failure of rain and snow in Tajikistan and Kyrgyzstan.

On the Karl Marx farm the people are in despair. On 13 June, their irrigation channels finally ran dry. They could only watch as their rice crop wilted, then shrivelled up completely. They have been confused by theories of unfriendly neighbouring countries denying them water, and terrorists destroying reservoirs and pumping facilities. The government has given them no explanations, no compensation, and no solutions, although they have been excused from paying their rice tax.

Uzak, who manages the government-owned store and can gauge the hunger and sense of urgency says: "there are many illnesses, headaches, as though something is always pressing on you. My skin always feels tight, and dry." Uzak has no alternative but to imbibe the same waters that probably killed his father. "When I travel to town and drink the water there, and return, I cannot drink our water for its salt." Life is hard, but it is set to get harder. "80 per cent of the people have used their reserves of food, and nobody has any money. There will be hunger this winter," he says. It is a chilling fact that life consumes the young quickly in this part of the world. Even quicker when there is no water. www.unicef.org

La sécheresse accable l'Usbequistan à mesure que la mer Aral se déssèche

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Aymuratov Uzak a 22 ans. Quand il était jeune, il a visité la ville de Myinak, la station balnéaire et la ville de pêche la plus importante de la mer Aral dans le grand nord de l'Usbequistan. Il a observé des Usbèques qui concourraient dans des courses à cheval en honneur d'une noce. Ces courses ont lieu depuis que leurs ancêtres, les Mongols, se sont installés en permanence pour laisser paître leurs animaux.

Uzak a vu les cavaliers se lancer à travers les sables, leurs pennons coloriés vibrant de couleur contre les sables brunis et le ciel blanchi, ainsi que d'étranges vaisseaux pourrissants qui s'étalent à travers le désert. Uzak a demandé à un chevrier ce que ces vieux rafiots rouillés faisaient là, gelés dur dans leur inclination perpétuelle comme s'ils continuaient toujours à sombrer à travers les vastes plaques de sel durci. «Ils étaient pour la mer, mais la mer est partie, Uzak. Nous avons trompé la nature.»

«Vous voyez,» dit Uzak, se référant à la sécheresse qui consomme l'Asie centrale. «Nous avons trompé la nature, et maintenant la nature nous trompe.» Quand Uzak avait onze ans, son père est mort du cancer des reins (une maladie qu'on attribue à la présence forte de sel dans l'eau potable). Six ans plus tard, la femme de 31 ans de son frère est morte dans son sommeil, et les médecins ont refusé de faire une autopsie «parce que ça serait une perte de temps,» ont-ils dit.

Au désespoir, son frère s'est suicidé et cela a laissé Uzak, à 17 ans, à s'occuper de sa mère, de ses deux sœurs et de deux petites nièces, dans la ferme collective Karl Marx qui est située à l'est de la mer Aral dans la région de Takhtakupir. Il ne peut pas assister au collège, et ses rêves de jeunesse semblent avoir disparu. Il espère se marier, être capable de payer l'éducation de ses enfants, de pouvoir continuer à s'occuper de sa mère, et d'améliorer ses habiletés à la dombra, un instrument à cordes à long cou qu'il pince pendant que nous parlons.

Nous avons trompé la nature

La majorité de l'Usbequistan se compose de basses-terres désertiques avec très peu de pluie. Le pays compte pour son eau sur les rivières nourries de neige fondante, la Amu Dar'ya (l'ancienne Oxus) et la Syr Dar'ya qui coulent des montagnes de leurs voisins à l'est, le Tajiquistan et le Kyrgyzstan. Même encore dans les 1920, il y avait des familles de pâtres sans domiciles qui erraient dans ces terres peu couvertes de végétation à la recherche de pâturage pour leurs animaux.

Le dessèchement de la mer Aral a commencé dans les années 1930 avec les politiques agraires à grande échelle de l'Union soviétique de Staline. D'énormes étendues de terrain non approprié en Asie centrale furent données à l'agriculture, et soutenues par des plans

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d'irrigation massive, des transferts de population forcés, des engrais et des pesticides. Ce qu'on voit aujourd'hui, les rivières drainées, les couches aquifères sèches, les tables d'eau empoisonnées et les grandes populations qui vivent sur des terres arides, sont les résultats directs de ces politiques. Ainsi que les maladies mystérieuses, la longueur de vie courte, les taux élevés de mortalité enfantine d'un grand nombre de populations en Asie centrale.

À mesure que les politiques agraires insoutenables s'écroulaient, les planificateurs ont compensé avec une intervention chimique à grande échelle et la canalisation d'une encore plus grande quantité d'eau sur les terres, tirée des rivières se jetant dans l'Aral. Ils ont transformé un paradis de pêche et de vie pastorale équilibré en un désastre écologique. L'industrie de pêche, autrefois une des plus abondantes au monde, a complètement disparu, et la côte a reculé jusqu'à 120 kilomètres à certains points. Certaines communautés qui se trouvaient à quelques kilomètres de la côte connaissent la mer Aral de nom seulement (les villageois à qui nous parlons en ont entendu parler, mais n'ont jamais vu la mer parce qu'elle est «trop loin».).

En reculant, la mer a exposé 27 000 kilomètres carrés de lit de mer sec. Les bassins de rivière ont commencé à attraper jusqu'à 25 millions de tonnes de sel de leurs régions en amont qui auraient autrefois été transportées dans la mer en salinité équilibrée. D'énormes tempêtes de poussière de sel et de pesticide sont maintenant poussées par les vents prédominants à des centaines de kilomètres à travers les champs de l'Usbequistan et du Kazakhstan, érodant davantage les capacités limitées du sol, détruisant les forêts, et empoisonnant la population.

Les côtes de la mer Aral sont le domicile de 3,5 millions de personnes. Dans la région d'Usbequistan de Karalpakia, il y a des taux très élevés de mortalité enfantine, de maladie parmi les femmes à l'âge d'avoir des enfants, de mortalité maternelle, d'anémie, de typhoïde, d'infections respiratoires et intestinales, de cancer, d'hépatite, d'empoisonnement par le DDT (surtout dans le lait maternel), et une réduction de la longueur de vie. Toute eau potable est contaminée chimiquement à des niveaux dangereux, et la plupart avec des bactéries, à des niveaux qu'on pourrait dire 'catastrophiques'. La sous-alimentation est commune.

À mesure que l'U.R.S.S. s'écroulait et que les républiques qui la constituaient optaient pour l'indépendance, les services sociaux dans les champs de coton et de blé des républiques du sud furent retirés du jour au lendemain. Et cette fois, pour la première fois, la puissante rivière Amu Dar'ya s'est desséchée à un record de 150 kilomètres au loin de la mer Aral, refusant toute eau qui s'échappe de la canalisation grâce à l'absence de pluie et de neige au Tajiquistan et au Kyrgystan.

À la ferme Karl Marx, les gens sont au désespoir. Le 13 juin, leurs canaux d'irrigation se sont finalement asséchés. Ils n'ont pu qu'observer leur récolte de riz qui s'est fanée, puis s'est ratatinée complètement. Ils sont confus par les théories de pays avoisinants qui leur refusent de l'eau, et par les terroristes qui détruisent les réservoirs et les installations de

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pompage. Le gouvernement ne leur a donné aucune explication, aucune compensation, aucune solution, bien qu'on leur ait dispensé de payer la taxe sur le riz.

Uzak, qui gère le magasin qui appartient au gouvernement et qui peut jauger la faim et le sens d'urgence dit : «Il y a beaucoup de maladies, de maux de tête, comme s'il y avait toujours quelque chose qui pressait sur vous. Ma peau se sent toujours serrée et sèche.» Uzak n'a pas d'autre choix que de boire la même eau qui a probablement tué son père. «Quand je voyage en ville et que je bois l'eau là-bas, et que je reviens, je ne peux plus boire notre eau à cause du sel.» La vie est dure, mais elle promet d'être encore plus dure. «80% des gens ont déjà mangé leur réserve de nourriture, et personne n'a d'argent. Il y aura la famine cet hiver,» dit-il. C'est un fait qui fait frissonner que la vie consume la jeunesse rapidement dans cette partie du monde. Encore plus vite quand il n'y a pas d'eau.
www.unicef.org

Zimbabwe: a new well allows Shupikai to return to school

(17.9)

Shupikai, a shy 11-year-old in Zimbabwe's impoverished Binga district, had no choice but to drop out of school when her mother fell sick with tuberculosis and persistent diarrhoea.

Her father was already ill from an unknown disease. Her younger sisters were just one and three years old, and had to be fed and cared for. Because her family did not have a latrine or refuse pit, everyone was at risk of contracting the disease that was causing her mother's diarrhoea unless Shupikai swept up and buried the faeces carefully. And because they did not have a well, several times a day Shupikai carried a huge 20-litre container to the bore-hole three kilometres away, pumped water with difficulty and then carried the heavy container on her head for the arduous 40-minute walk back home.

“If only water was close by, half my problems would be over.”

When Shupikai was asked what could be done to ease her problems, she immediately exclaimed, “Water, water! If only water was close by, half my problems would be over. And if we had a latrine, my mother would have easy access to it. It would be easier to take care of my parents and sisters."

As part of a UNICEF-sponsored Hygiene, Water and Sanitation Programme, the government of Zimbabwe, Shupikai's community and UNICEF worked together to build both a well and a household latrine for her family. Her father moulded bricks, dug the latrine pit and paid the builder in kind with goats and chickens.

The pressures on Shupikai were eased so much that within a few months she had resumed school.

www.unicef.org

Zimbabwe: un nouveau puits permet à Shupikai de retourner à l'école

(17.9)

Shupikai, une jeune fille gênée de 11 ans de la région appauvrie de Binga, au Zimbabwe, n'avait d'autre choix que de quitter l'école quand sa mère est devenue malade de la tuberculose et d'une diarrhée persistante.

Son père avait déjà contracté une maladie inconnue. Ses jeunes sœurs n'avaient qu'un an et trois ans, et il fallait qu'on les nourrisse et qu'on les soigne. Puisque sa famille n'avait pas de latrines ou de trou à déchets, tout le monde risquait de contracter la maladie qui causait la diarrhée de sa mère à moins que Shupikai ne balaie et n'enterre les fèces soigneusement. Et parce qu'ils n'avaient pas de puits, plusieurs fois par jour, Shupikai portait un énorme récipient de 20 litres au trou de sondage loin de trois kilomètres, y pompait de l'eau à grand effort et puis transportait le récipient lourd sur la tête pour la marche pénible de 40 minutes du retour à la maison.

«Si seulement l'eau était plus près, cela résoudrait la moitié de mes problèmes.»

Quand on a demandé à Shupikai ce qu'on pourrait faire pour alléger ses problèmes, elle s'est écriée immédiatement, «De l'eau, de l'eau! Si seulement l'eau était plus près, cela résoudrait la moitié de mes problèmes. Et si nous avions des latrines, ma mère pourrait facilement y avoir accès. Il serait plus facile de m'occuper de mes parents et de mes sœurs.»

Une partie du Programme d'hygiène, d'eau et d'aménagement sanitaire encouragé par l'UNICEF a vu le gouvernement du Zimbabwe, ainsi que la communauté de Shupikai et l'UNICEF travailler ensemble pour construire un puits et des latrines de ménage pour sa famille. Son père a moulé les briques, creusé les latrines et a payé le constructeur avec des chèvres et des poulets.

Les pressions sur Shupikai se sont tant allégées qu'après quelques mois elle a pu retourner à l'école.

www.unicef.org

Lesson 21

Stage 1 – Desired Results

Established Goals:
8-4-15 Explain how and **why water may need to be treated for use by humans**. Include filtration, settling, chlorination, fluoridation. GLO: B1, B3, D5
8-4-17 Identify substances that may pollute water, related environmental and societal impacts of pollution, and ways to reduce or eliminate effects of pollution. GLO: B2, B3, B5, D5

Understandings:	**Essential Questions:**
Students will understand that… Humans are the cause of the majority of the pollution found in Manitoba's Red River.	What are the various ways humans impact water and how do they attempt to fix the water they have damaged?
Students will know… That what they put down the drain doesn't just disappear.	**Students will be able to…** Distinguish between dangerous water pollution and organic pollution.

Stage 2- Assessment Evidence

Performance Tasks:	Other Evidence:
Participate in large group activity Participate in class discussion	Discuss strategies of other methods of waste disposal.

Materials Required

Who Polluted the Red River Story
Large glass aquarium
Many (25-30 depending on class numbers) film canisters to hold contents (*you can get these free form local film developing locations)

Label	**Contents**
Trees	Dry leaves
Construction Site	Dry, clay soil
Person Fishing	Fishing line/dental floss
Farmers	Baking Soda
Gardeners	Baking Soda
Beach Party	Litter
Family Picnic	Litter
Snack	Litter
Barnyard	Water & instant coffee
Hog Plant	Water & instant coffee
Washing the Car	Water & dish soap
Antifreeze	Water & blue & green food colouring
Mystery Liquid	Water & Red food colouring
Septic Tank	Water & yellow food colouring & toilet paper
Coal Mine	Vinegar
Electric Power Plant	Vinegar
Commuters	Vinegar & vegetable oil
Motor Boat	Vegetable Oil
Hydro Dam	Silverettes (cake decoration)
Expired medication	Jellybeans/rocket candy
Wastewater 1	Chocolate chips
Wastewater 2	Fish candy
Personal Watercraft	Vegetable oil

Stage 3 – Learning Plan

Teacher preparation prior to day
-fill & label containers with "pollution"
Teacher preparation on day
-half fill aquarium with clean water

Hand out film canisters to students with instructions that they are not to open them until they are called up in the story.
Read Water Story (BLM #1)

- get students to come up and empty containers into aquarium at the required time for their objects

Discussion Questions

1. Who polluted the Red River?
2. What effect did the increasing population have on the health of the River? *(more people mean less wetlands, which filter water, more cars, less open space, etc.)*
3. Can you think of any ways that population increases helped the river? *(higher population densities led to more efficient use of resources, stronger environmental laws, public resources like sewage treatment plants, etc.)*
4. Think about the pollution contained in your canister. Could something be done to prevent that type of thing from entering the water? How?
5. Challenge students to come up with ways to clean the water in the tank, after all, everything has to go somewhere. *(example: strain out solids, use filters, etc.)*
6. Once this type of pollution has entered the river, how can we get it out? How can we clean up the river? Do you think that it is easier to prevent pollution or to clean it up later?
7. What could each of us do to help improve the health of our river by preventing some of this pollution?
8. How does this relate to global water concerns?

***Be sure to keep "polluted" water for next lesson…

** Adapted from The Population Educator-Spring 2003 edition, "Who Polluted the Potomac?" Used with permission.*

Water Story (21.1)

For thousands of years, people have lived on the banks of the Red River. They hunted in the forests; harvested foods from wetlands, and caught fish in the river.

1. Imagine the tank of water in front of you was taken from the Red River by a Native Canadian about 500 years ago. How does it look to you? Would you drink this water? Eat fish that came from it? Swim in it?

One of the first explorers to visit the river kept a journal of his discoveries. He wrote about the Native Canadian villages, the tributaries of "sweet water" and seeing so many fish that he and his crew tried to scoop them out with a frying pan.

Some colonists began to arrive. They found fertile lands for farming, forests teeming with wildlife, and a river that produced ample food and water. It was an outstanding environment for settlement, and the colonists prospered.

