

Science Fair 2020 Izzy.K - Background

Project Title: Phytoremediation of Calgary Stormwater.

Problem To Solve: Polluted stormwater getting into rivers, and spreading toxic materials into the environment.

(In text citations, and the full website citation is at the bottom of the last page, because there was no room to add it in the boxes). (Everything was changed a bit for what goes onto the tri-fold (background paragraphs)).

STORMWATER ISSUES

Source(s):	Date:	Question:	Notes:
Why stormwater is a problem	Dec.5.2020	What makes stormwater a problem?	<ul style="list-style-type: none"> ● Dirty stormwater can affect rivers and other areas of water, because: ● There are fish, plants, and other wildlife that use that as their drinking source or that's where they live (DC.gov, why is stormwater a problem, N.D.). ● If other people consume that water, by possibly swallowing some or eating a fish that lives in that water, they run the chance of getting sick.

EXISTING STORMWATER MANAGEMENT IN CALGARY

Source(s):	Date:	Question:	Notes:
Storm drains in Calgary Stormwater management	Nov.25.2020	What does Calgary do for storm drains?	<ul style="list-style-type: none"> ● 60,000 storm drains in Calgary (Calgary, Storm Drains In Calgary, 2020). ● 800 outfalls (go right to the river), that's about 75 storm drains that go to each outfall (Calgary, Storm Drains In Calgary, 2020).. ● Basin: <ul style="list-style-type: none"> - "A drainage basin is any area of land where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water" (https://www.dictionary.com/). ● Sedimentation Basin: <ul style="list-style-type: none"> - A sediment basin is a temporary pond built on a construction site. It's to capture disturbed soil that is washed off during rain storms, and protect the water quality of a nearby stream, river, lake, pond, or bay (Dictionary.com, What Are Sedimentation Basins, 2020).
Storm ponds in Calgary	Nov.25.2020	What are wet and dry ponds?	<ul style="list-style-type: none"> ● A dry pond is dry most of the time and can have fields in it (Calgary, storm ponds in Calgary, 2020). ● "During a heavy rain, dry ponds will fill with water very quickly. This prevents the system from becoming overwhelmed, avoiding water backups into basements or flooding into houses, garages or businesses" (Storm ponds in Calgary).

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Water treatment online tour	Dec.4.2020	What filters does Calgary already have?	<ul style="list-style-type: none"> • Basically: They have a few filters to get debris, and chemicals out of the water, but that's after it passes through the rivers, that is for our drinking water. But what happens before it reaches that treatment? Are plants and animals getting sick, what's happening to the environment? • Calgary doesn't have anything that filters stormwater before getting into rivers. So that causes harm to plants and wildlife. Calgary relies on 'signs' and 'messages' by drains, but clearly people still put pultions down the drain. So I'm thinking no more 'dont do that, it's bad', we need to actually build something that filters out polluted stormwater before it affects the environment. <p>(Got the knowledge from: Calgary, water treatment online tour, 2020. I then used that knowledge, and made up my own statement).</p>
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STORMWATER MANAGEMENT IN OTHER COUNTRIES

