

Section I: Water Conservation as a Response to the Global Water Crisis

Turn off the faucet when you are brushing your teeth. Shorten your shower by a minute and save gallons of water a month. Monitor your water bill closely to check for unusually high use. Install a low-flow shower head. Only run your washing machine or dishwasher when you have a full load. Water your lawn and plants only when absolutely necessary. With each passing decade, statements such as these have become more and more common, as citizens are urged more and more to conserve water. In developed nations, such as the United States, the concept of a water crisis may be hard to believe as people living in those countries have become so used to turning on the faucet and having a seemingly unlimited amount of water come spewing out. “Worldwide, [though], the consumption of water is doubling every twenty years, at more than twice the rate of the increase in human population. According to the United Nations, by the year 2025, as much as two-thirds of the world’s population will be living in conditions of serious water shortage and one-third will be living in conditions of absolute water scarcity.” (“The WTO’s Threats to Global Water Security: The General Agreement on Trade in Services and Beyond.”) As such, water management has become a serious concern for municipalities across the globe as the struggle begins to provide clean, potable water to its citizens. A variety of agencies have already implemented water conservation measures, a trend that must continue in order to ensure that the world's water supply is able to meet the needs of generations to come.

Water is essential to nearly all human activities – from drinking, to farming, to producing energy, to manufacturing clothes and cars. In the past few decades with rapid industrialization, population growth, increased agricultural production, and pollution, among other factors, much strain has been placed on the world's water supply. “The global water stress and scarcity situation is being played out by a number of secular trends: the increase in global population and its subsequent effect on demand for food production that, in turn, drives agricultural water demand. Water use-intensive industries like mining and power are adding further stress to the demand curve, particularly in countries without near-universal potable water coverage. Moreover, issues like regional aquifer depletion and the

affects of pollution-contaminated groundwater sources are being having to be addressed for the first time in many countries.” (“Why Water Matters.”)

With such pressure present on global water supplies, reuse has become a very viable option for communities looking to extend their resources. Reclaiming or recycling water involves taking wastewater or water that has been used in some application such as washing, flushing or manufacturing, giving it a high degree of treatment and using the resulting water for a new, beneficial purpose. Reuse or recycled water can be used in a variety of ways, depending on how much it has been treated. Popular uses for recycled water include surface irrigation of orchards and vineyards, groundwater recharge, wetland, wildlife habitat, and stream augmentation, industrial cooling processes, landscape and golf course irrigation, toilet flushing, vehicle washing and food crop irrigation, among others. (“About Water Reuse.”) “Water reuse offers a climate independent water source that is dependable, locally-controlled, and generally beneficial to the environment. Water reuse allows communities to become less dependent on ground and surface water sources and can decrease the diversion of water from sensitive ecosystems. Additionally, water reuse may reduce the nutrient loads from wastewater discharges into waterways, thereby reducing and preventing pollution.” (“About Water Reuse.”) Countries all across the globe have instituted water reuse programs, many sprouting up in the 1990s, especially in the agricultural sector. In Italy, for example, 9,800 acres of crop land is irrigated with recycled water, as well as in Argentina where 8,995 acres of forests, vineyards, fruit trees and other crops are also irrigated with reuse water. (“What is Water Reuse?”)

Of the many countries that utilize recycled water as means for water conservation, Singapore has been one of the most successful, with its Public Utilities Board winning the Stockholm Industry Water Award in 2007. Although Singapore has a rainforest climate and averages more than ninety inches of rainfall each year, the country has faced water shortages throughout its history. As such, in 1998 the Public Utilities Board (PUB) and the Ministry of the Environment and Water Resources began a water reclamation study which aimed “to determine whether recycled water and desalination could be

viable options to meet the country's long-term water needs, and whether they would help reduce Singapore's reliance on imported water from Malaysia, a source of friction over the years"("NEWater in Singapore."). In May of 2000, the country's first water reuse plant was complete, with the water they produced branded under the name "NEWater". Today, there are four NEWater plants which meet thirty percent of Singapore's total water demand. ("NEWater.")

The NEWater facilities utilize common water reclamation technology including microfiltration, reverse osmosis and ultraviolet disinfection. In microfiltration the wastewater is passed through a membrane that traps solid particles, disease-causing bacteria, some viruses and protozoan cysts. Next, the water is processed through reverse osmosis where it is passed through a semi-permeable membrane that removes even more contaminants including heavy metals, nitrates, chlorides, sulphates and pesticides. Although at this point the water is of high quality, is it processed a third time using ultraviolet disinfection to ensure that the water is contaminant and organism free. ("NEWater.")