2. How do you think the colonists used the river? Do we use our rivers in the same ways today?

The river has changed a lot since it was first explored. This is a story of those changes. *Listen for the word printed on your canister. When you hear it, come up to the tank, open the canister and pour it's contents into the river.*

Years went by, and occasional storms drenched the area. High winds whipped thought the **trees** and blew the leaves into the water.

Gradually the city of Winnipeg grew on the banks of the Red River. Developers cleared wetlands and forests to build houses and businesses. Rain washed loose soil from **construction sites** into the river.

3. Is this water safe to drink? (If responses are "no", ask if the river had leaves or soil in it when explorers first drank from it?) Would you swim in it? Is it safe for wildlife?

At first, the city was small. Upstream, **farmers** planted crops to feed the city's growing population. Some of these crops grew right up against the banks of the river, and fertilizer washed off the land and into the water. Other farmers kept cows and other animals in their **barnyards**. As rainwater drained out of the barnyard, it carried some of the manure into a little creek behind the farm. The creek flows into the river.

4. Would you drink this water now? Would you swim in it? Go boating in it? Is it safe for wildlife?

Since the city was so close to Manitoba's beautiful lakes, many people built cottages nearby. These cottages are not connected to the city sewer system.

Wastewater from these houses flow into septic tanks under the ground. One homeowner has not maintained the **septic tank** and poorly treated sewage seeped into the river and the nearby lake.
At the beach at the nearby lake, teenagers are getting together to have a **beach party**. These teens are unaware that the wind has picked up and much of their waste has blown into the lake. Some of them take off on their **personal water crafts** to meet up with other friends.

To meet the electricity needs of the city, area officials decided that they would need to generate more power. Far upstream, a **coalmine** was dug. Rainwater drained down into the mineshaft and soaked the poles of wastes and scraps from mining. This made the rainwater become very acidic. Then the acid water trickled back out into the river.

To burn the coal and produce the power, an **electric power plant** was built along the river. Gasses coming out from the smokestacks combine with moisture in the air to form acids. The pollution falls back to Earth as acid rain or smog.

Another source of energy used in Manitoba are the **hydroelectric dams**. When damming the water, toxic mercury that has been stored under these waters is released, as land is flooded. *(released by a type of bacteria that becomes prevalent when areas are flooded)*

5. Would you drink this water now? Would you swim in it? Go boating? Could fish or water wildlife live in water that is acidic or poisoned with mercury?

Now Winnipeg is the largest metropolitan area in Manitoba. Traffic congestion is starting to become a problem for **commuters** who drive their cars to and from work everyday. Car exhaust fumes cause acid rain. If a car is not kept in good repair, it also might leak oil or other fluids, which will be washed off the pavement and into the river with the next rain.

And how do the residents of the city and its suburbs spend their time? In one neighbourhood, lots of **gardeners** are out working in their yards. Many of them are using weed killers and insect sprays to keep the lawns pretty. The next rain will wash these poisons into a little creek nearby, and then into the river.

One father is teaching his daughter how to change the **antifreeze** in their truck. They pour out the used antifreeze into the driveway. Antifreeze is sweet tasting and can poison animals that lick it. It can also get into the nearby creek and poison fish.

Nearby a boy **washes the family car**. The soapy water rushes down the driveway into the storm drain; the storm drain empties into the river. The grease and grime on a car contains asphalt from the roads, asbestos from the brakes,

rubber particles from the tires, toxic metals, and rust. If the boy had gone to a local car wash, the water would have been treated before it returned to the river.

While the boy washes the car, his mother is cleaning out her medicine cabinet and discovers some **expired medication**. Instead of throwing it out into the garbage where children or animals may get to it, she decides to dump it down the toilet. *(between 97 – 98% of water that is treated is cleaned… which still leaves 2-3% of contaminated water that is released back into the water system)*

Next door, a family is cleaning out their garage. They find an old rusty can with a tattered skull and crossbones label still stuck on it. What could it be? It looks dangerous and they want to get rid of it before someone gets hurt. But how? Junior gets an idea: "let's pour it down the drain by the curb!" So the **mysterious liquid** goes down the storm drain. The poison is out of sight – but is headed for the river. *(depending on the area of Winnipeg, some water is sent to the treatment facility-older areas, while in newer areas the storm drains send the water directly back to the river or to storm retention ponds)*

On nice days, many people head down to the river. Some zoom up and down the river in **motorboats** and don't notice that a little engine oil leaks into the water. A group of friends have spread a blanket on the shore near the Forks for a **snack**. Lots of families are **picnicking** in the parks along the river, too. With the strong winds in Winnipeg, the trash will blow into the river. On the shore, a **person fishing** snags a hook on a log and breaks off the fishing line.
At the water treatment facility in the North end of Winnipeg, a malfunction occurs and untreated **wastewater 1 & 2** flows directly into the river. *(This happened in Winnipeg in 2002).*
More recently, there have been big discussions in Winnipeg regarding the potential for a **hog plant**. Many are afraid that there may be runoff into our water system.

Discussion Questions

1. Who polluted the Red River?
2. What effect did the increasing population have on the health of the River? *(more people mean less wetlands, which filter water, more cars, less open space, etc.)*
3. Can you think of any ways that population increases helped the river? *(higher population densities led to more efficient use of resources, stronger environmental laws, public resources like sewage treatment plants, etc.)*
4. Think about the pollution contained in your canister. Could something be done to prevent that type of thing from entering the water? How?

5. Challenge students to come up with ways to clean the water in the tank, after all, everything has to go somewhere *(example: strain out solids, use filters, etc.).*
6. Once this type of pollution has entered the river, how can we get it out? How can we clean up the river? Do you think that it is easier to prevent pollution or to clean it up later?
7. What could each of us do to help improve the health of our river by preventing some of this pollution?

** Adapted from The Population Educator-Spring 2003 edition, "Who Polluted the Potomac?"*

L'histoire de l'eau (21.1)

Depuis des milliers d'années, des humains vivent sur les rives de la rivière Rouge. Ils ont chassé dans les forêts, récolté de la nourriture dans les terres mouillées et pris des poissons dans la rivière.

6. Imaginez que le réservoir d'eau devant vous ait été tiré de la rivière Rouge par un autochtone canadien il y a environ 500 ans. Comment cette eau vous semble-t-elle? Est-ce que vous la boiriez? Mangeriez-vous des poissons tirés de là? Nageriez-vous dedans?

Un des premiers explorateurs à visiter la rivière a tenu un journal de ses découvertes. Il a écrit à propos des villages autochtones canadiens, des tributaires «d'eau douce» et de voir un si grand nombre de poissons que son équipage et lui ont essayé de les écoper avec une poêle à frire.

Les colons ont commencé à arriver. Ils ont trouvé des terres fertiles pour l'agriculture, des forêts pleines d'animaux et une rivière qui produisait amplement de nourriture et d'eau.
C'était un environnement superbe pour une colonie, et les colons ont prospéré.

7. Comment pensez-vous que les colons ont utilisé la rivière? Est-ce qu'on utilise les rivières de la même façon aujourd'hui?

La rivière a beaucoup changé depuis les premières explorations. Voici l'histoire de ces changements. *Écoutez pour entendre le mot imprimé sur votre boîte métallique. Quand vous l'entendrez, approchez-vous du réservoir, ouvrez votre boîte métallique et versez-en le contenu dans la rivière.*

Au fil des années, des tempêtes occasionnelles ont trempé la région. De grands vents se sont déchaînés à travers **les arbres** et ont fait tomber des feuilles dans l'eau.

Graduellement, la ville de Winnipeg a grandi sur les rives de la rivière Rouge. Les développeurs ont déblayé les terres humides et les forêts pour y construire des maisons et des bâtiments pour les affaires. La pluie a emporté dans la rivière le sol friable des **lieux de construction**.

8. Peut-on boire cette eau en toute sécurité? Si la réponse est «non», demandez-vous si la rivière avait des feuilles et de la terre dedans quand les explorateurs en ont bu jadis. Nageriez-vous dedans? Est-elle saine pour les animaux?

Au début, la ville était petite. En amont, les fermiers ont planté des récoltes pour nourrir la population grandissante de la ville. Certaines de ces récoltes poussaient juste sur le bord des rives de la rivière et de l'engrais était emporté dans l'eau.

D'autres fermiers élevaient des cochons et d'autres animaux dans leurs **basses-cours**. Quand la pluie venait laver la basse-cour, elle emportait du fumier dans le petit ruisseau derrière la ferme. Le ruisseau coule dans la rivière.

- Pourriez-vous boire cette eau maintenant? Nageriez-vous dedans? Iriez-vous en bateau dessus? Est-elle saine pour les animaux sauvages?

Puisque la ville était si proche des beaux lacs manitobains, bien des gens se sont construit des chalets tout près. Ces chalets ne sont pas rattachés au système d'égouts de la ville. L'eau d'égout de ces maisons se déverse dans des réservoirs septiques sous terre. Un **propriétaire** n'a pas entretenu son réservoir septique et de l'eau d'égout mal traitée s'est infiltrée dans la rivière et le lac tout près.

Pour satisfaire les besoins d'électricité de la ville, les fonctionnaires de la région ont décidé qu'il faudrait générer plus de puissance électrique. Loin en amont, on a creusé une **mine de charbon**. L'eau de pluie s'est écoulée dans le puits de mine et a détrempé les tas de restes et de déchets de la mine. Cela a rendu l'eau de pluie très acide. Puis l'eau acide a dégoutté jusque dans la rivière. Pour brûler le charbon et produire du pouvoir, une **installation à génération électrique** fut construite le long de la rivière. Les gaz sortant des grandes cheminées se combinent avec l'humidité dans l'air pour former des acides. La pollution retombe sur la terre en pluie acide ou en brouillard fumeux.

Les **barrages hydroélectriques** sont une autre source d'énergie employée au Manitoba. Quand on retient l'eau avec un barrage, le mercure toxique qui s'est accumulé sous ces eaux est relâché à mesure que la terre est inondée. (*relâché par un genre de bactérie qui se répand quand les régions sont inondées)*

9. Boiriez-vous cette eau maintenant? Nageriez-vous dedans? Iriez-vous en bateau dessus? Est-ce que les poissons ou les animaux sauvages pourraient vivre dans l'eau qui est acide ou empoisonnée de mercure?

Maintenant Winnipeg est la plus grande région métropolitaine du Manitoba. La congestion véhiculaire devient un problème pour les **navetteurs** qui conduisent leurs voitures entre leurs domiciles et leur travail tous les jours. Les émanations des voitures causent la pluie acide. Si une voiture n'est pas gardée en bon état, il peut aussi y avoir des fuites d'huile ou d'autres liquides qui seront lavés de la chaussée et emportés par la prochaine pluie jusque dans la rivière.

Et comment les résidents de la ville et des banlieues passent-ils leur temps? Dans un voisinage, beaucoup de **jardiniers** travaillent dans leurs cours. Plusieurs d'entre eux utilisent des tueurs de mauvaises herbes et des insecticides pour que leurs pelouses soient belles. La prochaine pluie emportera ces poisons dans un petit ruisseau avoisinant, et puis dans la rivière.

Un père enseigne à sa fille à changer l'**antigel** dans leur camion. Ils versent l'antigel usagé dans leur entrée de voiture. L'antigel a un goût sucré et peut empoisonner les animaux qui le lèchent. Il peut aussi se rendre jusqu'au ruisseau avoisinant et empoisonner les poissons.

Tout près, un garçon **lave la voiture familiale**. L'eau savonneuse coule en bas de l'entrée de voiture jusque dans le tuyau de drainage; celui-ci se déverse dans la rivière. La graisse et la saleté sur une voiture contiennent de l'asphalte des routes, de l'amiante des freins, des particules de caoutchouc des pneus, des métaux toxiques et de la rouille. Si le garçon était allé à un centre de lavage de voitures local, l'eau aurait été traitée avant d'être retournée à la rivière.
Pendant que le garçon lave la voiture, sa mère nettoie son cabinet de médicaments et découvre des **médicaments surannés**. Au lieu de les jeter dans la poubelle où les enfants et les animaux pourraient les prendre, elle décide de les jeter dans la toilette.
(*entre 97 et 98% de l'eau traitée est propre … ce qui laisse 2 à 3% d'eau contaminée qui est relâchée dans le système d'eau)*

À côté, une famille nettoie son garage. Ils trouvent un vieux bidon rouillé avec une étiquette déchiquetée encore collée dessus figurant un crâne et deux os croisés. Qu'est-ce que ça peut bien être? Ça a l'air dangereux et ils veulent s'en débarrasser avant que ça fasse mal à quelqu'un. Mais comment? Junior a une idée : «vidons-le dans le tuyau de drainage au bord de la rue». Alors le **liquide mystérieux** s'en va dans le tuyau de drainage. Le poison est perdu de vue – mais s'en va vers la rivière. (*dépendant de la région de Winnipeg, une partie de l'eau est envoyée à une installation de traitement d'eau – les régions les plus anciennes, mais dans les régions plus nouvelles les tuyaux de drainage envoient l'eau directement dans la rivière ou dans des étangs de rétention d'eau*)

Les beaux jours, beaucoup de monde se rend à la rivière. Quelques-uns sillonnent la rivière à grande vitesse dans leurs bateaux-moteurs et ne remarquent pas qu'il y a une petite fuite d'huile de moteur dans l'eau. Un groupe d'amis a étendu une couverture sur la rive près de la Fourche pour prendre un **repas léger**. Beaucoup de familles font aussi un **pique-nique** dans les parcs le long de la rivière. Avec les vents forts de Winnipeg, les déchets se retrouveront dans la rivière. Sur la rive, une personne qui fait de la pêche accroche son hameçon sur un tronc d'arbre et casse la ligne de pêche.

À l'installation de traitement d'eau d'égout dans le nord de Winnipeg, il y a un problème dans le fonctionnement et de **l'eau d'égout** non traitée coule directement dans la rivière.
(*Cela est arrivé à Winnipeg en 2002*)

Questions à discuter

1. Qui a pollué la rivière Rouge?
2. Quel effet l'augmentation de la population a-t-elle eu sur la santé de la rivière? (*plus de gens veut dire moins de terres humides qui filtrent l'eau, plus de voitures, moins d'espaces ouverts, etc*.)
3. Pouvez-vous penser à des façons où l'augmentation de la population a aidé la rivière? (*une densité de population plus élevée a mené à un meilleur emploi des ressources, à des lois environnementales plus fortes, à des ressources publiques telles les installations de traitement d'eau d'égout, etc*.)
4. Réfléchissez à la pollution contenue dans votre boîte métallique. Est-ce qu'on pourrait faire quelque chose pour empêcher ce genre de chose d'entrer dans l'eau? Comment?
5. Lancez un défi aux élèves de trouver des façons de nettoyer l'eau dans le réservoir, après tout, il faut que tout aille quelque part. (*exemple : enlever les solides avec une passoire, employer des filtres, etc.*)
6. Une fois que cette pollution est entrée dans la rivière, comment peut-on l'en faire sortir? Comment peut-on nettoyer la rivière? Pensez-vous qu'il est plus facile d'empêcher la pollution ou de la nettoyer plus tard?
7. Qu'est-ce que chacun de nous pourrait faire pour aider à améliorer la santé de notre rivière en empêchant un peu de cette pollution?