Source(s):	Date:	Question:	Notes:
China	Dec.6.2020	What does China do?	<ul style="list-style-type: none"> • China demonstrates how green infrastructure, such as planting trees in cities, can address urban challenges, including stormwater run-off, air pollution. It can also generate benefits for communities, for people's health and for the economy. • The Chinese Ministry of Construction investigated 351 Chinese cities in 2010, and found that 65 percent of them had experienced flooding. What's even worse, is the large volume of runoff water going into the sewage system has impaired many cities' ability to treat wastewater. Most Chinese cities are in desperate need of clean water. • The Chinese government began a nationwide stormwater management campaign in 2013. Thirty-two cities of various sizes were chosen across the country to be tested. They were called "sponge cities." Sponge cities are committed to using natural infrastructure for stormwater management. • By planting more vegetation all around the city - on roofs, along sidewalks and in parks, it is helping China become 'a sponge', that retains and filters rainwater. <p>Each of these was cited from: The Nature Conservancy, stormwater management in China's cities, 2020).</p>
Denmark (Europe)	Dec.6.2020	What does Denmark do?	<ul style="list-style-type: none"> • BEST • DPF (dual porosity filtration) filters contain two thin, horizontal layers stacked one above the other. As runoff from streets flows from collection systems into the underground, the DPF filter uses gravity. It brings along dust, rubber, asphalt, heavy metals, and other contaminants. The runoff travels freely along the top layer, made up of a highly porous nylon netting. While moving along the top layer, gravity forces suspended solids in the runoff downward into the bottom layer, which features a limestone filtering mat. • The filter itself consists of about 30 sets of these layers arranged in a small box with ingoing and outgoing tubes. You just have to align more boxes next to each other, to build a chain. Its flexibility also brings the potential for an eventual household-scale device, according to a UC press release. • Testing at the demonstration facility, showed that the DPF method consistently reduced runoff contaminant loads from more than 100 mg/L to less than 5 mg/L, that's a 95% decrease. The DPF does not need chemicals or power to run. It is odorless, and makes almost no sound.

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			<p>Clogging is not an issue, and the mats require replacement or 'regeneration' only about once per year.</p> <p>Each of these was cited from: (StormWater.wef.org, Denmark demonstrates footprint-free stormwater treatment method, 2019).</p>
South Korea	Dec.6.2020	What does South Korea do?	<ul style="list-style-type: none"> • (Rainwater, not stormwater)? • Rainwater is collected from the rooftops via gutters, which flows to a sedimentation tank. This in turn connects via piping to the rainwater tanks, installed below ground. In the sedimentation tank a 500 micron filter strains particles from the water, and the rainwater tank itself works as a sedimentation basin. It is pumped inside the home and it is used directly for non-drinking purposes, and UV treatment is applied for drinking water. <p>Each of these was cited from: (WaterWorld, South Korea, 2020).</p>
USA	Dec.6.2020	What does the USA do?	<ul style="list-style-type: none"> • During periods of heavy rainfall or snowmelt, some wastewater systems are designed to occasionally overflow and discharge excess untreated sewage directly to nearby streams, ponds, rivers or other bodies of water. These discharges are known as combined sewer overflows. • Green infrastructure can be used to address stormwater runoff and sewer overflow problems. Green infrastructure works by slowing down the runoff, spreading it out over the land, and slowly soaking it into the ground, or in some cases reusing the water onsite. Green infrastructure is also sometimes referred to as "low impact development." These techniques also help to remove pollutants from runoff by allowing plants to filter out pollutants as the water slowly infiltrates into the ground. Some examples of green infrastructure techniques include rain gardens, pavement, rain barrels and green roofs. <p>Each of these was cited from: (EPA, Sources and Solutions: Stormwater, 2019).</p>

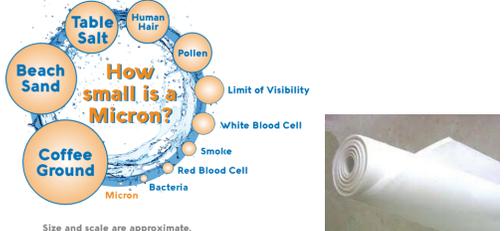
STORMWATER TREATMENT CONCEPTS/IDEAS

Source(s):	Date:	Question:	Notes:
Green Calgary	Dec.5.2020	What are the best types of filters out there (natural & manmade)? CHANGED FOR TRI-FOLD	<ul style="list-style-type: none"> • (This would be a cool fact to state in the beginning of my project, a section on my trifold): • "Did you know that 80% of Calgary's storm drains go directly to the river? That means that anything that goes down the storm drain, including runoff from the street and your yard, goes directly into our Bow and Elbow Rivers?!" Each of these was cited from: (Green Calgary. N.D.).
Lenntech.com	Dec.5.2020	Can oxygenation help clean water? (natural filter) CHANGED FOR TRI-FOLD	<ul style="list-style-type: none"> • Natural stream purification processes require a lot of oxygen, in order to provide for life forms that need oxygen. • (If I could create something in the river right when it comes out of the pipes. It could be a process where water goes over rocks, certain plants, as a natural filter. Talking to my dad: We think it would be too complicated to make something in the pipes, because the cold would most likely affect it, and it would have to be cleaned, thinking about how often and accessibility). <p>Each of these was cited from: (Lenntech, Why Dissolved Oxygen is Important, 2018).</p>