Another such country that is no stranger to water problems is China, whose "water supply is smaller than that of the U.S., yet must meet the needs of a population nearly five times as large" (Perkowski). According to the World Health Organization (WHO), one out of four Chinese lack access to clean water and one out of two are forced to consume water that is below WHO standards. In 2011, though, the country launched its twelfth five-year plan, shifting their environmental focus to water. In addition to significantly adding to their wastewater treatment, the government has initiated a new regulation that "limits the annual consumption of water to six hundred thirty five billion cubic meters by 2015, further increasing the need for water recycling facilities. For this reason, China expects to spend \$69 billion dollars on industrial waste water treatment. Because per capita water resources in China are only a quarter of the world's average, and industrial water consumption constitutes a quarter of the country's total water consumption, the recycling of deeply treated industrial waste water is essential" (Perkowski). It is clear that countries, as exhibited with these examples from Singapore and China, are beginning to feel the wrath of the world water crisis and thus, must act quickly to

alleviate their water supply issues, most often turning to conservation as the solution.

As water conservation has increased on a global scale a myriad of products have come on to the market that make it easy for consumers to save water in their own homes. These types of products include water efficient shower heads, and toilets, as well as home irrigation systems. In June of 2006 the Environmental Protection Agency launched a program in the United States to promote water efficiency and conservation, so called WaterSense. This voluntary program allows manufacturers to place a label on their product if it meets specifications developed by the EPA for water efficiency while also maintaining performance. The program was developed to show consumers that they do not need to make drastic lifestyle changes to conserve water. Since its inception in 2006, the EPA reports that its WaterSense products have saved a cumulative two hundred eighty seven billion gallons of water and over \$4.7 billion dollars in water and energy bills. (“WaterSense.”)

Another such water conservation technique that has gained popularity in recent years that can be utilized in the home is greywater recycling, especially in areas where water is commonly scarce such as Texas and other states in the American southwest, the Middle East and Australia. Grey water is residential wastewater that comes from kitchen and bathroom sinks, dishwashers, tubs and showers. Residential greywater recycling systems are made by modifying standard septic systems which separate greywater from blackwater, or water that has come in contact fecal matter. The grey water is then passed through a sand filtration system which removes various impurities, making the water suitable for reuse. The water is then transported to some sort of storage tank which can then used for home irrigation, and toilet flushing water, among other uses. (“Greywater Recycling Basics.”) “Grey water recycling helps reduce the burden on local freshwater supplies and the strain on wastewater systems,” all the while reducing consumers water and energy bills by nearly thirty five percent. (“Why Save Water?”)

With a global water crisis looming on the horizon, water conservation has become increasingly important, and although the variety of measures mentioned above are crucial to a secure water future,

still more can and should be done. As aware citizens, it cannot be expected that the government or other agencies will automatically solve the problem on their own, and certainly not overnight. Water conservation is a constant battle that requires continuous work.

Section II: Water Conservation in the Textile Industry

The textile industry is one of the largest in the world. Simply look around and you will see that textiles are indeed everywhere – “from the carpets beneath our feet, to the clothes on our backs, to the architectural textiles shielding us from the elements—textiles are completely ubiquitous” (Thiry). What many do not realize, though, is the amount of resources that go into producing fabric – especially in regards to water. Traditional textile manufacturing is very water intensive, using this resource in nearly all of its processes, from yarn production to dyeing and finishing. The United States Environmental Protection Agency estimates that a textile manufacturer producing 20,000 pounds of fabric each day consumes roughly 36,000 liters of water. (Shaikh) Like other chemical industries, textile manufacturing pollutes water quite extensively as well, as most of the dye stuffs and other, usually toxic, substances used throughout production are often returned to ecosystems through mills' wastewater. The debate over the future of water on Earth rages on, as thousands of people struggle each day with non-existent or polluted water sources, and companies worldwide begin using water as a thing of profit. As such the textile industry is facing increased pressure to change their ways, especially in the way of water conservation, in attempts to counteract years of wastefulness and contamination.

