Improving Water Quality and Advancing Climate Change Adaptation in Tantramar with Rain Gardens and Other Low Impact Developments

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Introduction

EOS Eco-Energy received support from Eco Action to plant and monitor a series of rain gardens, and organize and monitor depaving events. Rain gardens will be planted in targeted areas of the greater Sackville region prone to flooding. Stormwater runoff from some of these areas can also negatively impact water quality of the Waterfowl Park due to pollutants and sediment accumulation.

Rain gardens are depressions a few inches deep planted with native water-loving and drought tolerant plants that slow and absorb stormwater.[1] EOS will plant 16 to 20 rain gardens over the course of summers 2019 and 2020 on residential properties in flood-prone areas. The average size per garden will be about 100sq ft. It is beneficial to have many smaller rain gardens throughout a flood-prone area to help slow and absorb water in numerous locations. Success is ensured because homeowners will volunteer to have a rain garden and will commit to looking after it.

This project will also showcase other low impact developments (LIDs) by doing one larger community-based "depaving" event per year (for a total of 2-3 over the course of the project). At these events, pavement is dug up and replanted with plants and/or permeable pavers, asphalt, etc.

EOS will monitor the gardens and de-paved spaces, taking note of runoff, sediment, etc. before the gardens and LIDs are installed and after. We will talk to local residents and collect photos and details about localized flooding. After gardens are planted we will monitor for improvements and also check on the number of native plants that survive from year to year. We will keep track of participants and volunteers who learn more about climate adaptation and change their behaviours by planting their own rain gardens with the use of before and after surveys.

This project forms part of additional work by EOS Eco-Energy to address climate change impacts on environmental and human well-being. Specifically, the larger project examines: (1) water quality across the Tantramar River Watershed including monitoring 12 sites for a full suite of water quality parameters; and (2) community-based workshops for Canadians on climate change actions, adaptation, and ways to reducing their climate-related stress and anxiety.

[1] Bilingual EOS how-to guides on rain gardens are available on the EOS website at: https://eosecoenergy.com/fr/wp-content/uploads/2018/10/sm-FR-Rain-Gardens-How-to-Handout-for-Tantramar.pdf and https://eosecoenergy.com/en/wp-content/uploads/2018/03/sm-Rain-Gardens-How-to-Handout-for-Tantramar.pdf

This report summarizes our activities during year 1 of the project which included planning the first set of residential rain garden projects and community depaving project. It also involved water quality monitoring and a series of workshops and educational events.

Priorities and Objectives

The project priorities are:

1. Canadians will build climate resilience through living natural infrastructure, such as rain gardens (main priority)
2. Contribute to the diversion and reduction of substances that negatively affect water quality
3. Contribute to reducing climate-related hazards and disaster risks, specifically fresh water flooding
4. Canadians will contribute to the conservation and sustainable use of Canada's fresh water since rain gardens help recharge groundwater sources

The project objectives are:

1. Improve water quality of the Sackville Waterfowl park, storm water runoff and ground water in general where rain gardens are planted.
2. Increase local resiliency to climate change induced flooding and droughts using natural infrastructure (rain gardens, low impact developments).
3. Reduce climate change induced fresh water flood risks.
4. Improve and restore land to more natural features (rain gardens are planted with native plants, act like a wild meadow, and double as pollinator and butterfly gardens)
5. Increase capacity of local Canadians (including indigenous, youth, small businesses and the general public) to adapt to climate change using simple techniques.

Methodology: Our Process for Success

During year 1 of the project (2018-2019) we undertook the following steps:

1. Promoted the opportunity for rain gardens in flood prone areas of downtown Sackville by way of bilingual posters (see below), social media posts, press releases, information booths, our newsletter and website. One of the press releases can be seen here: https://www.sackvilletribunepost.com/community/eos-eco-energy-launches-rain-garden-program-in-sackville-250955/
2. Visited 10 properties in down Sackville, met with homeowners, decided on garden locations and designs, shapes, plants, etc.
3. Took photos and drew 10 garden site plans.