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Storm drain filters	Dec.7.2020	Possible product to consider?	<ul style="list-style-type: none"> The 'Hydro Kleen Filter' is a tool that's a specific model that installs directly into catch basins and street drains. It is built with filters that target specific pollutants, these tools work to address material to an important location. Ultra-Storm Drain Filters can go in any gutter, inlet or drain. Designed for long term stormwater filtration, these storm drain filters are inserted directly into the drain, so it's not too obvious to see. It's made from a high-resistance polyethylene material and installs easily to the outflow pipe located within the storm drain. This process works by first allowing debris, oil, silt and sediment to enter the drain, then the water. <p>Each of these was cited from: (GEI Works, silt barriers, 2020).</p>
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QUESTIONS I HAD

Source(s):	Date:	Question:	Notes:
N/A	Dec.7.2020	What are 'limestone filtering mats'?	<ul style="list-style-type: none"> It's basically like a filter. It's just thin like a mat.
Micron filters	Dec.7.2020	What are 'micron filter strains'?	<ul style="list-style-type: none"> It's a filter to catch really tiny particles. Each of these was cited from: (InspiredLiving.com, what is a micron rating, 2016). <div style="text-align: center;">  <p style="font-size: small;">Size and scale are approximate.</p> </div>
Polyethylene	Dec.7.2020	What is 'polyethylene material'?	<ul style="list-style-type: none"> Polyethylene is a lightweight, durable thermoplastic with a variable crystalline structure. It is one of the most widely produced plastics in the world. Each of these was cited from: (Omnexus, polyethylene (PE), 2020).

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Teacher Told Me To Add

Source(s):	Date:	Question:	Notes:
Plants Clean Water	Dec.13.2020	What are the benefits of plants in water?	- Every aquatic plant cleans water. Aquatic plants filter out minerals, carbon dioxide, ammonia, nitrates and nitrites. This filtering of the water helps keep the water clean. Aquatic plants convert carbon dioxide into oxygen which aerates the water.
	Dec.15.2020		
	Dec.16.2020	How does oxygen filter water?	JUST IN THE PARAGRAPHS DOCUMENT

(For the paragraphs on a separate document, I had other 'titles' but the teacher told me to take it out, and I added 'What are the benefits of plants in water?') (Also removed 'I') (Also added pictures and my ideas into paragraphs).

[Water | Free Full-Text | Constructed Wetlands for Wastewater Treatment | HTML \(mdpi.com\)](#)

Abstract 1

"...The aim of this work is to present a review on the application of wetlands as "living" filters for water purification, with special emphasis focused in the removal of micropollutants, especially xenobiotic organic compounds such as pharmaceuticals and pesticides residues, which are not efficiently removed by conventional wastewater treatment plants. Furthermore, the role of wetlands as protection zones which contribute to the improvement of the aquatic ecosystems' quality will be discussed."

Abstract 2 \$

"... Constructed wetlands can be designed to maximise the removal of both nutrients and pathogens by enhancing macrophyte diversity and natural disinfection processes by incorporating lagoons, shallow-water wetlands and subsurface-flow wetlands into the treatment train."

"... This paper addresses the role of constructed wetlands in nutrient and pathogen removal in Queensland's wetlands, and presents three case studies with respect to effluent reuse."

Abstract 3 \$

"Phytoremediation of metals is a cost-effective "green" technology based on the use of specially selected metal-accumulating plants to remove toxic metals from soils and water. Wetland plants are important tools for heavy metal removal."