** Adapté de The Population Educator – édition printemps 2003, «Who Polluted the Potomac?»*

Lesson 22

Stage 1 – Desired Results

Established Goals:
8-4-15 Explain how and why water may need to be treated for use by humans. Include: **filtration, settling**, chlorination, fluoridation. GLO: B1, B3, D5

Understandings:	**Essential Questions:**
Students will understand that… There are marked differences between technological and educational advances between countries. There are global issues related to access to clean drinking water.	What are the various ways humans impact the water and how do they attempt to fix the water they have damaged?
Students will know…	**Students will be able to…**
That there are differences between countries around the world in regards to access to money, education and technology.	Work together as a small group to created a water filter Problem solve if they do not have the resources to accomplish the goal of clean water

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
Working as a small group to create a filter Follow instruction on handout	Reflection questions and class discussion

Materials Required

Potentially Per Group	Other
• 1 2-litre pop bottle • 1 1-litre pop bottle • 1 500-ml plastic bottle • 1 cut in half 500-ml plastic bottle • 1 cup fine sand • 1 cup coarse sand • 1 cup fine gravel • 1 cup coarse gravel • 0.5 cup of activated charcoal – purchased at aquarium stores (not really necessary, can crush a charcoal briquette or not include it in the lesson) • 1 cotton ball • 1 small piece (about 10 cm²) of cheese cloth • 1 rubber band • Measuring cups to transport filter sand, gravel and charcoal	1. Monopoly money 2. ***Water from pervious lesson (Who Polluted the Red River) or soil to make dirty water 3. Country profiles and instruction handouts (See attached BLMs)

Stage 3 – Learning Plan

Water for the World

<u>Water Filter Activity</u>
(adapted from Engineers Without Borders Canada, used with permission)

Advance Preparation

- prepare materials
- cut off the bottom of the 2 litre bottles
- cut the cheese cloth into 10 cm² pieces
- prepare “dirty” water – add approximately 250 mls of “dirty” water from pervious activity (Who Polluted the Red River) or, if unavailable, add approximately 2 tbs of soil to a 500 ml bottle

- Assemble country packages

- Each country will receive a package that includes a country profile, instruction on how to a make the filter, and the amount of monopoly money based on the table to right

Country	Monopoly Money
Sweden	$1100
United States	$1000
Canada	$825
Brazil	$200
Ghana	$60
Cameroon	$50
Sudan	$50
Uganda	$40
Ethiopia	$20
Afghanistan	$18

Procedure

a. Have all of the filter material in the "store" at the front of the class and choose two students to be The World Bank (it is better to choose students who may not be as intimidated by others and is willing to be "tough" with the class).
b. Go through basics of the country profile (BLM#1) and explain what each heading means to the students if not understood.
c. Divide the students into country groups (4 per group). Distribute a country package to each group (contains: country profile, country instructions, cut up 2-litre, a 500 ml container half full of dirty water, a bucket to catch water from the cleaning and the cut up 500-ml bottle to test dirty water as it comes from the filter)
d. Explain to the students they are to make a water filter as outlined on the instruction sheet. They may purchase needed equipment from the "World Bank" with the money they have. If asked how they can get things (as a poorer country) let them know that they may have to do what they have to do…
e. After about 20 minutes have representatives from each group come up to the front of the room to demonstrate their country's water filter – use approximately 500 ml of "solvent (clean water) for each filter to get rid of excessive dust form sand and gravel, and then get them to pour the dirty water (either "Red River" water of water with soil in it) through the filter.
f. Follow-up with discussion questions listed below. Have students reflect and write personal feelings before the class is opened up for discussion.

Reflection & Discussion Questions

1. Did you feel that you began to take on the role of your country? Did do anything out of desperation or use your position of power over another country?
2. How did this activity make you feel?
3. How does this activity simulate "real life"? How is it different?

Background Teacher's Notes

Activated charcoal (activated carbon) filters have been used in homes to remove taste and odor. Taste and odor, although undesirable, are generally not considered unhealthy. In recent years, however, activated charcoal filters have been used to remove some of the contaminants that have been discovered in water supplies.

Activated charcoal is most effective at removing organic compounds such as volatile organic compounds, pesticides and benzene. It can also remove some metals, chlorine and radon. As with any treatment system, it cannot remove all possible drinking water contaminants.

Because activated charcoal systems are limited in the types of compounds they can effectively remove, it is essential that the homeowner determine which water contaminants are present before purchasing such a system. Anyone who suspects they have a water quality problem should first have their water analyzed by their local health department or a reputable laboratory. These analyses are costly, but worth the expense since they are necessary to determine the appropriate home treatment system and how best to operate such a system. A state or local health official can interpret water analysis results. Some laboratories may also provide this service.

Note that home water treatment is considered only a temporary solution. The best solutions to a contaminated drinking water problem are to either end the practices causing the contamination or change water sources. Activated charcoal is a black solid substance resembling granular or powdered charcoal. It is

extremely porous with a very large surface area. Certain contaminants accumulate on the surface of the activated charcoal in a process called adsorption. The two main reasons that chemicals adsorb onto activated charcoal are a "dislike" of the water, and attraction to the activated charcoal. Many organic compounds, such as chlorinated and non- chlorinated solvents, gasoline, pesticides and tri-halo-methane can be adsorbed by activated charcoal. Activated charcoal is effective in removing chlorine and moderately effective in removing some heavy metals. Activated charcoal will also remove metals that are bound to organic molecules. It is important to note that charcoal is not necessarily the same as activated charcoal. Activated charcoal removes vastly more contaminants from water than does ordinary charcoal.

Home activated charcoal treatment systems are quite simple. The activated charcoal is normally packaged in filter cartridges that are inserted into the purification device. Water needing treatment passes through the cartridge, contacting the activated charcoal on its way to the faucet. Activated charcoal filters eventually become fouled with contaminants and lose their ability to adsorb pollutants. At this time, they need to be replaced. Activated charcoal treatment systems are typically point of use installed where they typically treat water used for drinking and cooking only. Activated charcoal filters can be placed on the end of the faucet, on the countertop, or under the sink. Point of use systems often have a bypass so that water for purposes other than drinking and cooking can also be dispensed at the tap without being treated. This increases the life of the activated charcoal, reducing the time between filter replacements.

http://www.doityourself.com/stry/activatecharcoal

COUNTRY (OH 22.1)

General

Area: Main Language:	Population: Growth Rate:

Water Resources

Rainfall: Total water withdrawals: m³/cap/year	Total Water Use Domestic: % Industrial: % Agricultural: %

Health

Life Expectancy:	years
Infant Mortality rate:	infant deaths/1000 live births

Literacy

Adult Literacy:	% of population age 15 and above

Economy

GDP per capita (PPP US$)

Overseas Development Assistance (Aid)

% of GDP

PAYS (OH 22.1)

Général

Région: Langage principal:	Population: Taux de croissance:

Ressources d'eau

Pluie: Total de l'eau retirée : m³/cap/an	Emploi total de l'eau Domestique: % Industriel: % Agricole: %

Santé

Vie anticipée: years Taux de mortalité enfantine : enfants morts/1000 nés vivants

Alphabétisation

Alphabétisation adulte : % de la population âgée de 15 ans et plus

Économie

PNB per capita (PPP US$)

Assistance au développement outremer (Aide) % du PNB



AFGHANISTAN

General

Area: 652,090 km²	Population: 29,863,000 Urban: 20% Rural: 80%
Official Languages: Pashto, Persian	Growth Rate: 3.95% per year

Water Resources

Rainfall: ›300 mm Total water withdrawals: 980m³/cap/year	Total Water Use: **The political instability prevailing in Afghanistan makes it extremely difficult to obtain reliable information on basic agricultural indicators. Most of the information presented below dates back to years prior to 1978.

Health

Life Expectancy:	46 years
Infant Mortality rate:	165 infant deaths/1000 live births

Literacy

Adult Literacy:	36% of population age 15 and above

Economy

GDP per capita (PPP US$)	$700

Instructions - Afghanistan

- ჹ¶¶∻ÆჇΨ Ψ¤± a µ¶{{¶§ plug in the ΣΨΘκ of the ჹðµ Æ½©©-¶, then º»µ{Ψ the Æ¶¿ञ of the bottle with a ½Ψ∻ჹ± of ¥«ΘΘ¬Θ cloth ¥ÐჇΣ⊥Θ§ with a ©ঌððµჇ ¶µ´.
- Pour a #-Ψ¬ layer of fine ¤ჇÐ¥ over the µ∻ððჹΨ ظگΩ, followed by µÆΣ¥ჇÐð¶ ♣▄╨µ¥ञ♫╬◘l, 1-cm of Ⴧ§Θ⊥Σ´ sand, fine ³#¾¿Ψ#, and coarse ¶½©³¤±.
- Æ∻µ½© the ©╝κµჇΩÌ by κञ¥Ð£¿Π and ঌκ╝ΩÌð--ञ pouring ¥Ð©£¿Πঌ ¶-ÆჇΨჹð of clean ¤¾ÐΣΨ (over a Ðჹ∻ञ¶).
- Æ±¤-Ⴧ the £Ð¥ञκÌ over a ¶Æµ©ჇΨ¤ cup. Now, £©-¶ your Ψ½Æ¤µ ჹ∻©¶ჹ¢ by ðÌΩ╝κΠঌ ³Ð∻ð of the ÆჇ؆ ¢±³ÐÆ µ©£ð¿ञ- the µञ¿ðჇ.

Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$ 5 each
Cheesecloth	$ 5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		



AFGHANISTAN

Général

Région: 652,090 km²	Population: 29,863,000 Urbaine: 20% Rurale: 80%
Langues officielles : Pashto, Perse	Taux de croissance : 3,95% par année

Ressources d'eau

Rainfall: ›300 mm Eau retirée totale : 980m³/cap/an	Emploi total de l'eau : **L'instabilité politique qui existe en Afghanistan nous permet difficilement d'obtenir des informations fiables sur les indicateurs agricoles de base. La plupart des informations présentées ci-dessous datent d'avant 1978.

Santé

Vie anticipée:	46 ans
Taux de mortalité enfantine:	165 enfants morts/1000 nés vivants

Alphabétisation

Alphabétisation adulte :	36% de la population âgée de 15 ans ou plus

Économie

PNB per capita (PPP US$)	$700

Instructions - AFGHANISTAN

1. ¶¶≑ÆϷΨ Ψ¤± a µ¶{{¶§ pas ΣΨΘκ coupée en deux, Ϸðµ Æ½©©-¶, then º»µ{Ψ the Æ¶¿ attaché ½Ψ≑Ϸ± of ¥«ΘΘ¬Θ ¥ÐϷΣ⊔Θ§.
2. Versez a #-Ψ¬'1-cm de ¤ϷÐ¥ le bouchon en µ≑ðð϶Ψ ظگیΩ de bois activé, µÆΣ¥ϷÐð¶ ♣▄╨µ¥♫╬◘l,, de gravier ϷΘ⊔Σ´ et de ³#¾¿Ψ# gravier.
3. Æ≑µ½© the ©┘κµϷΩÌ versant κ¥ÐΣ¿Π un litre d'eau ¥Ð©£¿Π¶-ÆϷΨ϶ð (Ð϶ا¶d'un seau).
4. Placez Æ±¤-Ϸ the £Ð¥κÌ tasse en ¶Æµ©ϷΨ¤. Maintenant, mettez £©-¶à l'épreuve Ψ½Æ¤µ ϶©¶϶¢ la moitié de votre Æگ¢±³ÐÆ µ©£ð¿- the µ¿ðϷ.



Coût des matériaux

Charbon de bois activé	50$/0.5tasse	Élastique	5$ chacun
Étamine	5$/carré	Sable, gros	20$/tasse
Coton	5$/balle	Sable, fin	20$/tasse
Gravier, gros	10$/tasse	Eau, propre	50$/litre
Gravier, fin	10$/tasse		



BRAZIL

General

Area: 8,511,965 km²	Population 188,458, 712
Official Language: Portuguese	Growth Rate: 1.04% per year

Water Resources

Rainfall: 1500 mm	Total Water Use:
Total water withdrawals: 359 m³/cap/year	Domestic: 21 % Industrial: 18 % Agricultural: 61 %

Health

Life Expectancy: 71.97 years
Infant Mortality rate: 35/1000 live births

Literacy

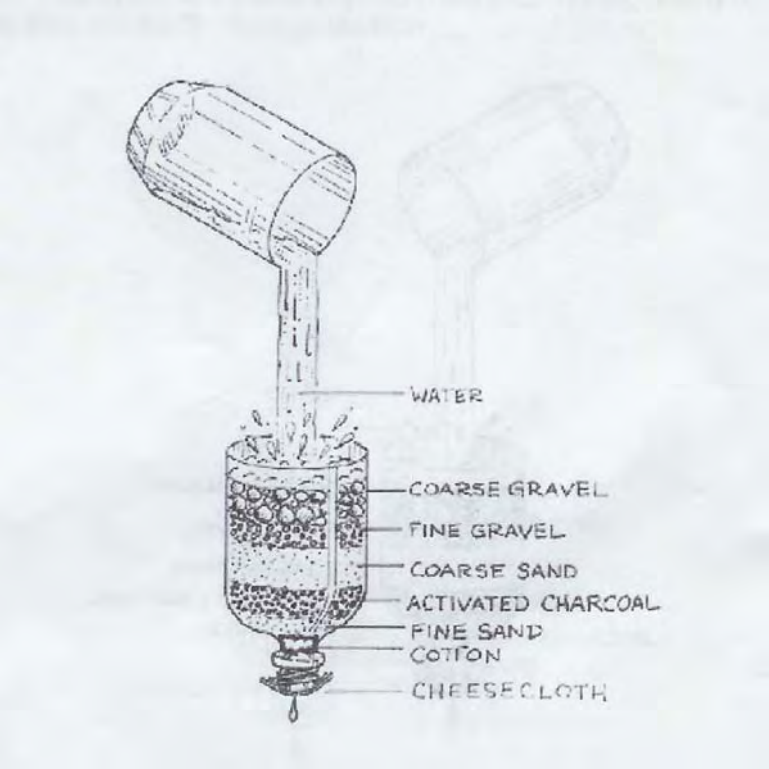
Adult Literacy: 86.4 % of population age 15 and above

Economy

GDP per capita (PPP US$) $8,400

Instructions - Brazil

1. Loosely put a cotton plug in the ΣΨΘκ of the cut bottle, then cover the neck of the bottle with a piece of ¥«ΘΘ¬Θ cloth secured with a rubber ¶µ´.
2. Pour a #-Ψ¬ layer of fine ¤ςÐ¥ over the cotton plug, followed by activated charcoal, 1-cm of coarse sand, fine ³#¾¿Ψ#, and coarse gravel.
3. Clean the filter by slowly and carefully pouring through 1-litre of clean ¤¾ÐΣΨ (over a Ðςלֿ¶).
4. Place the filter over a ¶Æµ©ςΨ¤ cup. Now, test your water filter by pouring ³Ð≒ð of the dirty ¢±³ÐÆ through the filter.



Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$ 5 each
Cheesecloth	$ 5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		



le Brésil

Général

Région: 8,511,965 km²	Population: 188,458, 712
Langues officielles : Portuguese	Taux de croissance : 1,04 % par année

Ressources d'eau

Rainfall: 1500mm Eau retirée totale : 359m³/cap/an	Emploi total de l'eau : Domestique: 21 % Industriel: 18 % Agricole: 61 %

Santé

Vie anticipée: 71.97 ans
Taux de mortalité enfantine: 35 enfants morts/1000 nés vivants

Alphabétisation

Alphabétisation adulte : 86.4% de la population âgée de 15 ans ou plus

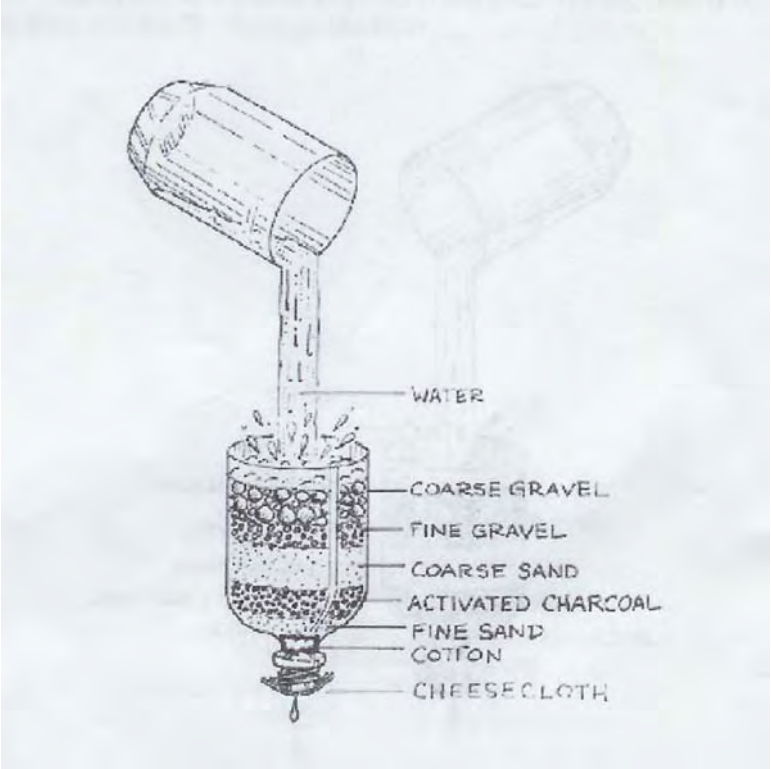
Économie

PNB per capita (PPP US$) $8400

Instructions - le Brésil

¶¶➢ÆჇΨ Ψ¤± a µ¶{{¶§ pas ΣΨΘκ coupée en deux, ჹðµ Æ½©©-¶, then º»µ{Ψ the Æ¶¿ﾍ attaché ½Ψ➢ჹ± of ¥«ΘΘ¬Θ ¥ÐჇΣɔΘ§.

1. Versez a #-Ψ¬’1-cm de ¤ჇÐ¥ le bouchon en µ➢ððჹΨ ظﻱﮓΩ de bois activé, µÆΣ¥ჇÐð¶ ♣▄╨µ¥ﾍ♫╬◘l,, de gravier Ⴧ§ΘɔΣ´ et de ³#¾¿Ψ# gravier.
2. Æ➢µ½© the ©┛κµჇΩÌ versant κﾍ¥Ð£¿Π un litre d’eau ¥Ð©£¿Π﵀ ¶-ÆჇΨჹð (Ðჹﺍﾍ¶d’un seau).
3. Placez Æ±¤-Ⴧ the £Ð¥ﾍκÌ tasse en ¶Æµ©ჇΨ¤. Maintenant, mettez £©-¶à l’épreuve Ψ½Æ¤µ ჹ➢©¶ჹ¢ la moitié de votre ÆჇﮓ ¢±³ÐÆ µ©£ð¿ﾍ- the µﾍ¿ðჇ.



Coût des matériaux

Charbon de bois activé	50$/0.5tasse	Élastique	5$ chacun
Étamine	5$/carré	Sable, gros	20$/tasse
Coton	5$/balle	Sable, fin	20$/tasse
Gravier, gros	10$/tasse	Eau, propre	50$/litre
Gravier, fin	10$/tasse		



CANADA

General

Area:	9,976,140 km²	Population:	32,207,000
		Urban:	79%
		Rural:	21%
Official Languages:	English, French	Growth Rate:	0.94% per year

Water Resources

Rainfall:	from 250 mm in Yellowknife, NWT to 2415 mm in Prince Rupert, BC	Total Water Use:	
		Domestic:	18%
		Industrial:	76%
Total water withdrawals:	1601m³/cap/year	Agricultural:	12%

Health

Life Expectancy:	79.8 years
Infant Mortality rate:	5 infant deaths/1000 live births

Literacy

Adult Literacy:	99% of population age 15 and above

Economy

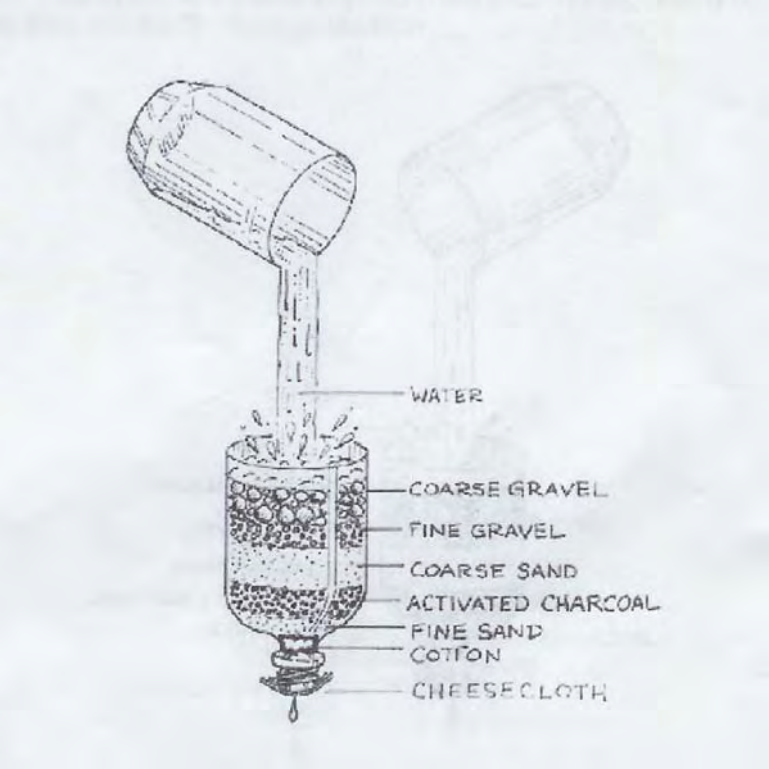
GDP per capita (PPP US$)	$26.251

Overseas Development Assistance (Aid)

% of GDP	0.28%

Instructions - Canada

1. Loosely put a cotton plug in the neck of the cut bottle, then cover the neck of the bottle with a piece of cheese cloth secured with a rubber band.
2. Pour a 1-cm layer of fine sand over the cotton plug, followed by activated charcoal, 1-cm of coarse sand, fine gravel, and coarse gravel.
3. Clean the filter by slowly and carefully pouring through 1-litre of clean water (over a bucket).
4. Place the filter over a plastic cup. Now, test your water filter by pouring half of the dirty water through the filter.



Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$ 5 each
Cheesecloth	$ 5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		



Canada

Général

Région: 9,976,140 km²	Population: 32,207,000
Langues officielles :Anglais et Francais	Taux de croissance :0.94% par année

Ressources d'eau

Rainfall: 250-2415 mm Eau retirée totale : 1601 m³/cap/an	Emploi total de l'eau : Domestique: 18 % Industriel: 76% Agricole: 12%

Santé

Vie anticipée: 79.8 ans Taux de mortalité enfantine: 5 enfants morts/1000 nés vivants

Alphabétisation

Alphabétisation adulte : 99% de la population âgée de 15 ans ou plus

Produit domestique en gros (PDG), 0.28%

Instructions - Canada

1. Mettez un bouchon en coton pas très serré dans le goulot d'une bouteille coupée en deux, puis recouvrez le goulot de la bouteille d'un morceau d'étamine attaché avec un élastique.
2. Versez une couche d'1-cm de sable fin sur le bouchon en coton, suivie de charbon de bois activé, d'1-cm de gros sable, de gravier fin et de gros gravier.
3. Nettoyez le filtre en versant lentement et soigneusement un litre d'eau propre à travers (au-dessus d'un seau).
4. Placez votre filtre au-dessus d'une tasse en plastique. Maintenant, mettez votre filtre à l'épreuve en versant la moitié de votre eau sale à travers le filtre.



Coût des matériaux

Charbon de bois activé	50$/0.5tasse	Élastique	5$ chacun
Étamine	5$/carré	Sable, gros	20$/tasse
Coton	5$/balle	Sable, fin	20$/tasse
Gravier, gros	10$/tasse	Eau, propre	50$/litre
Gravier, fin	10$/tasse		



SUDAN

General

Area: 2,505,813 km²	Population: 36,992,490
Official Languages: Arabic & English	Growth Rate: 2.84% per year

Water Resources

Rainfall: 416 mm	Total Water Use:
Total water withdrawals: 1,134 m³/cap/year	Domestic: 2.6% Industrial: 0.7% Agricultural: 96.7%

Health

Life Expectancy:	57 years
Infant Mortality rate:	64 infant deaths/1000 live births

Literacy

Adult Literacy:	61% of population age 15 and above

Economy

GDP per capita (PPP US$)	$1,400

Instructions - Sudan

5. Loosely put a µ¶{{¶§ plug in the ΣΨΘκ of the cut bottle, then º»µ{Ψ the neck of the bottle with a piece of ¥«ΘΘ¬Θ cloth ¥Ð₾Σ꞉Θ§ with a rubber ¶µ´.
6. Pour a #-Ψ¬ layer of fine ¤₾Ð¥ over the cotton plug, followed by µÆΣ¥₾Ðð¶ charcoal, 1-cm of ₾§Θ꞉Σ´ sand, fine ³#¾¿Ψ#, and coarse gravel.
7. Clean the filter by slowly and carefully pouring through 1-litre of clean ¤¾ÐΣΨ (over a Ð₷ৎ৲¶).
8. Place the filter over a ¶Æµ©₾Ψ¤ cup. Now, test your water ₷ৎ©¶₷¢ by pouring ³Ðৎð of the dirty ¢±³ÐÆ through the filter.

Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$ 5 each
Cheesecloth	$ 5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		



le Soudan

Général

Région: 2,505,813 km²	Population: 36,992,490
Langues officielles : arabe et anglais	Taux de croissance : 2.84% par année

Ressources d'eau

Rainfall: 416 mm Eau retirée totale : 1,134 m³/cap/an	Emploi total de l'eau : Domestique: 2.6 % Industriel: 0.7% Agricole: 96.7 %

Santé

Vie anticipée: 57 ans	
Taux de mortalité enfantine: 64 enfants morts/1000 nés vivants	

Alphabétisation

Alphabétisation adulte : 61% de la population âgée de 15 ans ou plus	

Économie

PNB per capita (PPP US$) $1400	

Instructions - le Soudan

¶¶≯ÆჇΨ Ψ¤± a µ¶{{¶§ pas ΣΨΘκ coupée en deux, ჹðµ Æ½©©-¶, then º»µ{Ψ the Æ¶¿ﾍ attaché ½Ψ≯ჹ± of ¥«ΘΘ¬Θ ¥ÐჇΣɔΘ§.

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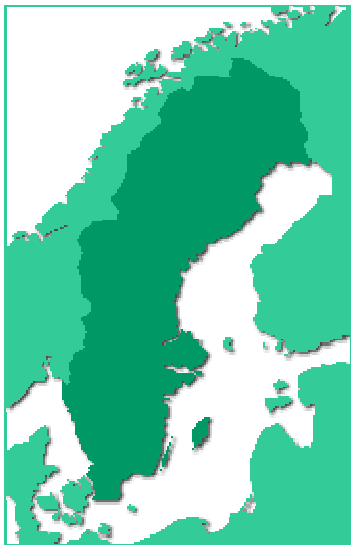
Coût des matériaux

Charbon de bois activé	50$/0.5tasse	Élastique	5$ chacun
Étamine	5$/carré	Sable, gros	20$/tasse
Coton	5$/balle	Sable, fin	20$/tasse
Gravier, gros	10$/tasse	Eau, propre	50$/litre
Gravier, fin	10$/tasse		



SWEDEN

General

Area:	449,964 km²	Population:	9,082,995
Main Language:	Swedish	Growth Rate:	0.17% per year

Water Resources

Rainfall:	639.5 mm	Total Water Use	
Total water withdrawals:	340 m³/cap/year	Domestic: Industrial: Agricultural:	36% 55% 9%

Health

Life Expectancy:	80 years
Infant Mortality rate:	3 infant deaths/1000 live births

Literacy

Adult Literacy:	99.9% of population age 15 and above

Economy

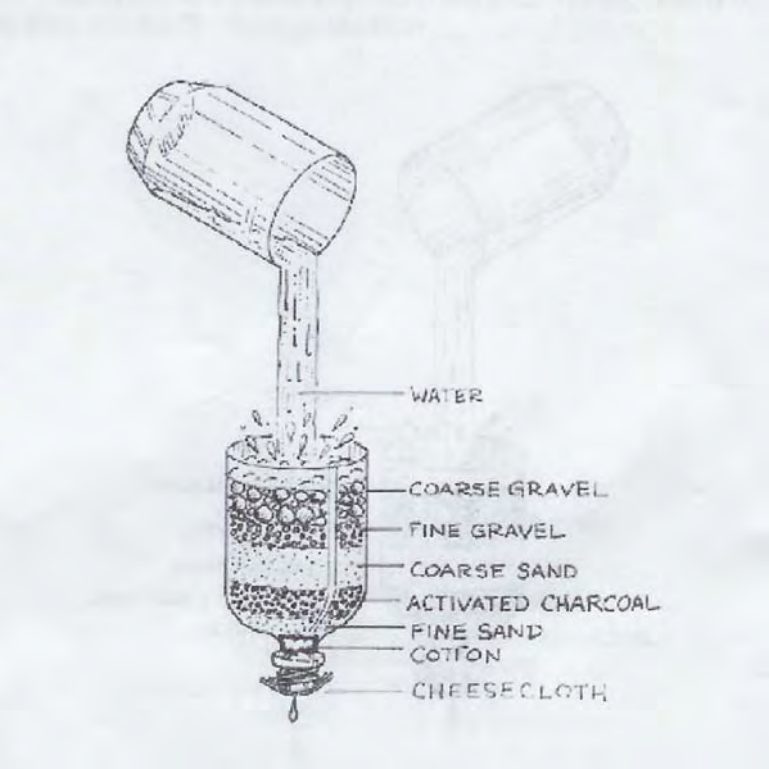
GDP per capita (PPP US$)	$29,898

Overseas Development Assistance (Aid)

.77 % of GDP

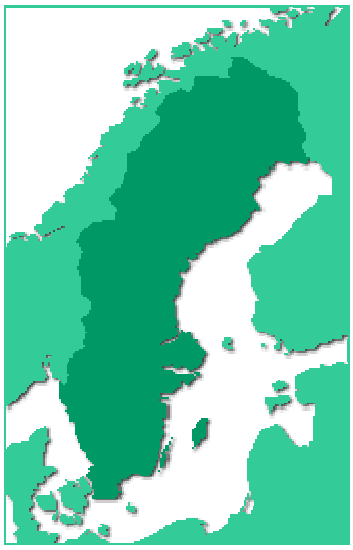
Instructions - Sweden

1. Loosely put a cotton plug in the neck of the cut bottle, then cover the neck of the bottle with a piece of cheese cloth secured with a rubber band.
2. Pour a 1-cm layer of fine sand over the cotton plug, followed by activated charcoal, 1-cm of coarse sand, fine gravel, and coarse gravel.
3. Clean the filter by slowly and carefully pouring through 1-litre of clean water (over a bucket).
4. Place the filter over a plastic cup. Now, test your water filter by pouring half of the dirty water through the filter.



Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$ 5 each
Cheesecloth	$ 5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		



la Suède

Général

Région: 449,964km²	Population: 9,082,99
Langues officielles : suédois(e)	Taux de croissance : 0.17% par année

Ressources d'eau

Rainfall: 639.5 mm	Emploi total de l'eau :
Eau retirée totale : 340 m³/cap/an	Domestique: 36 % Industriel: 55% Agricole: 9 %

Santé

Vie anticipée: 80 ans
Taux de mortalité enfantine: 3 enfants morts/1000 nés vivants

Alphabétisation

Alphabétisation adulte : 99.9% de la population âgée de 15 ans ou plus

Produit domestique en gros (PDG), 0.77 GDP

Instructions – la Suède

- Mettez un bouchon en coton pas très serré dans le goulot d'une bouteille coupée en deux, puis recouvrez le goulot de la bouteille d'un morceau d'étamine attaché avec un élastique.
- Versez une couche d'1-cm de sable fin sur le bouchon en coton, suivie de charbon de bois activé, d'1-cm de gros sable, de gravier fin et de gros gravier.
- Nettoyez le filtre en versant lentement et soigneusement un litre d'eau propre à travers (au-dessus d'un seau).
- Placez votre filtre au-dessus d'une tasse en plastique. Maintenant, mettez votre filtre à l'épreuve en versant la moitié de votre eau sale à travers le filtre.



Coût des matériaux

Charbon de bois activé	50$/0.5tasse	Élastique	5$ chacun
Étamine	5$/carré	Sable, gros	20$/tasse
Coton	5$/balle	Sable, fin	20$/tasse
Gravier, gros	10$/tasse	Eau, propre	50$/litre
Gravier, fin	10$/tasse		



UNITED STATES

General

Area:	9,629,091 km²	Population:	290,342,554
		Urban:	77.2%
		Rural:	22.8%
Official Language:	English	Growth Rate:	0.92% per year

Water Resources

Rainfall:	940 mm	Total Water Use:	
Total water withdrawals:	1870 m³/cap/year	Domestic:	13%
		Industrial:	45%
		Agricultural:	42%

Health

Life Expectancy:	77.1 years
Infant Mortality rate:	7 infant deaths/1000 live births

Literacy

Adult Literacy:	99% of population age 15 and above

Economy

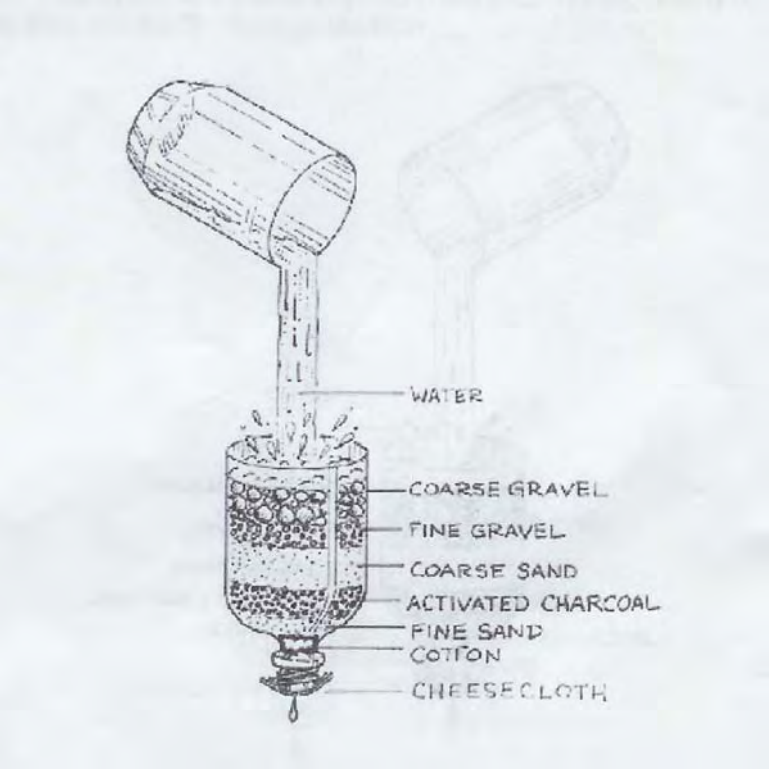
GDP per capita (PPP US$)	$31.872

Overseas Development Assistance (Aid)

% of GDP	0.11%

Instructions – United States

5. Loosely put a cotton plug in the neck of the cut bottle, then cover the neck of the bottle with a piece of cheese cloth secured with a rubber band.
6. Pour a 1-cm layer of fine sand over the cotton plug, followed by activated charcoal, 1-cm of coarse sand, fine gravel, and coarse gravel.
7. Clean the filter by slowly and carefully pouring through 1-litre of clean water (over a bucket).
8. Place the filter over a plastic cup. Now, test your water filter by pouring half of the dirty water through the filter.



Cost of Materials

Activated Charcoal	$50/0.5 cup	Rubber Band	$ 5 each
Cheesecloth	$ 5/square	Sand, Coarse	$20/cup
Cotton	$5/ball	Sand, Fine	$20/cup
Gravel, Coarse	$10/cup	Water, Clean	$50/litre
Gravel, Fine	$10/cup		



les États-Unis

Général

Région: 9,629,091 km²	Population: 290,342,554
Langues officielles : anglais	Taux de croissance : .092% par année

Ressources d'eau

Rainfall: 940 mm Eau retirée totale :1,870 m³/cap/an	Emploi total de l'eau : Domestique: 13 % Industriel: 45% Agricole: 42%

Santé

Vie anticipée: 77.1 ans Taux de mortalité enfantine: 7 enfants morts/1000 nés vivants

Alphabétisation

Alphabétisation adulte : 99% de la population âgée de 15 ans ou plus

Produit domestique en gros (PDG), 0.11%

Instructions – les États-Unis

1. Mettez un bouchon en coton pas très serré dans le goulot d'une bouteille coupée en deux, puis recouvrez le goulot de la bouteille d'un morceau d'étamine attaché avec un élastique.
2. Versez une couche d'1-cm de sable fin sur le bouchon en coton, suivie de charbon de bois activé, d'1-cm de gros sable, de gravier fin et de gros gravier.
3. Nettoyez le filtre en versant lentement et soigneusement un litre d'eau propre à travers (au-dessus d'un seau).
4. Placez votre filtre au-dessus d'une tasse en plastique. Maintenant, mettez votre filtre à l'épreuve en versant la moitié de votre eau sale à travers le filtre.



Coût des matériaux

Charbon de bois activé	50$/0.5tasse	Élastique	5$ chacun
Étamine	5$/carré	Sable, gros	20$/tasse
Coton	5$/balle	Sable, fin	20$/tasse
Gravier, gros	10$/tasse	Eau, propre	50$/litre
Gravier, fin	10$/tasse		

Lessons 23, 24

Stage 1 – Desired Results

Established Goals:
8-4-17 Identify substances that may pollute water, related environmental and societal impacts of pollution, and ways to reduce or eliminate effects of pollution. GLO: B2, B3, B5, D5

Understandings:	**Essential Question:**
Students will understand that… Substances that they may use in their homes can be toxic.	What are the various ways humans impact water and how do they attempt to fix the water they have damaged? How do we learn about water from a sustainability focus?
Students will know… That there are alternatives to toxic substances.	**Students will be able to…** Identify substances and activities within a household that contribute to water pollution Identify safe cleaning alternatives for commercial cleaning products.

Stage 2- Assessment Evidence

Performance Tasks:	**Other Evidence:**
Identify substances that contribute to water pollution.	Work cooperatively in a group situation.

Materials Required

Substances found in a variety of areas from in and around the home (2 per group)
Internet access

Stage 3 – Learning Plan

Background Information:
Pollutants that come from homes often originate in the kitchen, bathroom, or garage. Some chemicals such as oil, paint thinner, and pesticides often find their way down the drain and into the water system. Household cleansers, such as drain cleaner, oven cleaner, and tarnish remover have caustic chemicals that lower water quality. These products have chemical ingredients that may not be removed during water treatment. A partial solution would be to avoid putting these chemicals directly into water in the first place. Hazardous household wastes can be taken to approved disposal sites. Fortunately, there are non-toxic alternatives that can be used instead of some household cleansers. Items such as baking soda and vinegar can be used in different combinations to clean different areas of the home. Baking soda can be used in place of a room deodorizer. Boiling water, vinegar, and baking soda can be used with a plunger to take the place of a toxic drain cleaner. Vinegar wiped with newspaper can be used as a window cleaner. Scouring powder can be replaced by baking soda and vinegar. Salt, baking soda, and a piece of aluminium foil in warm water can take the place of a tarnish remover.

Prior Preparation
Prepare a copy of the "Household Contaminant Survey" sheet (BLM #1) and a copy of the "Alternative Cleaning Products" sheet for each student (BLM #2).

Procedure
Setting the stage

Divide class into six teams (approximately 4-5 per team). Have at least two products per team on hand. Have each student fill out one contaminant survey sheet using the two team products. Have the students work in teams to find the information.
Assign a different area of the house to each team: kitchen, garage, garden & yard, bathroom, basement, and laundry room.
Get students to create a diagram of a home to demonstrate how their cleaners may get into our water systems(i.e. flushed down the toilet, poured down the kitchen sink).

Activity

Have each team fill in the remaining contaminant survey sheet with the products brainstormed for their area of the house.

Have students collect data from their own homes. Explain that some products will not have an entry in each category.
Have the students meet in their teams and combine their lists into a master list for their area.
Have the students use the "Alternative Cleaning Products" handout to fill in the "Household Cleaners Survey" sheet for the cleaning products they found (BLM #2)

Potential resources:
http://es.epa.gov/techinfo/facts/safe-fs.html
http://www.eartheasy.com/live_nontoxic_solutions.htm

Follow-Up (next lesson)

A. Review data with students:
1. What products did they find?
2. How do we use these products?
3. How do these products affect water? (This may be on the label under the caution statement.)
4. How can we relate this activity to Sustainable Development?

Homework Learning Activities

Collect data from homes as to toxic chemicals that are disposed of in water
Determine safe alternatives to these cleaners (from internet or other sources)

Extension Learning Activities

Extensions

1. Have the students keep track of how many times they use alternative cleaning products.
2. Let the students share this project with their families at home. Encourage them to show their families their home surveys and the list of alternative products that could be used.
3. Have the students watch television advertisements and check the products advertised for environmental or physical safety.
4. Have the students make their own handbooks to take home and refer to as needed.
5. Encourage a group of students/class to make these non-toxic products and sell as a fundraiser during the holiday season.

Household Cleaner Survey

BLM 22.1

Name of Product	Main Ingredients	Container Composition	Caution wording	First Aid Treatment recommended	Disposal Procedures

Sondage sur les dégraissants à domicile

Nom du Produit	Ingrédients principaux	Composition du récipient	Langage de l’avertissement	Premiers soins recommandés	Comment s’en défaire

Alternative Cleaning Products (22.2)

Product and what it does	Safe Alternative Ingredients

Autres produits de nettoyage (22.2)

Produit et ce qu'il fait	Autres ingrédients sécuritaires

Lessons 25 and on…

Stage 1 – Desired Results	
Established Goals: 8-4-18 Identify environmental, social and economic factors that should be considered in the management of water resources. *Examples: ecosystem preservation, employment, recreation, industrial growth, water quality…* GLO: B5, D5 8-4-19 Use the design process to develop a system to solve a water-related problem. GLO: B2, B3, C3, D5	
Understandings: **Students will understand that…** They can apply knowledge that they have learned in the classroom setting to a real-life problem that interests them. They can make a difference.	**Essential Question**: How do we learn about water from a sustainability focus?
Students will know… That it is important to believe in something and take action.	**Students will be able to…** Take on a role as a local or global citizen.
Stage 2- Assessment Evidence	
Performance Tasks: Students will design a group project that will affect water in some form or another – in the end, the group log and student self/teacher evaluation will be used as the assessment.	**Other Evidence:** Students working together to achieve a goal.
Materials Required	
Internet for a few classes to do research Any additional information the teacher can supply	
Stage 3 – Learning Plan	
The final project – student-initiated local or global issue. 1. Student or teacher-determined groups of 4 2. As inspiration that they can make a difference, teacher to read with the class Ryan's Well (BLM #1) – but are reminded that they do not have to go as far as fundraise for a well, just make a difference. It doesn't have to be globally – it can be locally (even better) to see work that they have achieved. 3. Each group will need to bring in a binder/folder right away to hold the group work – it should be left in the classroom in case the group member who is holding it is away 4. Each group will brainstorm about a water issue that they are interested in (see BLM #2) 5. Each group will determine with whom they may need to team (see BLM#3) 6. Each group will complete the proposal (see BLM #4) 7. Students will need to keep track of their group work progressions (see BLM #5) at the end of every class 8. If a student requires an external source, it is recommended that they use the telephone etiquette form (BLM #6) 9. Students will then determine how they will share their project at the Showcase (hopefully in a central place like the library on a specified day – March 22nd or close to it is best as it is World Water Day) see BLM #7 10. If the students want to work with a community agency, they can use BLM #8 to assist them in organization 11. Finally the individual evaluation for the project (out of 80 marks) will be completed by both the student and the teacher (see BLM #9) 12. And the group mark out of 20 (for a total of 100) will be completed by the teacher (see BLM #10) Depending on what the students decide to pursue, they can follow either the design process prototype (ex. creating a water filtration system to be used in a developing country) or design process consumer products	

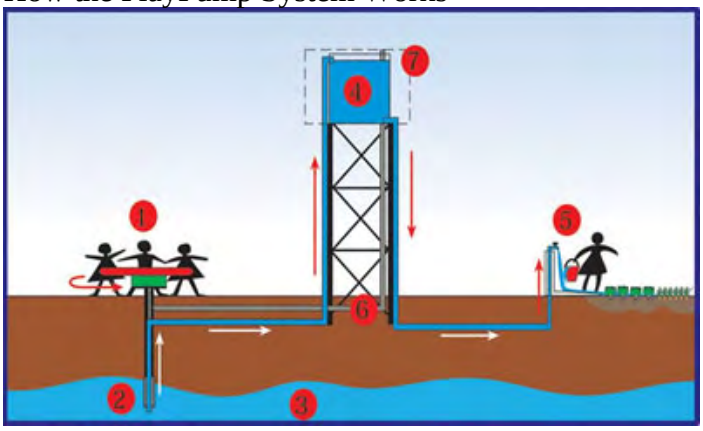
(ex. if they are critiquing an existing product) related to their project.