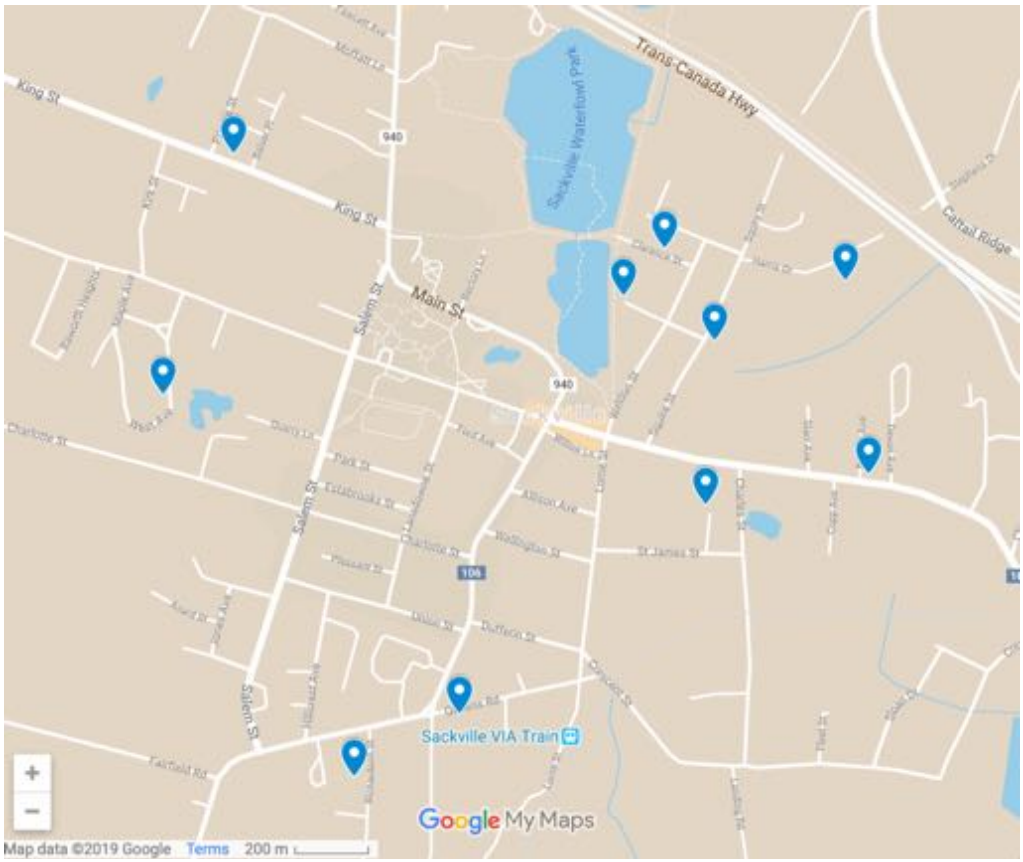
4. Sourced and ordered plants through our local nursery called Anderson's Greenhouse, which has agreed to store and look after the plants until we need them.
5. Took photos of flood events in downtown Sackville.
6. Monitored water quality in the Tantramar River watershed monthly from May to October.
7. Researched depaving projects, surface cover options, sources and prices (see the Appendix for a summary of our findings).
8. Sought interest in a depaving project(s) and obtained co-operation from the Town of Sackville to depaving a parking area at the Visitor Information Centre.
9. Designed and priced the depaving project, took photos and made sketches.
10. Organized and hosted a series of workshops on climate change, eco-anxiety and adaptation issues.

Bilingual posters promoting the rain garden program.