Abstract 4 \$

"Turfgrass benefits... enhanced entrapment and biodegradation of synthetic organic compounds..."

Abstract 5 \$

"The plant species were Buffalograss 609 and Big Muhly, both commonly found in Texas. The results of this study showed a significant improvement in nutrient removal with the presence of these plants in the filter."

Abstract 6 \$

"Phytoremediation offers a cost-effective, non-intrusive, and safe alternative to conventional cleanup techniques. In this study, we used ornamental hydrophytes plants as constructed wetlands to treat urban or rural domestic wastewater. "

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Phytoremediation

Phytoremediation technologies use living plants to clean up soil, air, and water contaminated with hazardous contaminants. It is defined as "the use of green plants and the associated microorganisms, along with proper soil amendments and agronomic techniques to either contain, remove or render toxic environmental contaminants harmless".

ADDITIONAL TERMS TO SEARCH ABSTRACTS:

- ~~Bio-filtration~~
- "Constructed wetlands for wastewater treatment"
- ~~Phytoremediation~~
- Eco Sustainable water treatment

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Some Ideas I Have:

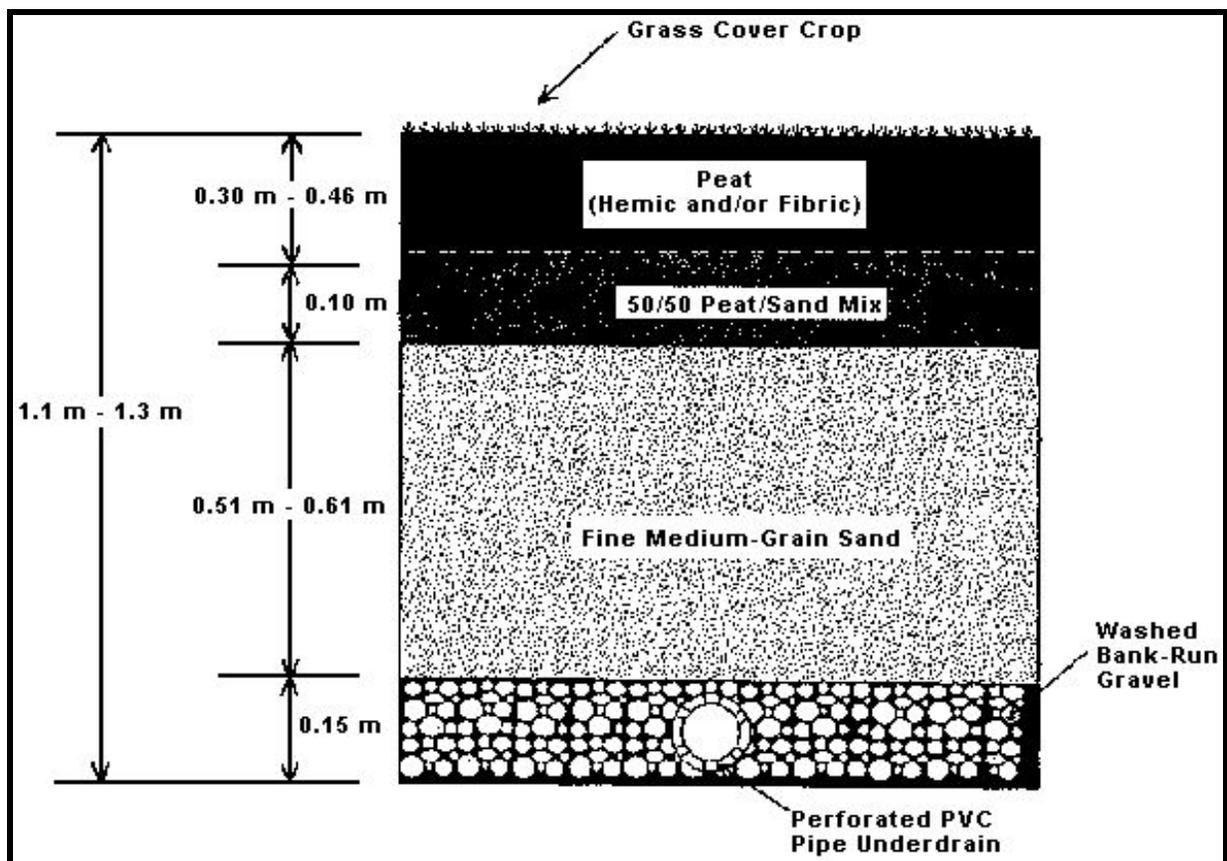
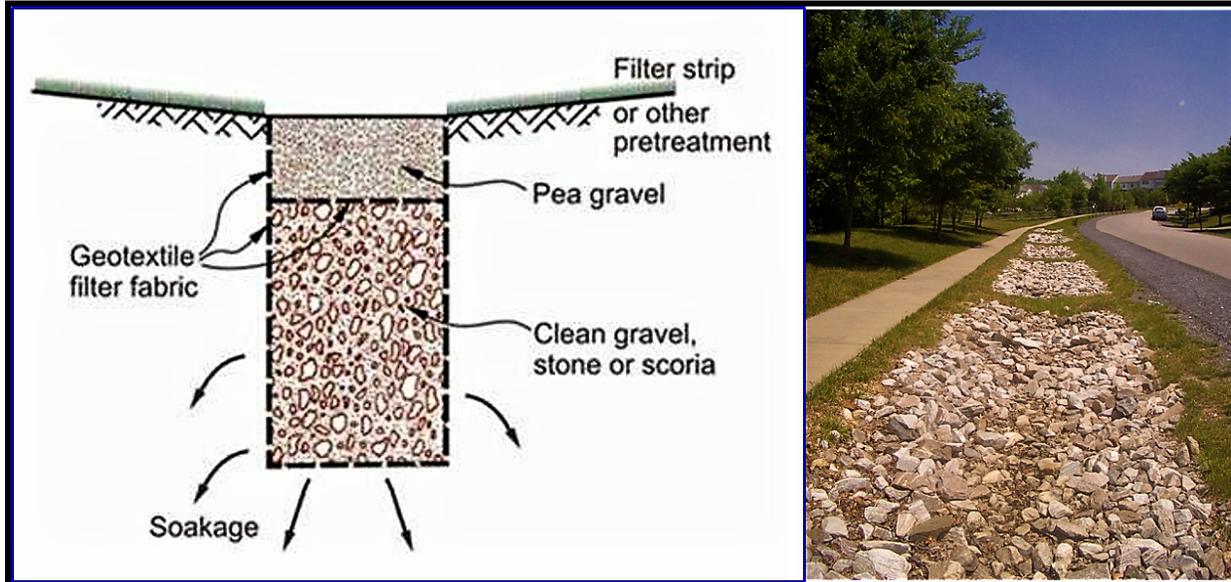
- A lot of places around the world use natural things to filter out stormwater.
- **Idea 1:** Make a 'whirlpool', that as stormwater comes out of the outfall into the river, there would be 'fences' that push the water in a circle. By doing that, it can move the water over top of plants (will add some), and over rocks, causing it to filter itself through oxygenation, before entering the main river current.
- **Idea 2:** Pre-built filtration assembly that is inserted into the outfall pipe by the river. This unit would be removable for cleaning and maintenance.
- You start with an idea, do your investigation, and you determine if it's feasible or not.
- It is very challenging to come up with an idea that will work and be cost effective. This is probably why Calgary doesn't have something already. That's why it would be important to FULLY teach people why it's important to watch what you put down storm drains.
- **Idea 3:** Thought about the idea of installing 'fences' into the water that had filters on it, but realized it wouldn't work, because of the fish not being able to swim through.
- **Cost:** I am **NOT** going to make something that goes right under each storm drain, because the cost would be too much, and the matince would be too much work. Example: If there are 60,000 storm drains, that's 60,000 X (money). It would be more than \$100, but even if it was \$100, that's **\$6,000,000!** So it makes more sense to treat stormwater at the 800 outfalls near the river (eg, $\$100 \times 800 = \$80,000$).