In 2011 the internationally known environmental organization, Greenpeace, published an investigative report which profiled toxic water pollution by China's textile industry, in particular. The report entitled “Dirty Laundry” focused on two prominent textile manufacturing facilities in the country, the Youngor Textile Complex, located on the Yangtze River Delta and the Well Dyeing Factory, located on a tributary of the Pearl River Delta. Greenpeace reported that water samples taken from the facilities showed that both companies were releasing a variety of very toxic chemicals into both the Yangtze and Pearl deltas. These substances included such hazardous and persistent chemicals as alkylphenols and perfluorinated chemicals (PFCs) which are known hormone disruptors that can cause cancer, birth defects and other developmental disorders. The report made headlines in the United States as many prominent brands were linked to these facilities including Abercrombie & Fitch, Adidas,

Calvin Klein, H&M, Lacoste, Nike and Puma, most of which cited in their brand literature that they did not support manufacturing operations that were not environmentally friendly. ("Dirty Laundry.") The report led to Greenpeace's call to action of global clothing brands to "champion a toxic-free future" and suspend all environmentally unfriendly manufacturing practices, including wasteful water consumption, so called the "Detox Campaign". ("The Detox Campaign.") "Greenpeace's Detox Campaign is helping create a greener economy by challenging major global brands to rid their textile production processes of hazardous chemicals. The Detox Campaign has already successfully demonstrated the power of grassroots activism and social media in pressuring corporations to clean up their production practices." ("Textile Industry and Water Pollution.")

While water pollution remains a significant challenge for textile manufacturers, at the heart of the matter is water conservation. As mentioned, textile manufacturers consume large quantities of water when making fabric. "Almost all dyes, specialty chemicals and finishing chemicals are applied to textiles in water baths. Most fabric preparation steps, including desizing, scouring, bleaching and mercerizing, use water. And each one of these steps must be followed by a thorough washing of the fabric to remove all chemicals used in that step before moving on to the next." ("Textiles and Water Use.") With competition for water increasing as water tables dwindle, sources of clean water are reduced and the price of water goes up, manufacturers are forced to consider conservation programs, even if they are simply to cut costs.

One such manufacturer that has committed itself to reducing its water footprint is DyeCoo, a Netherlands based company that has developed a waterless dyeing technique utilizing recycled carbon dioxide and modified disperse dyes, a class of dyes used predominantly on polyester. In addition to not using any water, the technology uses no auxiliary chemicals and less energy than conventional dyeing processes, having the potential to cut operating costs nearly in half. (Rodie) In traditional dyeing, fabrics or yarns are placed in a water and dye solution with other chemicals that cause the dye molecules to exhaust into the fibers. As mentioned, this process requires significant amounts of water which are

often pumped out of dyeing facilities untreated. The process used by DyeCoo instead of a waterbath uses recycled carbon dioxide to exhaust dye molecules into the polyester fibers. When heated to a certain temperature and pressurized carbon dioxide enters into what is called a supercritical state. In this state, the carbon dioxide takes on the properties of both a liquid and a gas, making it easy for the dye molecules present in the dye chamber to diffuse into the polyester fibers. The chamber is then “rinsed” by replacing the contaminated carbon dioxide with fresh carbon dioxide, which is then depressurized. When the contaminated carbon dioxide is no longer under pressure, the excess dyestuff, oil and moisture present in the dye chamber separate out of the solution, and almost all of the carbon dioxide can then be recycled and used in subsequent dyeing operations. In 2010, a Thailand-based fabric and garment maker called the Yeh Group launched a line of fabrics using the carbon dioxide dyeing process. In 2012, the well-known activewear company Adidas introduced its DryDye t-shirt collection in select markets in Asia and Europe. (Rodie) "The first run totaled 50,000 shirts — saving enough water to provide one day's drinking water for 750,000 people, or to fill approximately one Olympic-sized swimming pool — and Adidas is expanding its distribution and offerings around the world and across product categories as quickly as production capacities, material and color scope allow." (Rodie)

The textile industry as a whole in a unique position as fabric manufacturers and retailers have acted as great contributors to the issues surrounding Earth's water supply but at the same time are in a position to alleviate the situation through more responsible use of water. This is due in part to an increased awareness by consumers and their interest in purchasing more environmentally friendly products. Many well known companies have joined in on this trend including Levi's, a popular denim company, who in 2011 introduced their WaterLess jeans line. On average it takes 42 liters of water to finish one pair of jeans. Finishing refers to processes done to a fabric or garment after it has been made into a useable material and includes such things as bleaching, softening, and other techniques to improve the hand or performance of a textile. “During the production process, a typical pair of jeans

are “finished” in large washing machines and dryers to create a unique look and feel. Using traditional garment washing methods, the average pair of jeans undergoes 3 to 10 washing cycles – adding up to approximately 42 liters of water per unit.” (Benander) The new Levi jeans utilize 28% less water by combining the multiple wet processing steps into a single process, and incorporating ozone processing into the garment washing. So far Levi's claims they have saved 172 million liters of water with their WaterLess Jeans. With increasing pressure by both political agencies and concerned consumers, it is apparent that many in the textile industry are beginning to realize their impact and are working to decrease their water footprint.