Residential Rain Garden Plans and Pre-Monitoring

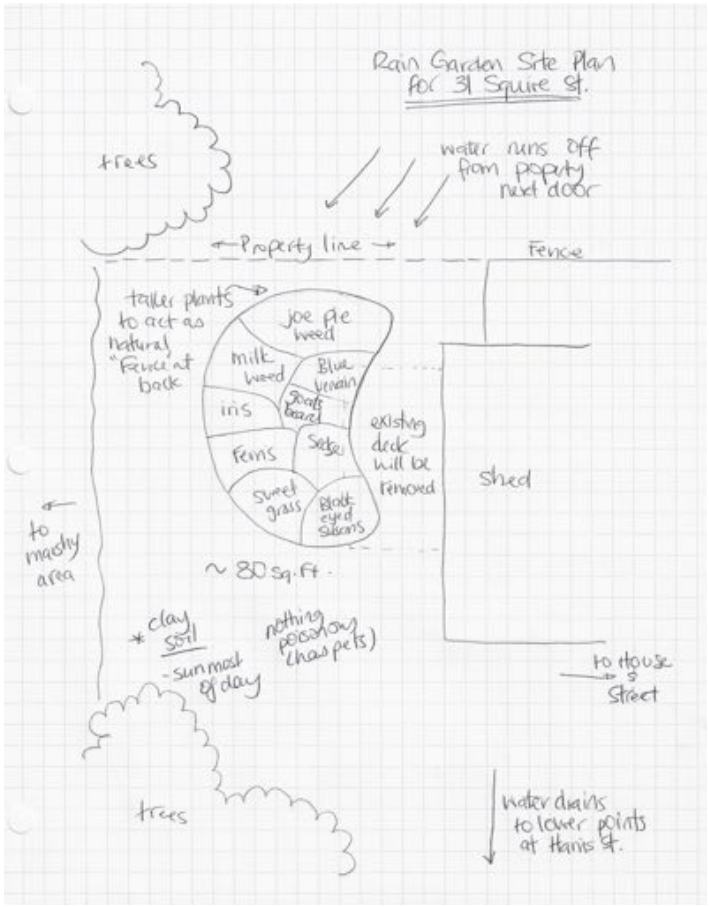
During fall 2018 we visited 10 residential properties in flood-prone areas of downtown Sackville. They are represented on the following map. Rain garden locations for year 1 represent a good distribution around town with gardens near the Sackville Waterfowl Park (King St, Morgan Lane, Squire St, Clarence St, Harris St), uphill from the Lorne St. area which has suffered from chronic flooding issues (Bennet St, Queens Rd, Bridge St, Richardson St), and finally near the Quarry which is an area of higher elevation that drains down through town (West Ave). We developed garden plans for each location and plan to plant them during spring and summer 2019 (year 2 of the project).

Map of Rain Garden Project Locations



31 Squire St

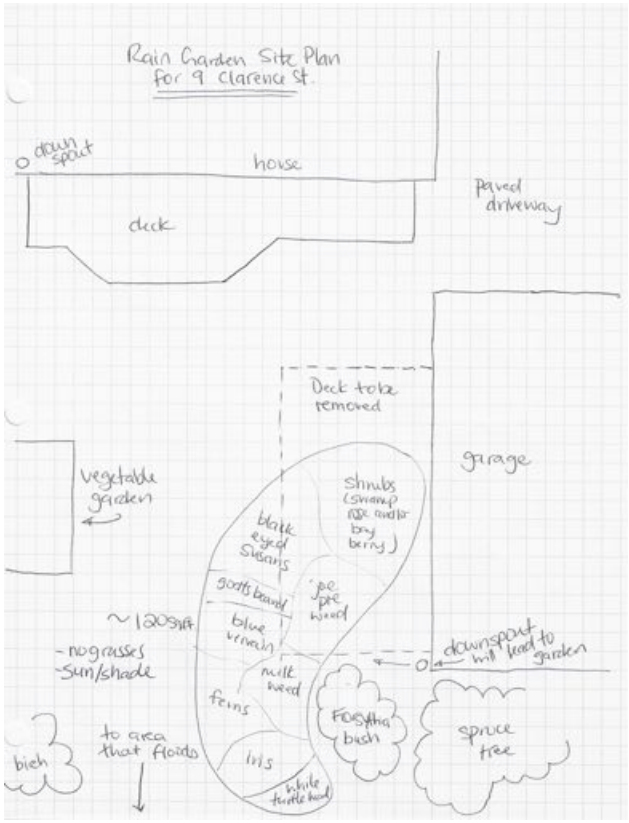
The rain garden will be planted in the back yard to catch rain from the neighbour's property and from a shed roof. A lower section of Squire St further down the road can be flooded during rain events so this rain garden will help with flooding in the Squire St area, which is near the Sackville Waterfowl Park.



Note: remainder of old deck will be removed and rain garden planted.