Challenges To Consider:

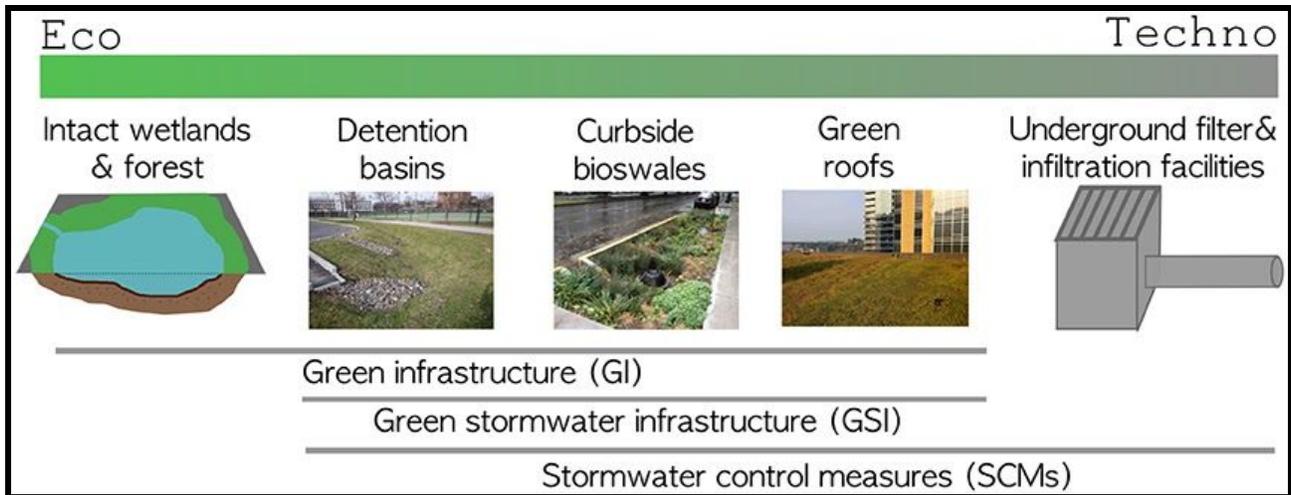
- Seasonal weather changes (freezing and thawing).
- Available space above and below ground.
- Overall cost.
- Maintenance (cleaning and repairing).
- Impact on the surrounding environment (eg, fish, plants, etc).
- Variable water flow (eg, heavy rainfall, snow/ice melt, Chinooks).
- Unintended discharge of collected pollutants.
- Unwanted water flow obstruction and backup.

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Pictures (random):