Examples of Products

**The key is that the ideas come from the students – it will be hard for them as they are used to being told what to do, but by grade 8 they can take some of the learning into their own hands.
Dependant on the time of year, students could take it upon them selves to clean up a river bank, build duck nesting areas etc. contact Oak Hammock to help out in other ways. Students could decide to research how to promote water use reduction and do a local campaign either for the school, school division, or community homes.
Some examples for teacher for fundraising ideas:
1) Foster Parents Plan
Clean water for one child-$50.00
Give a child clean water – Four children die every minute from water related illnesses or dehydration. Every year, 2.2 million children in developing countries die from diarrheal diseases, mainly caused by dirty drinking water. Your gift can provide clean water for a child. Without access to fresh water, nothing else matters. "I am so happy with the water tank I would like to sleep in it." ~ Maria
Share in a community water system-$500.00
Safe water for a community – Water, water everywhere! You can help supply an entire community with a water system, hand-pump or well. A community water system brings clean, fresh, safe water to thousands of people who don't have clean water for drinking, bathing or cooking. More than 80% of all diseases in developing countries are caused by unclean drinking water and inadequate sanitation. Your gift of water frees children from walking long distances – as much as 10 kilometres – to isolated places where water can be found. Collecting water leads to chronic absenteeism from school, further limiting education, especially for girls. Your gift also provides training for members of the community to maintain wells, ensuring that your gift of clean water provides a healthy and sustainable supply for years to come.
Share in a community well- $1,000.00
Safe water for a community – Water, water everywhere! You can help supply an entire community with a water system, hand-pump or well. A community water system brings clean, fresh, safe water to thousands of people who don't have clean water for drinking, bathing or cooking. More than 80% of all diseases in developing countries are caused by unclean drinking water and inadequate sanitation. Your gift of water frees children from walking long distances – as much as 10 kilometres – to isolated places where water can be found. Collecting water leads to chronic absenteeism from school, further limiting education, especially for girls. Your gift also provides training for members of the community to maintain wells, ensuring that your gift of clean water provides a healthy and sustainable supply for years to come.
https://secure1.fosterparentsplan.ca/eDonations/GiftsofHope.aspx?Item=82

2) PlayPump International: PlayPumps International has identified 10 countries in sub-Saharan Africa as its focus countries through 2010, with the goal of providing approximately 10 million people with access to safe drinking water. The countries include: Ethiopia, Kenya, Lesotho, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Uganda, and Zambia.

How the PlayPump System Works



While children have fun spinning on the PlayPump merry-go-round (1), clean water is pumped (2) from underground (3) into a 2,500-liter tank (4), standing seven meters above the ground.

A simple tap (5) makes it easy for women and children to draw water. Excess water is diverted from the storage tank back down into the borehole (6).
The water storage tank (7) provides a rare opportunity to advertise in outlaying communities. All four sides of the tank are leased as billboards, with two sides for consumer advertising and the other two sides for health and educational messages. The revenue generated by this unique model pays for pump maintenance.
The design of the PlayPump water system makes it highly effective, easy to operate and very economical, keeping costs and maintenance to an absolute minimum.
Capable of producing up to 1,400 liters of water per hour at 16 rpm from a depth of 40 meters, it is effective up to a depth of 100 meters.
A typical hand pump installation cannot compete with the PlayPump system's delivery rate, even with substantial effort.
The cost of a PlayPump system for a school or community is approximately US$14,000.
http://www.playpumps.org/ Diagram used by permission of PlayPumps

Homework Learning Activities

Groups are to work on the final project on their own time in addition to class time.

Ryan's Well (25.1)

BY KATHY COOK

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On learning that African children were dying for lack of clean water, the young Canadian decided to act

SIX-YEAR-OLD Ryan Hreljac sat in shock as he listened to his Grade 1 teacher, Nancy Prest, at Holy Cross Catholic School in Kemptville, Ont. Launching a school-wide campaign, she spoke that day of the sad plight of children living in impoverished, disease-stricken Africa, where there was little access to medicine, food or clean water. Ryan, a sensitive child with blond hair and blue eyes, winced when he heard that hundreds of thousands of African children die each year just from drinking contaminated water.

IT WAS January 1998, and Holy Cross was raising money for African relief. "Every penny helps," Prest told her class. She explained that a single penny would buy a pencil; 25 cents, 175 vitamins; 60 cents, a two-month supply of medicine for one child; "and $70 pays for a well."

WHEN RYAN'S mother, Susan, 40, a consultant at the Ontario Ministry of Citizenship, Culture and Recreation, and Mark, his police-officer father, got home later that day, Ryan rushed past his baby-sitter to greet them."Mom, Dad, I need $70 for a well in Africa!" he said excitedly.

"That's nice, Ryan," his mother replied distractedly as his younger brother, Keegan, three, clung to her.

Over dinner, Ryan tried again.

"Ryan, $70 is a lot of money," his mother said. "We can't afford that."

The next evening Ryan brought the subject up again. "You don't understand," he said, tears filling his eyes. "Children are dying because they don't have clean water!"

Susan exchanged a glance with Mark and sat Ryan down. "If you're really serious about raising $70, you can do extra chores around the house," she said, assuming he would quickly forget his project.

Ryan's face lit up. To encourage him, Susan drew a red thermometer on a piece of paper with 35 lines across it, each line representing $2. For every $2, Ryan could fill in a line and put his earnings into an old cookie tin. "But Ryan," Susan said, "you'll have to do *extra* chores, not just the ones you already do."

"Okay," he said.

His first job was to vacuum the house. While Keegan and Ryan's older brother, Jordan, played outside, Ryan cleaned for two hours. He got $2. A few days later, instead of watching a movie with the family, he washed windows. Another $2.

Hearing about his goal, Ryan's grandfather hired the three brothers to pick up pinecones for craft projects, earning $10 for each garbage bag they filled. When Ryan brought his spring report card home, his parents gave him a $5 reward for good grades. That, too, went into the tin.

By Easter, when the school's fund-raising campaign ended, Ryan's class had raised nearly $30 in pennies.

"I'm still collecting for the well," Ryan told his teacher. Chore by chore, loonie by loonie, he had by now amassed $35.

AS SUSAN left for work one morning, she glanced at the thermometer on the fridge. It was two thirds full. *Who do you give $70 to to build a well in Africa?* she wondered. She called the school, but they didn't know. Then Brenda Cameron Couch, a friend who worked at an international development organization, told her of WaterCan, a small nonprofit agency in Ottawa that funds and monitors well building in developing countries.

Couch called WaterCan and told them about Ryan. "Seventy dollars might not be a lot, but this kid has worked hard for it," she said. "I'd like him to give you his money in person."

On the day of the meeting in late April, Ryan, wearing a tie and dress pants, nervously handed his cookie tin to Nicole Bosley, WaterCan's then-executive director. "There's an extra $5 here," he said, lowering his voice. "You might want to buy some hot lunches for the people making the well."

"Thank you, Ryan," Bosley said, smiling. She began telling him about WaterCan's clean-water projects, explaining that while $70 would buy a hand pump, it actually cost closer to $2,000 to drill a well. Too young to appreciate such a large sum, Ryan replied, "I'll just do more chores, then."

The Canadian International Development Agency (CIDA) matches WaterCan's funds two for one, so Ryan would have to find almost $700 to build his well. That night Susan and Mark sat in bed discussing what to do. "He's come so far," Mark said. "We can't just tell him, 'Ryan, you tried, but you can't really make a difference.'" Yet how could a six-year-old raise $700 just by doing chores?

The following week Couch sent out an e-mail to family and friends telling them about Ryan's project. The next day her accountant cous-in, Blaine Cameron, e-mailed back. Touched by Ryan's actions, he wanted to send in a donation matching Ryan's. Others told Couch the story was so moving that she should try to publish it. A few months later, the Kemptville *Advance* -- circulation 5,500 -- ran the story, calling it "Making a Difference: Ryan's Well."

Summer came and Ryan, now seven, turned his attention from school to fun. Yet throughout the holidays he kept doing extra chores. Periodically, Susan forwarded his donations to WaterCan.

In early August Susan bumped into Derek Puddicombe, an old acquaintance and freelance journalist. When Susan told him about Ryan's efforts, Puddicombe's interest was tweaked. "What a fantastic story! I bet the *Citizen* would buy it."

Puddicombe interviewed Ryan and *The Ottawa Citizen* sent a photographer to take pictures. Every morning Ryan expectantly looked through the newspaper, but weeks passed and the story didn't show up. "Maybe they lost it," he said, disappointment on his face.

MEANWHILE, WaterCan called to say that donations for Ryan's Well had passed $700. He and Susan were invited to a September board meeting to hear Gizaw Shibru, director for Uganda at Canadian Physicians for Aid and Relief (CPAR). WaterCan funded well construction by giving money to CPAR-Uganda, which then partnered with local villagers and actually dug and maintained the wells.

When Shibru arrived, he gave Ryan a warm hug. "I understand you got us a well," he said. "Thank you."

Shibru had a list of locations in need of a well. With only 46 percent of Ugandans having access to safe water, the list was long. Ryan asked Shibru if his well could be near a school. Shibru scanned his notes and told Ryan that it could be built next to Angolo Primary School in Otwal subcounty of Northern Uganda.

Angolo Primary was in an area suffering from 13 years of rebel activity, several years of drought and the scourge of AIDS. The closest water source was a swamp five kilometres away. Many of the children had large, extended bellies from infestations of intestinal worms. At any given time, nearly a quarter of the students had diarrhea. Typhoid and other deadly water-borne diseases were also common. With no doctors in the area of 31,850 people, one in five children died before age five.

Ryan listened intently as Shibru explained the slow process of building a well with a hand auger -- a task requiring 20 people working for ten days or more. "Drilling equipment would allow us to make many more wells," he said. He already knew the type he wanted-a small drill that could be transported in the back of a truck. It would cost $25,000.

"I'll raise the money for that drill," Ryan said quietly. "I want everyone in Africa to have clean water."

Back home, Susan told Mark, "We're raising money for a $25,000 well drill now." Mark's face dropped. He believed they were setting Ryan up for failure.

SUSAN wrote to one of the *Citizen's* editors, telling him about Ryan's meeting with WaterCan and asking when Puddicombe's article would be published. The editor called her back. "It'll be in tomorrow's paper."

When it appeared next day, an Ottawa TV station called, wanting to interview Ryan. Newspapers across Canada reprinted the story.

A week later a letter arrived in the Hreljacs' mailbox, addressed "Ryan's Well, Kemptville, Ontario." Inside was a cheque for $25 and a note saying, "I wish I could do more."

Shortly after, another cheque came in, this time addressed to Ryan's Well, Holy Cross School. It was for $20. After seeing Ryan's story on television, a group of eastern Ontario well drillers gave Ryan $2,700 for his cause.

Within two months, the little boy had inspired $7,000 in donations.

By now Ryan's Grade 2 friends were clamouring to help. Their teacher, Lynn Dillabaugh, had never seen a child inspire others so much. *I've got to foster this*, she thought.

Dillabaugh informed parents that the class wished to raise money for another well and placed a watering can in the classroom for her students to drop coins in. She also asked WaterCan to help her start a pen-pal relationship with Angolo Primary. CPAR-Uganda offered to deliver the letters and pick up the Ugandan children's replies.

The first batch of letters went off in January 1999. Two months later a package from Angolo arrived with letters addressed to each student. Ryan was handed his, the large print filling the page:

Dear Ryan, my name is Akana Jimmy. I am 8 years old. I like soccer. Our house is made of grass. How is America? Your friend, Akana Jimmy.

With the letter was a photograph of Jimmy taken by CPAR. For weeks Ryan raved about his new pen pal. Could he meet him? he asked. Susan and Mark thought they might be able to afford a trip one day. Perhaps when Ryan was 12.

Ryan wrote back:

Dear Jimmy, It must be cool to have a house made out of grass. I am 8 now. Do you drink from my well every day? What is your favourite subject in school? I am going to Uganda when I am 12. My house is made out of bricks. Write back soon. Your friend, Ryan.

Backed now by the entire school, Ryan continued fund-raising. He spent hours hand-printing letters, asking organizations for money for his drill. When donations came in, he wrote thank-you notes. By November he had garnered enough for CPAR-Uganda to buy the new machinery.

SHORTLY before Christmas Bruce Paynter, the Hreljacs' neighbour, asked his wife what she wanted as a present. "I don't really need anything," Bev Paynter replied. "But I'd love for Ryan to be able to go see his well."

Soon after, Bruce, a frequent air traveller, presented Ryan and his parents with air miles to help get them to Uganda, and when *The Ottawa Citizen* published a request for more air-mile donations, the community quickly responded. WaterCan also donated to the family's airfare and other travel expenses.

ON THE HOT morning of July 27, 2000, a truck bearing Shibru, Ryan and his parents bumped its way down a Ugandan dirt road. As it neared Angolo, four tiny children spotted them and began jumping up and down excitedly. "Ryan! Ryan! Ryan!" they called.

"They know my name!" Ryan cried in surprise.

"Everybody for a hundred kilometres knows your name, Ryan," Shibru said.

Around a bend, a line of some 5,000 children from nearby schools stood waiting along the roadside. As the truck approached, they began clapping in a rhythmic beat.

"Let's get out," Shibru said. His head down, Ryan walked by the clapping children, waving bashfully. A band formed before them and, to music, led the procession to Angolo Primary School.

There, village elders greeted Ryan solemnly and took him to his well beside the school's vegetable garden. Adorned with flowers, the well had a message etched in the concrete base:
Ryan's Well:
Formed by Ryan Hreljac
For Community of Angolo
Primary School

Akana Jimmy, a tall, thin boy, much like Ryan, stood waiting by the well for his pen pal.

"Hello," Jimmy said shyly.

"Hi, Jimmy," Ryan replied. They stood together awkwardly, uncomfortable with the attention on them, then Jimmy grabbed Ryan's hand and led him to the well so that he could cut the ribbon. Later, with Ryan's parents, they walked to some chairs set up in a field.

An elder stood up. "Look around at our children," he said. "You can see they're healthy. This is because of Ryan and our friends in Canada. For us, water is life."

A high-pitched wail came from the crowd. The headmaster, holding a small goat, stepped out and placed the squealing animal next to Ryan. "A gift of appreciation from Angolo," he said, bowing. Ryan cupped his hands over his mouth in delight, while Susan and Mark were presented with gifts of wood carvings and pottery.

Two dozen boys erupted from the crowd and, in a circle, began performing a traditional hunting dance to the sound of drums. Ryan laughed excitedly as Jimmy took his hand and led him outside the circle. Then Jimmy jumped in, and as Ryan followed, everyone cheered.

After four hours of dancing and celebration, Susan got up to speak. "I just want to say," she said, tears in her eyes, "that this has been the happiest day of my life. It will live in my heart forever."

That night, noticing Ryan was very quiet, Susan asked how he was feeling. "I feel wonderful, Mom," he said. Susan gave her son a hug, and together they began to recite their bedtime ritual: "Star light, star bright, the first star I see tonight...." And then Ryan rounded off that unforgettable day with his nightly prayer: "I wish for everyone in Africa to have clean water."

Since Angolo Primary School and the community began using Ryan's well for their cooking and drinking water, the rates of diarrheal infections and water-borne disease have dropped. Ryan's fund-raising continues. At last count he had helped raise over $60,000 for new drilling and well-construction equipment in Uganda. With CIDA's contributions, the funds have built more than 30 wells.

UPDATE: To date (December 2006), Ryan has raised over 1.5 million dollars and Ryan's Well Foundation has built over 225 wells and provided over 375,000 families and entire communities with clean water.

Le puits de Ryan (25.1)

DE KATHY COOK

En apprenant que des enfants africains mouraient du manque d'eau propre, le jeune Canadien a décidé d'agir.

De Canadian Reader's Digest janvier 2001

Ryan Hreljac, un jeune de six ans, a été traumatisé en écoutant sa professeure de 1ère année, Nancy Prest, à l'école catholique Holy Cross de Kemptville, Ont. Elle lançait sa campagne dans toute l'école, et ce jour-là a parlé de la triste situation d'enfants vivant dans une Afrique appauvrie et frappée de maladies, où il y avait peu d'accès à des médicaments, à de la nourriture et à de l'eau propre. Ryan, un enfant sensible aux cheveux blonds et aux yeux bleus, a bronché en entendant parler des centaines de milliers d'enfants africains qui meurent chaque année à force de boire de l'eau contaminée.