9 Clarence St

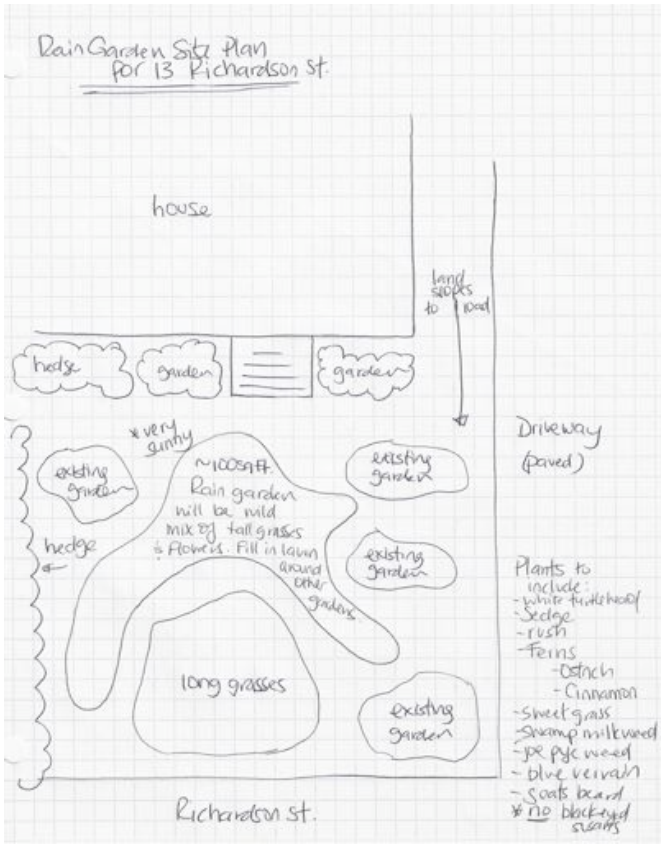
Rain garden will be planted by the garage where the homeowner will remove the deck. It will catch water from roof of garage, driveway, and land to try and let it absorb more into the ground before leading to flooding further down the property. This location is also very close to the Sackville Waterfowl Park.



Note: Deck will be removed by shed and garden planted there to help decrease flooded area in back yard.

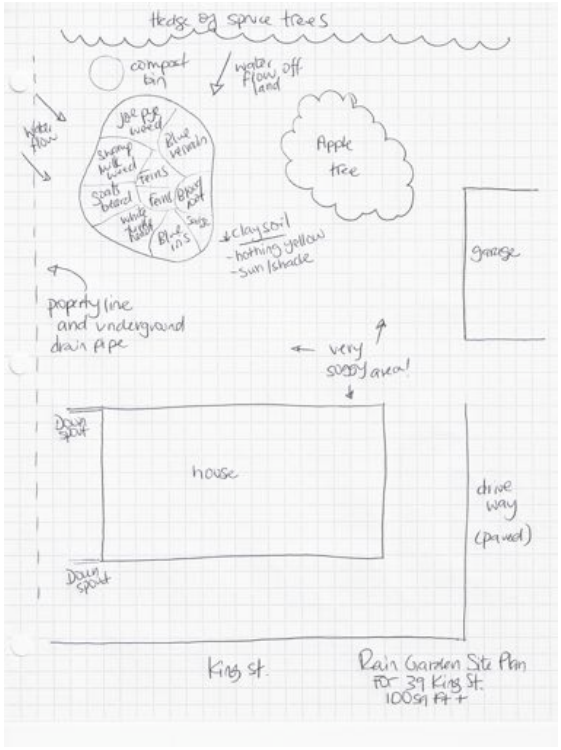
13 Richardson St

This garden will be placed in a publicly visible location on the front lawn. This is a busy street which leads to an entrance to Salem Elementary School. Areas around this property are lower lying and impacted by floods and poor drainage including Salem Elementary School and towards Lorne St and the marshes. The homeowners reported getting some water in their basement during rain events, so the garden will help draw water away from the house and let it absorb into the ground. The garden will be a free form shape to fill in around existing gardens with the ultimate goal for the homeowner of having a grass-free, natural lawn.