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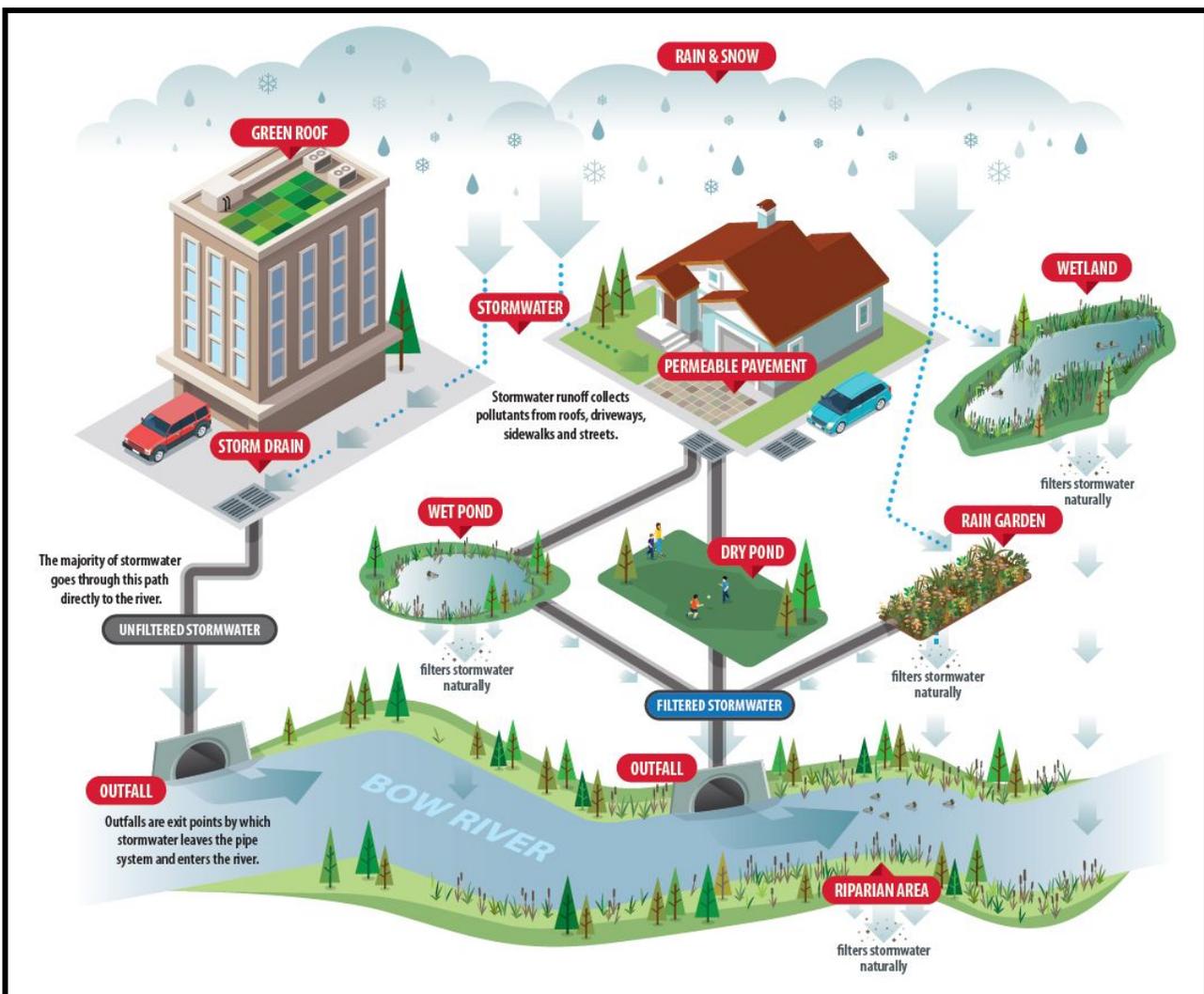
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Pictures (from sources): Calgary:

Referring To The Picture Below:

In many Calgary communities there are effective stormwater treatment designs built into the landscape. For 20% of the total stormwater, these provide natural filtration using wet/dry ponds, rain gardens, and wetlands. Stormwater from these areas does not need further filtering.

However, where 80% of stormwater drains directly into the river, that is the focus of my innovation project.



(City of Calgary, stormwater management, 2020)

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China:

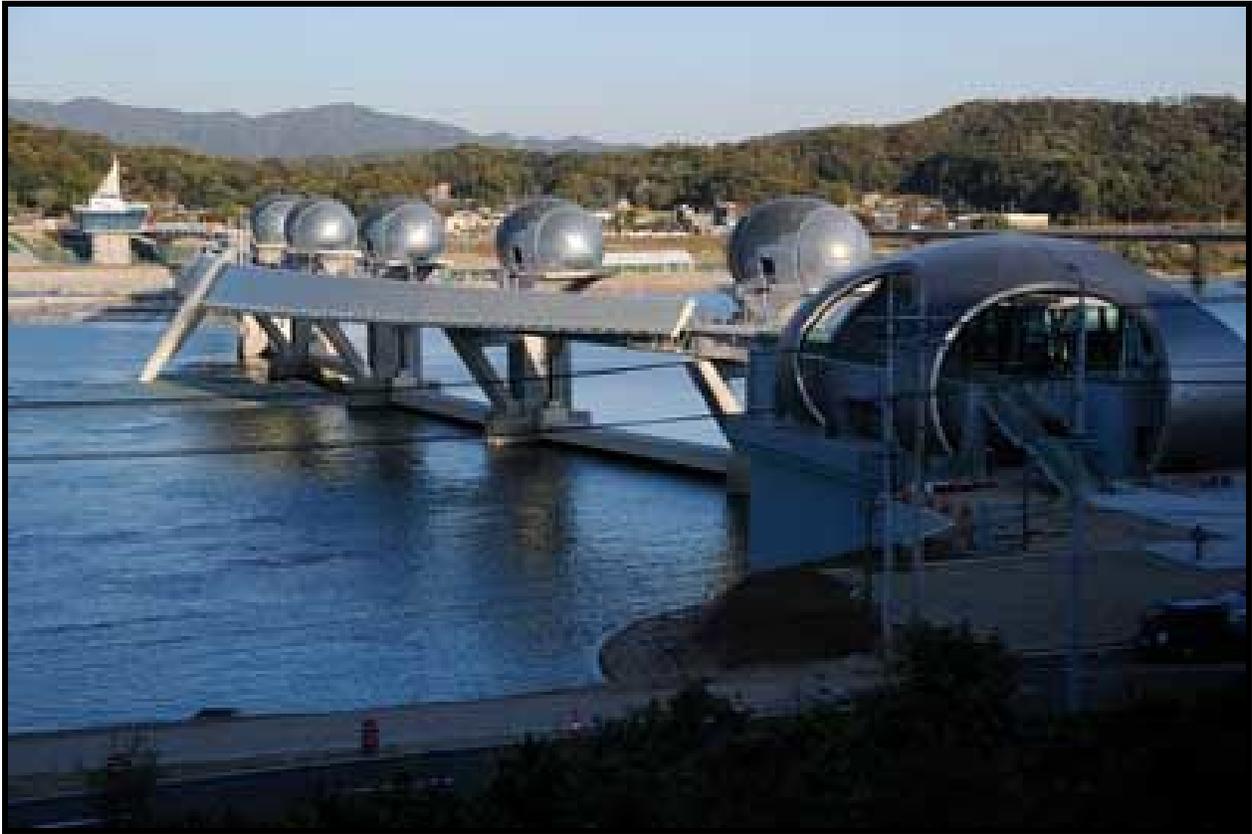


Denmark:



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South Korea:



USA:



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Bibliography (from here to the last page):

I used 'bibme', but after I did a couple, it asked me to pay, so I had to make my own. (In order I put the websites, is the order of them cited). (Did these citations three different times, and had to re-do them all because they were wrong, they should now be correct):

STORMWATER ISSUES: [Why stormwater is a problem](#)

Why is Stormwater a Problem? (n.d.). *Department of Energy & Environment*. Retrieved on 2020 December 05, from <https://doee.dc.gov/service/why-stormwater-problem#:~:text=Stormwater>.

EXISTING STORMWATER MANAGEMENT IN CALGARY: [Storm drains in Calgary](#) [Stormwater management](#) [Storm ponds in Calgary](#) [Water treatment online tour](#)

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STORMWATER MANAGEMENT IN OTHER COUNTRIES: [China](#) [Denmark \(Europe\)](#) [South Korea](#) [USA](#)

Stormwater Management in China's Cities (2020). *The Nature Conservancy*. Retrieved on 2020, December 06, from <https://www.nature.org/en-us/about-us/where-we-work/asia-pacific/china/stories-in-china/stormwater-management-in-china-s-cities/>.

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STORMWATER TREATMENT CONCEPTS/IDEAS: [Lenntech.com](#) [Storm drain filters](#) [\(Green Calgary \(NA\)\)](#)

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Ultra-Storm Drain Filters (2020). *GEI Works*. Retrieved on 2020, December 07, from <https://www.silt-barriers.com/stormdrainfilters.html>.

CHANGED FOR BACKGROUND PARAGRAPHS