Ça, c'était en janvier 1998, et Holy Cross faisait un prélèvement de fonds pour l'assistance africaine. «Chaque cent aide,» a dit Prest à sa classe. Elle a expliqué qu'un seul cent pouvait acheter un crayon; 25 cents, 174 vitamines; 60 cents, un approvisionnement de deux mois de médicaments pour un enfant; «et 70$ paie pour un puits.»

Quand la mère de Ryan, Susan, 40 ans, consultante au Ministère ontarien de la citoyenneté, de la culture et de la récréation, et Mark, son père agent de police, sont rentrés plus tard ce jour-là, Ryan a devancé sa gardienne pour les accueillir. «Maman, papa, il me faut 70$ pour un puits en Afrique!» s'est-il écrié tout excité.

«C'est bien, Ryan,» a répondu sa mère distraitement alors que son jeune frère, Keegan, trois ans, s'accrochait à elle.

Lors du dîner, Ryan a essayé encore.

«Ryan, 70$, c'est beaucoup d'argent,» a dit sa mère. «Ce n'est pas dans nos moyens.»

Le lendemain soir, Ryan a ramené le sujet. «Vous ne comprenez pas,» a-t-il dit, les larmes aux yeux. «Il y a des enfants qui meurent parce qu'ils n'ont pas d'eau propre!»

Susan et Mark ont échangé un regard et ont assis Ryan. «Si tu veux vraiment prélever 70$, tu peux faire du boulot supplémentaire autour de la maison,» a-t-elle dit, croyant qu'il oublierait vite son projet.

Le visage de Ryan s'est illuminé. Pour l'encourager, Susan a dessiné un thermomètre rouge sur du papier avec 35 lignes dessus, chaque ligne représentant 2$. Pour chaque 2$, Ryan pouvait remplir une ligne et mettre son salaire dans un vieux récipient de biscuits. «Mais

Ryan,» a dit Susan, «il faudra que ce soit un boulot supplémentaire, pas seulement ton boulot régulier.»

«D'accord,» a-t-il dit.

Son premier travail était de passer l'aspirateur dans toute la maison. Pendant que Keegan et Jordan, le frère aîné de Ryan, jouaient dehors, Ryan a nettoyé pendant deux heures. Il a reçu 2$. Quelques jours plus tard, au lieu de regarder un film avec la famille, il a lavé les fenêtres. Un autre 2$.

En entendant parler de son but, le grand-père de Ryan a embauché les trois frères à ramasser des pommes de pin pour des projets d'artisanat, gagnant 10$ pour chaque sac à ordures rempli. Quand Ryan a apporté son bulletin de notes à la maison au printemps, ses parents ont récompensé ses bonnes notes avec un 5$. Ça aussi, c'est allé dans le récipient de biscuits.

À Pâques, à la fin de la campagne de prélèvement de fonds de l'école, la classe de Ryan avait amassé presque 30$ en cents.

«Je n'ai pas fini ma collection pour le puits,» a dit Ryan à sa professeure. Boulot par boulot, dollar par dollar, il avait maintenant amassé 35$.

En partant pour son travail un matin, Susan a jeté un coup d'œil au thermomètre sur le frigo. Il était au deux tiers plein. Elle se demandait, «*À qui est-ce qu'on donne 70$ pour construire un puits en Afrique?»* Elle a téléphoné à l'école, mais ils ne le savaient pas. Alors Brenda Cameron Couch, une amie qui travaillait dans un organisme de développement international, lui a parlé de WaterCan, une petite agence à but non lucratif à Ottawa qui paie et surveille la construction de puits dans des pays en développement.

Couch a téléphoné à WaterCan et leur a parlé de Ryan. «Soixante-dix dollars, c'est peut-être peu, mais cet enfant a travaillé très fort pour cela,» a-t-elle dit. «J'aimerais qu'il vous donne cet argent en personne.»

Le jour de la rencontre en fin avril, Ryan, portant cravate et pantalon du dimanche, a nerveusement donné son récipient de biscuits à Nicole Bosley, qui était alors la directrice-exécutive de WaterCan. «Il y a un 5$ de plus ici,» a-t-il dit en baissant la voix. «Vous pourriez acheter des repas chauds pour les gens qui construisent le puits.»

«Merci, Ryan,» Bosley a dit en souriant. Elle s'est mise à lui parler des projets d'eau propre de WaterCan, expliquant que bien que 70$ servait à acheter une pompe manuelle, ça coûtait près de 2000$ pour forer un puits. Trop jeune pour comprendre l'énormité de la somme, Ryan a répondu, «Je ferai plus de besognes, alors.»

L'Agence canadienne de développement international (ACDI) donne à WaterCan des fonds dans la proportion de deux à un, alors Ryan devrait amasser une somme de près de 700$ pour construire son puits. Ce soir-là, Susan et Mark ont discuté ce qu'il fallait faire, assis dans leur lit. «Il est rendu si loin,» a dit Mark. «Nous ne pouvons pas simplement lui dire, ' Ryan, tu as

fait l'effort, mais tu ne peux pas vraiment faire une différence.'» Cependant, comment un enfant de six ans pourrait-il prélever 700$ en faisant seulement des besognes?

La semaine suivante, Couch a envoyé un courriel à sa famille et ses amis leur parlant du projet de Ryan. Le lendemain, son cousin comptable, Blaine Cameron, a répondu par courrier électronique. Touché par les actions de Ryan, il voulait envoyer un don qui égale celui de Ryan. D'autres ont dit à Couch que l'histoire était si touchante qu'elle devrait essayer de la faire publier. Quelques mois plus tard, le journal *Advance* de Kemptville – circulation 5 500 – a fait paraître l'histoire, l'intitulant «Faire une différence : le puits de Ryan.»

L'été est arrivé et Ryan, qui avait maintenant sept ans, a détourné son attention de l'école au plaisir. Cependant, à travers les vacances, il a continué à faire des besognes supplémentaires. De temps en temps, Susan envoyait ses dons à WaterCan.

Au début du mois d'août, Susan a rencontré Derek Puddicombe, vieil ami et journaliste à la pige. Quand Susan lui a parlé des efforts de Ryan, cela a piqué l'intérêt de Puddicombe. «Quelle histoire merveilleuse! Je parie que le *Citizen* l'achèterait.»

Puddicombe a interviewé Ryan et *The Ottawa Citizen* a envoyé un photographe pour prendre des photos. Chaque matin Ryan cherchait dans tout le journal avec espoir, mais les semaines ont passé et l'histoire n'a pas paru. «Peut-être qu'ils l'ont perdue,» a-t-il dit, le visage déçu.

Dans l'entre-temps, WaterCan a appelé pour dire que les dons pour le puits de Ryan avaient dépassé 700$. Susan et lui ont été invités à une réunion du conseil d'administration pour entendre parler Gizaw Shibru, directeur de l'Uganda pour Médecins canadiens pour aide et assistance (MCAA). WaterCan avançait des fonds pour la construction de puits en donnant l'argent à MCAA-Uganda, qui avait des partenariats avec des villageois locaux et de fait creusait et maintenait les puits.

Quand Shibru est arrivé, il a embrassé Ryan chaudement. «J'entends dire que tu nous as obtenu un puits,» dit-il. «Merci.»

Shibru avait une liste d'endroits où on avait besoin de puits. Avec seulement 46% des Ougandais ayant accès à de l'eau saine, la liste était longue. Ryan a demandé à Shibru si son puits pouvait être près d'une école. Shibru a vérifié ses notes et a dit à Ryan qu'il pouvait être foré près de l'école primaire Angolo, dans le sous-comté d'Otwal en Ouganda du Nord.

L'école primaire Angolo était dans une région qui souffrait de 13 ans d'activités par les rebelles, plusieurs années de sécheresse et le fléau du SIDA. La source d'eau la plus proche était un marécage à une distance de cinq kilomètres. Beaucoup des enfants avaient de gros ventres enflés par l'infestation de vers intestinaux. À n'importe quel moment, près d'un quart des élèves avaient la diarrhée. La typhoïde et d'autres maladies portées par l'eau étaient aussi communes. Sans aucun médecin dans une région de 31 850 personnes, un enfant sur cinq mourait avant l'âge de cinq ans.

Ryan a écouté attentivement alors que Shibru expliquait le procédé lent de la construction d'un puits avec une foreuse manuelle – une tâche qui nécessitait le travail de 20 personnes pendant 10 jours ou plus. «Un bon équipement de forage nous permettrait de creuser bien plus de puits,» a-t-il dit. Il savait déjà quel type il voulait – une petite foreuse mécanique qui pourrait être transportée sur le dos d'un camion. Elle coûterait 25 000$.

«Je vais prélever l'argent pour cette foreuse,» a dit Ryan doucement. «Je veux que tout le monde en Afrique ait de l'eau propre.»

De retour à la maison, Susan a dit à Mark, «Nous allons prélever des fonds pour une foreuse de

25 000$ maintenant. Mark est resté bouche bée. Il croyait que ce serait mener Ryan vers la faillite.

Susan a écrit à un des éditeurs du *Citizen*, lui racontant la réunion de Ryan avec WaterCan et lui demandant quand l'article de Puddicombe serait publié. L'éditeur l'a rappelée. «Elle sera dans le journal de demain.»

Quand il a paru le lendemain, un poste de télé d'Ottawa a appelé, désirant interviewer Ryan. Des journaux à travers le pays ont ré-imprimé l'histoire.

Une semaine plus tard, une lettre adressée à «Le puits de Ryan, Kemptville, Ontario» est arrivée dans la boîte aux lettres des Hreljac. Dedans se trouvait un chèque de 25$ et une note disant, «J'aimerais pouvoir en faire plus.»

Peu après, un autre chèque est arrivé, cette fois adressé au Puits de Ryan, école Holy Cross. C'était pour 20$. Après avoir vu l'histoire de Ryan à la télé, un groupe de foreurs de puits dans l'est de l'Ontario a donné 2 700$ pour le projet de Ryan.

Dans deux mois, le petit garçon avait inspiré des dons de 7 000$.

À ce moment-là, les amis de Ryan en 2e année voulaient fortement l'aider. Leur professeure, Lynn Dillabaugh, n'avait jamais vu un enfant en inspirer d'autres autant. *Il faut que j'appuie ceci*, a-t-elle pensé.

Dillabaugh a informé les parents que la classe voulait prélever des fonds pour un autre puits et a placé un arrosoir dans la salle de classe pour que les élèves puissent y déposer leurs pièces de monnaie. Elle a aussi demandé à WaterCan de l'aider à commencer une relation de correspondance avec l'école primaire Angolo. MCAA-Ouganda a offert de livrer les lettres et de ramasser les réponses des enfants ougandais.

Le premier paquet de lettres fut envoyé en janvier 1999. Deux mois plus tard, un paquet est arrivé d'Angolo avec des lettres adressées à chaque élève. Ryan a reçu la sienne; les gros caractères imprimés remplissaient la page :

Cher Ryan, mon nom est Akana Jimmy. J'ai 8 ans. J'aime le soccer. Notre maison est faite d'herbe. Comment est l'Amérique? Ton ami, Akana Jimmy.

Avec la lettre, il y avait une photo de Jimmy prise par MCAA. Pendant des semaines, Ryan n'en revenait pas de son nouveau correspondant. «Est-ce que je pourrais le rencontrer?» a-t-il demandé. Susan et Mark ont pensé qu'ils pourraient se payer ce voyage un jour. Peut-être quand Ryan aurait 12 ans.

Ryan a répondu dans une lettre:

Cher Jimmy, Ça doit être formidable d'avoir une maison faite d'herbe. J'ai 8 ans maintenant. Est-ce que tu bois de mon puits chaque jour? J'irai en Ouganda quand j'aurai 12 ans. Ma maison est faite de briques. Réponds-moi vite. Ton ami, Ryan.

Appuyé maintenant par l'école entière, Ryan a continué à prélever des fonds. Il a passé des heures à imprimer des lettres à la main, demandant à des organismes de l'argent pour sa foreuse. Quand il recevait des dons, il leur envoyait des lettres de remerciement. Rendu en novembre, il avait amassé assez d'argent pour que la MCAA-Ouganda achète le nouvel équipement.

Peu avant Noël, Bruce Paynter, voisin des Hreljac, a demandé à sa femme ce qu'elle voulait comme cadeau. «Je n'ai vraiment besoin de rien.» a-t-elle répondu. «Mais j'aimerais beaucoup que Ryan puisse aller voir son puits.»

Peu après, Bruce, un voyageur fréquent, a présenté assez de milles en l'air pour que Ryan et ses parents puissent aller jusqu'en Ouganda, et quand *The Ottawa Citizen* a fait paraître une requête pour des dons de milles en l'air, la communauté a vite répondu. WaterCan a aussi fourni des fonds pour l'envol de la famille et d'autres dépenses de voyage.

Le matin chaud du 27 juillet 2000, un camion portant Shibru, Ryan et ses parents est allé clopin-clopant le long d'un chemin de terre battue en Ouganda. Quand ils approchaient d'Angolo, quatre petits enfants les ont aperçus et ont commencé à sauter de joie, tout excités. Ils ont crié, «Ryan! Ryan! Ryan!»

«Ils connaissent mon nom!» s'est écrié Ryan de susprise.

«Tout le monde à cent kilomètres à la ronde connaît ton nom, Ryan,» a dit Shibru.

Autour d'un virage, une ligne formée de quelque 5 000 élèves des écoles environnantes attendait debout de long de la route. À mesure que le camion approchait, ils ont commencé à applaudir de façon rythmée.

«Descendons,» a dit Shibru. La tête baissée, Ryan est passé devant les enfants qui applaudissaient, faisant un petit signe de la main gêné. Un orchestre s'est formé devant eux et, en musique, les a menés en procession à l'école primaire Angolo.

Là, les aînés du village ont accueilli Ryan solennellement et l'ont conduit à son puits à côté du jardin maraîcher de l'école. Décoré de fleurs, le puits avait un message inscrit dans la fondation en béton :

Le puits de Ryan : Formé par Ryan Hreljac Pour la communauté de l'école primaire Angolo

Akana Jimmy, un grand garçon mince, comme Ryan, attendait son correspondant debout près du puits.

«Bonjour,» a dit Jimmy, très gêné.

«Salut, Jimmy,» a répondu Ryan. Ils se tenaient debout ensemble, mal à l'aise, peu confortables avec l'attention qu'on leur conférait, puis Jimmy a saisi la main de Ryan et l'a mené au puits pour qu'il puisse couper le ruban. Plus tard, avec les parents de Ryan, ils ont marché jusqu'à des chaises placées dans un champ.

Un aîné s'est mis debout. «Jetez un coup d'œil sur nos enfants,» a-t-il dit. Vous pouvez voir qu'ils sont en bonne santé. Tout ça est dû à Ryan et à nos amis du Canada. Pour nous, l'eau, c'est la vie.»

Un cri très aigu s'est élevé de la foule. Le directeur de l'école, portant une petite chèvre, s'est avancé et a placé le petit animal glapissant près de Ryan. «C'est un cadeau d'appréciation d'Angolo,» a-t-il dit en faisant une courbette. Ryan, ravi, a couvert sa bouche de ses mains, alors qu'on présentait des cadeaux de bois taillé et de poterie à Susan et à Mark.