39 King St

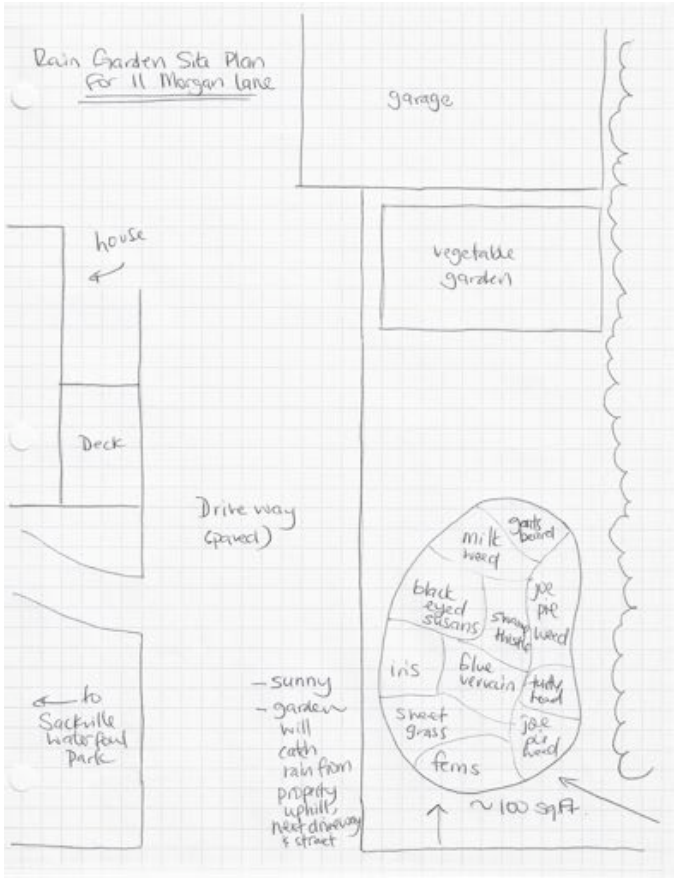
The garden will be in the back corner of property to left of apple tree and somewhat visible from the street. It will catch runoff from the neighbour's property and the land to try to reduce sogginess of back yard. Further down King St, water will pool at the end of the street by an entrance to the Waterfowl Park during rain events.



Looking at back of property toward row of spruce trees.

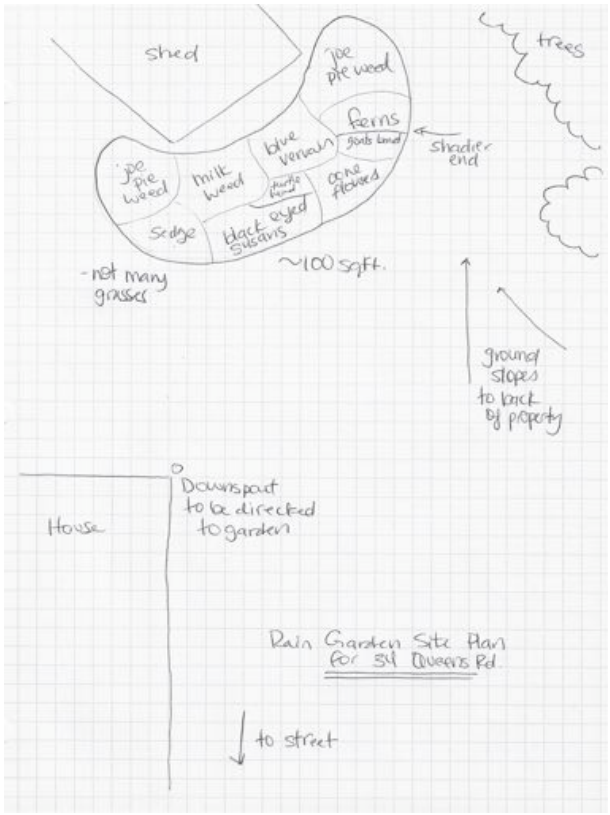
11 Morgan Lane

The garden will be located to the right of the driveway. It will catch rain from the neighbour's driveway and from Morgan Lane. This garden is an ideal location and will help limit runoff and sediments from reaching the Waterfowl Park.