Water conservation methods are not only utilized by individual brands but also by entire governments who have initiated programs to create more water secure textile industries. One such program is the Swedish Textile Water Initiative, launched in 2010 as a joint project between textile and leather companies in the country and the Stockholm International Water Institute. As of May 2012, thirty two Swedish companies had joined the Swedish Textile Water Initiative, all initiating projects that focus on "water issues in the supply chains of textile and leather retailers with the aim of contributing to wiser water management, from thread and raw hide to product.” (“Swedish Textile Water Initiative.”) In 2012, the Initiative published its first set of manufacturing guidelines to be used by the member companies and their suppliers to ensure that they are taking adequate steps in regards to water conservation, as well as wastewater treatment and pollution control. In these guidelines there were three levels or categories that facilitate continuous improvements and to enable factories at all levels of performance to take part in water management and utilize the STWI guidelines. (“Swedish Textile Water Initiative.”)

It is clear that after years of over consumption and poor water management various sectors within the textile industry are working to improve their environmental standing, especially in regards to water conservation. Oftentimes, in conserving water companies not only help in alleviating potential water shortages but also can cut operating costs significantly – yet another benefit of implementing

water saving practices into textile manufacturing processes.

Section III: The Australian Textile Industry's Water Conservation Initiatives

Being second to only Antarctica as the driest continent on Earth, Australia is no stranger to arid conditions. Over eighty percent of the country experiences less than six hundred millimeters of rainfall annually, fifty percent experiencing below three hundred millimeters; most of which falls during their “wet” season that occurs from November to April. (“Australia's Climate.”) Within the past few decades though, as with many other places across the globe, Australia has faced increased water shortages due in part to population increases and climate change, further straining their limited water supply. Dubbed by Australians as the “Big Dry”, their most recent drought, which lasted nearly a decade, left dams at only twenty five percent capacity at its worst point. (Van Dijk) Although the Australian government declared “Big Dry” over in early 2012, the country has and continues to prepare for future water shortages, investing great amounts of money into infrastructure as well as research and development for water management and conservation. These initiatives have come to include the country's textile industry, which in order to accommodate fluctuating water supplies and remain viable in the international market have adopted cleaner production methods, especially in regards to water conservation.

Of the many fibers used extensively by the textile industry worldwide, cotton is by far one of the most widely utilized, with Australia being the world's fourth largest exporter behind the United States, India and Uzbekistan. China is Australia's biggest customer, buying up nearly seventy five percent of their harvest, which in its 2011-2012 season was over five hundred million bales. (“The Australian Cotton Industry.”) “For the last two seasons, the Australian cotton industry has generated in excess of \$2.5 billion in export revenue, making it one of Australia’s largest rural export earners and helping to underpin the viability of many rural communities.” (“The Economic of Cotton in Australia.”) A majority of the approximately fifteen hundred cotton farms in Australia, are family owned and operated and employ roughly eight thousand people across the country. In a normal year these farms

produce enough cotton to clothe five million people. (“Major Commodities – Cotton.”) In a report published by the National Land and Resources Audit of Australia it was stated that the “key issues facing the cotton industry and driving industry strategic direction” are ongoing drought, competition for land and water resources, changing climate scenarios, and market demand for better quality fiber. (“The Australian Cotton Industry – Signposts for Australian Agriculture.”)

As such, the Australian cotton industry has become one of the most water efficient in the world, “producing 'more crop per drop' than any other nation at two and a half times the world’s average yields”(“Water.”). This is due to cotton growers use of a variety of techniques to reduce their water use including in-field moisture monitoring, reducing evaporation, scheduling irrigations, improved soil health and new irrigation techniques such as overhead sprinklers and drip irrigation. Surface irrigation, also known as flood irrigation, is the most common type of irrigation system in the world. Through this process, as the name implies, water is introduced and distributed to crops by the “gravity flow of water over the soil surface”. The water distribution is usually uncontrolled and thus, very inefficient. (Ley) In 1999, Corish Farms, a cotton producer located in Goondiwindi, Australia installed a drip irrigation system. In these systems water is delivered to the plants through a network of pipes and valves directly on to the plant's roots. As the water delivery is localized, less water is used and thus, the system is much more efficient. Over a period of four years, Corish Farms decreased their water use by forty percent all the while decreasing crop stress from flood irrigation, lowering labor costs and increasing cotton yields. (Cross) The cotton industry as a whole, according to Cotton Australia, has achieved similar results, increasing their water productivity by forty percent over the last decade, improving their efficiency three to four percent each year since 2003. (“Water.”)