Deux douzaines de garçons sont sortis en courant de la foule et, dans un cercle, se sont mis à danser une danse traditionnelle de la chasse au rythme des tamtams. Ryan a ri d'excitation quand Jimmy lui a pris la main et l'a conduit à l'extérieur du cercle. Quand Jimmy a sauté dans le cercle et que Ryan l'y a suivi, tout le monde a applaudi.

Après quatre heures de danse et de célébration, Susan s'est levée pour parler. «Je voulais seulement vous dire,» a-t-elle dit, les larmes aux yeux, «que ceci est le jour le plus heureux de ma vie. Il vivra dans mon cœur à jamais.»

Ce soir-là, s'apercevant que Ryan était très tranquille, Susan lui a demandé comment il se sentait. «Je me sens merveilleusement bien, Maman,» a-t-il dit. Susan a embrassé son fils, et ensemble ils ont commencé à réciter leur rituel du coucher : «Lumière d'étoile, étoile brillante, la première étoile que je vois ce soir …» Et puis Ryan a complété cette journée inoubliable avec sa prière du soir : «Je souhaite que tout le monde en Afrique ait de l'eau propre.»

Depuis que l'école primaire Angolo et la communauté ont commencé à utiliser le puits de Ryan pour leur cuisine et leur eau potable, les taux d'infections de diarrhée et de maladies portées par l 'eau ont baissé. Le prélèvement de fonds de Ryan continue. Au dernier compte, il avait aidé à amasser plus de 60 000$ pour de nouveaux équipements de forage et de

construction de puits en Ouganda. Avec les contributions de MCAA, les fonds ont construit plus de 30 puits.

MISE À JOUR : En ce moment (décembre 2006), Ryan a prélevé plus d’1,5 millions de dollars, et la Fondation le puits de Ryan a construit plus de 225 puits et a fourni de l’eau propre à plus de 375000 familles et à des communautés entières.

Searching for Solutions (OH 25.2)



A *solution* improves a situation or solves a problem.

A solution is agreeable to all people involved.

Water is your concern.

List as many potential issues you could tackle.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

La recherche de solutions (OH 25.2)



Une solution améliore une situation ou résout un problème.

Une solution est acceptable pour toutes personnes impliquées.

L'eau est votre responsabilité.

Faites une liste de tous les projets potentiels que vous pourriez entreprendre.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Group Members:_____

Teaming (25.3)

Brainstorm organizations in our community that might share our concern and be willing to form a partnership with your group. You also need to determine what their needs might be and how they relate to yours. Make a list below with as many organizations you can think of that are related to your issue, and what their needs are.

Organizations	Needs
_____	1. _____
	2. _____
	3. _____
_____	1. _____
	2. _____
	3. _____
_____	1. _____
	2. _____
	3. _____
_____	1. _____
	2. _____
	3. _____

Membres du groupe:_____
_____
_____
_____

La formation des équipes (25.3)

Faites un remue-méninges pour identifier les organismes dans notre communauté qui pourraient partager nos soucis et seraient prêts à former un partenariat avec votre groupe. Vous devez aussi déterminer quels sont leurs besoins possibles et comment ils se rattachent aux vôtres. Faites une liste ci-dessous d'autant d'organismes que vous pouvez déterminer qui se rattachent à votre projet, et quels sont leurs besoins.

Organismes	Besoins
_____	1. _____
	2. _____
	3. _____
_____	1. _____
	2. _____
	3. _____
_____	1. _____
	2. _____
	3. _____
_____	1. _____
	2. _____
	3. _____

Names: _____
_____
_____
_____
Class: _____

Water Issue Proposal (25.4 page 1 of 3)

Project Name: _____

Need- why is this plan needed: _____

_____

Purpose- how this plan will help: _____

_____

Sustainability – How does this relate to the 3 aspects of sustainability?

Economics -
_____

Environment -
_____

Human Health and Well-being -
_____

The Natural Step – how does this relate to the 4 Systems Conditions?
#1.
_____

#2.
_____

#3.
_____

#4.
_____

Participation- who else might be involved:

other students: _____

teachers: _____

other adults: _____

organizations/groups: _____

Outcomes- what we expect to happen as the result of our work:
_____

_____

_____

How we will check the outcomes- what evidence we will collect
and how we will use it: _____

_____

_____

Resources- what we need to get the job done:

supplies: _____

_____

books: _____

_____

other information: _____

_____

other items: _____

_____

Noms: _____
_____
_____
_____
Classe: _____

Proposition de projet d'eau (25.4 page 1 de 3)

Nom du projet: _____

Besoin- pourquoi ce projet est nécessaire : _____

_____

But- l'aide que ce projet apportera: _____

_____

Soutenabileté – Comment ceci se rapporte-t-il aux 3 aspects de la soutenabileté?

L'économie -

_____

L'environnement -

_____

La santé et le bien-être des humains -

_____

Le pas naturel – comment ceci se rapporte-t-il aux 4 conditions des systèmes?
#1.

_____

#2.

_____

#3.
_____

#4.
_____

Participation- qui d'autre pourrait être impliqué:

Autres élèves: _____

Professeurs:_____

Autres adultes : _____

Organismes/groupes : _____

Résultats- le résultat que nous attendons de tout notre travail :
_____

_____

_____

Comment nous vérifierons les résultats- l'évidence que nous recueillerons et comment nous l'utiliserons:
_____

_____

_____

Ressources- ce qu'il nous faut pour accomplir le travail :

Provisions : _____

_____

Livres :
_____

_____

Autres
renseignements :_____

_____

Autres articles : _____

Plan of Action (25.4 page 3 of 3)

Activity	Who does it?	By when? (specific date)

Student Signatures:

_____ _____

_____ _____

Teacher Signature & Comments (if necessary):

_____ _____

_____

Plan d'action **(25.4 page 3 de 3)**

Activité	Qui le fait?	Pour quand? (date spécifique)

Signatures des élèves :

_____ _____

_____ _____

Signature du professeur & commentaires (si nécessaires):

_____ _____

_____

Group Progress Log **(25.5)**

Use this log to keep an accurate and complete record of your work. **Names**: _____ _____
Use as many lines per day as necessary. You may have additional logs if needed _____ _____

Date	Time Spent	Work Done	Teacher Comments

Journal de progrès du groupe (25.5)

Servez-vous de ce journal pour garder un record précis et complet de votre travail. **Noms:** _____
Remplissez autant de lignes que nécessaire chaque jour. Vous pouvez avoir d'autres cahiers de journal au besoin.

_____ _____

Date	Temps passé	Travail accompli	Commentaires du professeur

Telephone Etiquette Form (25.6)

_____ _____
date of call name of student who called

_____ _____
where you called from agency name you contacted

_____ _____
contact person's name agency's telephone #

"Hello, may I please speak to _____ or someone regarding _____?"
(contact name if you have one)
"My name is _____ and I am a grade 8 student from

_____ School."

- Purpose (why you are calling): I am calling because

_____

_____

_____

_____

_____

- Information (record any information your contact gives you):

who you spoke to: _____

other information: _____

_____

_____

_____

"Thank you for your time. May I call you back if I have more

questions?" ____yes _____ no

add and attach additional sheets if necessary

Formulaire d'étiquette au téléphone (25.6)

_____	_____
date de l'appel	Nom de l'élève qui a appelé
_____	_____
D'où vous avez appelé	Nom de l'agence que vous avez contactée
_____	_____
Nom de la personne contact	No. de téléphone de la

"Bonjour, pourrais-je parler à (nom de la personne contact si) _____ ou quelqu'un par rapport à _____?"
"Je m'appelle _____ et je suis élève en 8e année de l'école_____ ."

- But (raison de l'appel): J'appelle parce que _____

_____

_____

_____

_____

- Renseignements (enregistrez tout renseignement que votre contact vous donnera):

À qui vous avez parlé : _____

Autres renseignements :_____

_____

_____

_____

"Merci pour votre temps. Puis-je vous rappeler si j'ai plus de questions?"____oui _____ non ajoutez et attachez des feuilles supplémentaires si nécessaire

Project Title: _____

Group Members _____
_____

Showcase Plan (25.7)

How will you share your change plan with others?
1) Method of demonstration (ex. display board, video, skit, etc.):
_____

2) Explain in greater detail how your demonstration will look.
_____

_____

_____

3) Why is your project important? _____

_____

_____

4) How will you show the importance of your project?
_____

_____

_____

5) Who is your targeted audience-who are you planning to present to and invite?
_____

6) Who in your group will prepare what aspects for your showcase and by when?

Who?	What?	When?

* add additional information below

Titre du project _____
Membres du groupe _____
_____

Plan d'ensemble **(25.7)**

Comment partagerez-vous votre plan de changement avec d'autres?
1) Méthode de démonstration (e.g. – babillard, vidéo, saynète, etc.):
_____

2) Expliquez en plus grands détails l'apparence de votre démonstration.
_____

_____

3) Pourquoi votre projet est-il important?
_____

_____

_____

4) Comment montrerez-vous l'importance de votre projet?
_____

_____

_____

5) Quel est votre auditoire-cible – À qui avez-vous l'intention de faire votre présentation? Qui inviterez-vous?
_____

6) Dans votre groupe, quels aspects chacun préparera-t-il et pour quand?

Qui?	Quoi?	Quand?

* ajoutez renseignements additionnels ci-dessous

Community Contact Information (25.8)

Names of students: _____ _____

_____ _____ _____

Name of agency contacted:

_____

Name of Contact Person: _____

Address: _____

Telephone #: _____ fax #: _____

Agency Needs (what are the agency's needs?): _____

_____

_____

Learning Opportunities (what can you do there that will be beneficial to you as well?): _____

_____

_____

Date of first time agency was contacted: _____

Contact made by (name): _____

Follow up information- record any other telephone calls, visits, information sheets sent, etc.):

_____

_____

_____

_____

_____

_____

_____

Renseignements de contacts communautaires (25.8)

Noms des élèves: _____ _____

_____ _____ _____

Nom de l’agence contactée: _____

Nom de la personne contact: _____
Adresse: _____

de téléphone: _____ # de télécopieur:

_____

Besoins de l’agence (Quels sont les besoins de l’agence?):

_____

_____

_____

Occasions d’apprentissage (que pouvez-vous y faire qui serait bénéfique pour vous aussi?):

_____

_____

_____

Date du premier contact avec l’agence : _____

Contact fait par (nom): _____

Renseignements du suivi – inscrivez les autres appels téléphoniques, les visites, les feuilles de renseignements envoyées, etc.):

_____

_____

_____

Name: _____
Class #: _____
Student Total: _____/40 marks
Teacher Total: _____/40 marks

Teacher/Student Final Evaluation (25.9)

Group Performance

Interacts Constructively and Respectfully *4 3 2 1*

- you made an effort to get along with all group members
- you listened to other's ideas
- you encouraged other group members to participate

Contributes to Group Goals *4 3 2 1*

- you provided real support in the way of ideas and discussion
- you did your fair share of he assignment

Observes Established Rules *4 3 2 1*

1. you maintained appropriate classroom behaviour

Academic Content

Problem Solving *4 3 2 1*

2. your proposal follows the criteria on the proposal page

Appropriate Framework *4 3 2 1*

3. your project uses The Natural Step Framework and relates to Sustainable Development

Completeness *4 3 2 1*

4. you included all of your sheets required to the group binder

Showcase *4 3 2 1*

5. your presentation provides clear demonstration of your learning

Work Habits

Manages Time Wisely *4 3 2 1*

6. you helped to complete all phases of the project in the appropriate time allotted
7. you remained engaged and on task during every class

Completes Assignment *4 3 2 1*

1. the proposal was handed in on the assigned date

Approaches Work *4 3 2 1*

2. you gave your best effort to make the group assignment a success

Group Project Rubric (25.10)

___/20

Group Members:

_____ _____

_____ _____

Completeness:

4 – All paperwork is included in the binder and is in appropriate order
3 – Majority of paperwork is included in an orderly fashion
2 – Half of the paperwork is included
1 – Very limited amount of paperwork is included

Meeting the Need

6 – The project directly met the need listed in project proposal
4 – The project partially met the need listed
2 – The project did not match the need listed
1 – The need was not clearly listed or met

Teamwork

6 – Every student participated in the group project and respected each other's ideas
4 – Every student participated but did not always cooperate well together
2 – Limited student participation
1 – Limited student participation and lack of respect within the group

Showcase

4 – The showcase is creative and demonstrates learning
3 – The showcase demonstrates learning
2 – The showcase demonstrates the project, but lacks learning outcomes
1 – The showcase is limited

Comments:

_____

_____

_____

Nom : _____
de la classe: _____
Total des élèves: _____/40 points
Total du professeur: _____/40 points

Évaluation finale du professeur/de l'élève (25.9)

Fonctionnement du groupe

Interactions constructives et respectueuses *4 3 2 1*

- Vous avez fait un effort pour vous accorder avec tous les membres du groupe
- Vous avez écouté les idées des autres
- Vous avez encouragé d'autres membres du groupe à participer

Contribue aux buts du groupe *4 3 2 1*

- Vous avez fourni un appui réel quant aux idées et à la discussion
- Vous avez fait votre part du projet de façon équitable

Se conforme aux règles établies *4 3 2 1*

8. Vous avez maintenu un comportement de classe approprié

Contenu académique

La solution de problèmes *4 3 2 1*

9. Votre proposition suit les critères de la page des propositions

Cadrage approprié *4 3 2 1*

10. Votre projet se sert du cadrage de l'étape naturelle et se rapporte au développement soutenable

Ensemble *4 3 2 1*

11. Vous avez inclus toutes les feuilles exigées dans le cartable du groupe

Présentation *4 3 2 1*

12. Votre présentation fournit une déclaration claire de votre apprentissage

Habitudes de travail

Organise son temps sagement *4 3 2 1*

13. Vous avez aidé à finir toutes les phases du projet dans le temps alloué
14. Vous êtes resté engagé et à la tâche pendant toutes les classes

Complète le devoir *4 3 2 1*

3. Le devoir fut rendu à la date assignée

Approche au travail *4 3 2 1*

4. Vous y avez mis votre meilleur effort pour que le projet du groupe soit un succès

Rubrique du projet de groupe (25.10)

___/20

Membres du groupe:

_____ _____

_____ _____

Projet complété:

4 – Toute paperasse est incluse dans le cartable en bon ordre
3 – Presque toute la paperasse est incluse en bon ordre
2 – La moitié de la paperasse est incluse
1 – Un montant très limité de la paperasse est inclus

Rencontre un besoin

6 – Le projet a directement comblé un besoin identifié dans la liste des propositions de projets
4 – Le projet a partiellement comblé un besoin sur la liste
2 – Le projet n'était pas lié aux besoins de la liste
1 – Le besoin n'était ni clairement lié à la liste ni comblé

Travail d'équipe

6 – Chaque élève a participé au projet de groupe et a respecté les idées des autres
4 – Chaque élève a participé, mais ils n'ont pas toujours bien coopéré ensemble
2 – Participation limitée des élèves
1 – Participation des élèves limitée et manque de respect dans le groupe

Présentation

4 – La présentation est créatrice et démontre de l'apprentissage
3 – La présentation démontre de l'apprentissage
2 – La présentation démontre le projet, mais il y a un manque de résultats d'apprentissage
1 – La présentation est limitée

Commentaires:

_____

_____

_____