Australia is not only one of the world's top cotton producers, it is also the world's leader in wool production, supplying twenty four percent of the global wool supply, followed by China, New Zealand, former USSR republics, and Argentina. Australia is also the world’s leading wool exporter, accounting for two-thirds of the world’s wool exports. There are a variety of different types of wool, ranging from

very fine to very course. Fine wool is referred to as merino wool, of which seventy six percent of the Australian sheep flock produces. As merino sheep produce finer wool than other breeds, it is often used to manufacture high quality fashion apparel, while more course wool is used in outerwear and rug making. (“About the Wool Industry.”) Producing fabric from wool fiber is a very involved process which includes numerous steps, many of which are very water intensive. Throughout these various steps, many wool processing companies in Australia have implemented systems to reduce their water usage as well as recycle water as much as they can.

Once a sheep has been sheered, the fiber goes through a washing process called scouring in which impurities present in the wool are removed including dirt, grease and sweat salt. The scouring process uses a lot as the wool travels through a series of hot water-detergent baths to remove the impurities and then additional cold water baths to rinse off the detergent and impurities. (“Wool Scouring.”) Throughout the 1980s due to land and environmental issues in Europe, many European wool companies moved their scouring operations to Australia. One such company was Compagnie D'Importation De Laines (CIL), a French wool producer, who acquired Goulburn Wool Scour in Australia in 1988. Soon after acquisition, CIL implemented a reduce, reuse, and recycle campaign after finding that Goulburn had some environmental issues of its own. In order to reduce water consumption the company substituted some of the initial hot water treatments with a vacuuming process to remove the dirt and grease from the wool fibers. The company also developed a recycling system in which the rinse water is passed through a vat with algae present to remove contaminants in the water, which was then reused in successive scouring procedures, reducing their water consumption by nearly fifty percent. (“Cleaner Production - Goulburn Wool Scour.”) These adaptations of the scouring process served as an excellent example in water conservation to other Australian scouring companies and also demonstrated that Australia could “compete by playing to its natural advantages in wool production and by being better at adding value than the competition” (“Cleaner Production - Goulburn Wool Scour.”).

Once the wool has been scoured, it is combed in order to straighten out the fibers so that they

can be spun into yarn which is then woven or knit and used in the apparel or home furnishings market. One of the premier yarn manufacturers in the country, Australian Country Spinners, has also implemented a water recycling system within their yarn spinning and dyeing processes in order to continue their business in times of water shortages as well as add value to their yarn that is distributed throughout the world. In an audit conducted by the Australian Department of Sustainability, Environment, Water, Population and Communities it was found that each pound of finished yarn the company produced required about thirty three gallons of water. They also found that ninety percent of their wastewater was relatively clean. Thus the company began segregating their water streams in order to recycle the clean wastewater within the plant, reducing their water usage by approximately forty five percent. (“Teamwork Delivering Improved Environmental Performance: Australian Country Spinners.”) “Over a three-year period, water recycling and a range of cleaner production initiatives and methods such as low temperature dyeing technology have improved [the company's] process efficiency translating to a savings in excess of \$1.1 million dollars.” (“Case Studies.”) Even if the environment, or the ability to compete in the global market are not a company's main motives for conserving water, it comes with a host of other advantages including decreasing costs, as seen with the Australian Country Spinners.

By utilizing a variety of water conservation technologies, Australia has become one of the most water efficient countries on the globe. The country can serve as an excellent example of both the government and various industries harnessing the power of research and development to implement water saving measures, especially in regards to their textile industry. While other nations may not presently face such drastic water shortages, it is still important for governments, businesses and consumers alike to take in to consideration implementing more water efficient processes into everyday life as to ensure that necessary water supplies will be present in the future. Those living in developed countries have become used to a world of plenty – plenty of food, plenty of clothes, plenty of shelter, and most important, plenty of water. If they're is not plenty of water, though, as is predicted in years to

come, this world of plenty will soon become a world of scarcity.

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