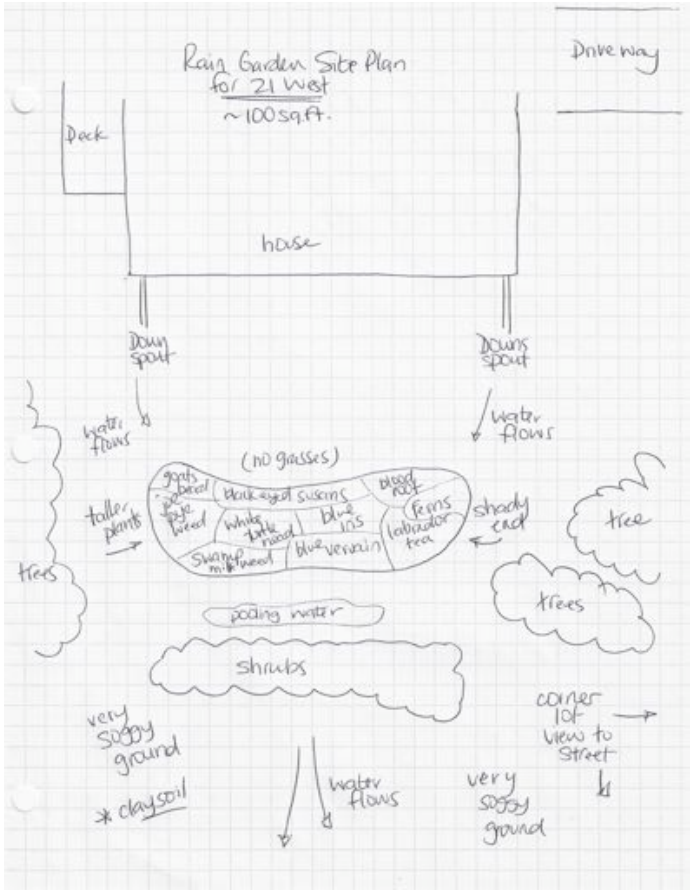
34 Queens Rd

The garden will be located to the side of house at the back corner, visible from road, and around shed. It will catch water from the shed roof and house roof. The homeowners noted that rain water will run across their driveway and down toward Lorne St, a low-lying area with chronic flooding problems.



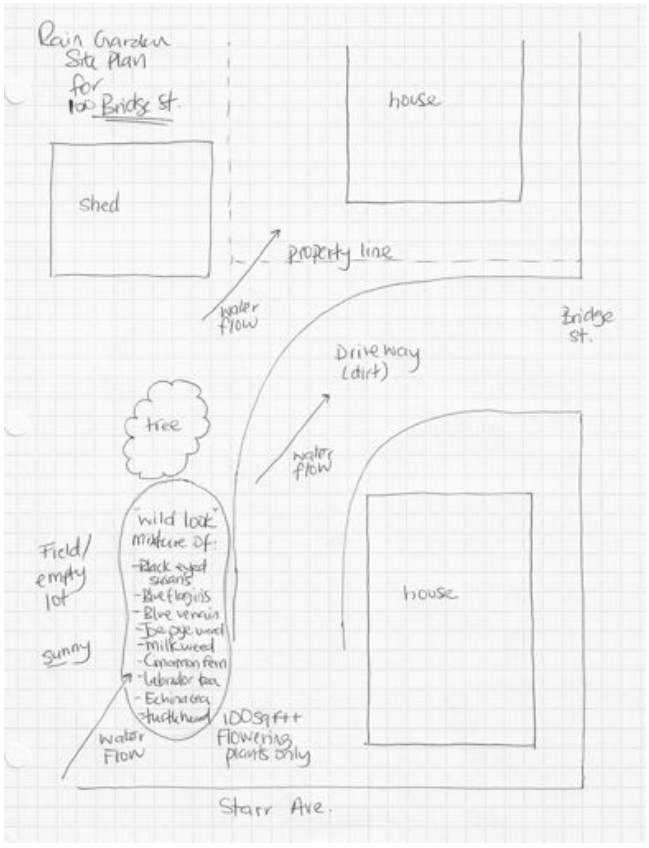
21 West Ave

The rain garden will be located to the side of the house and catch rain from the downspouts. Runoff goes toward the side lot beyond the garden location and some runoff in the general area will go towards the Quarry, some will go further downhill and back up in culverts on Maple Ave, another area known for localized flooding. The property has a lot of clay soil and water was seen laying on the lawn as we visited just after a fall rain storm.



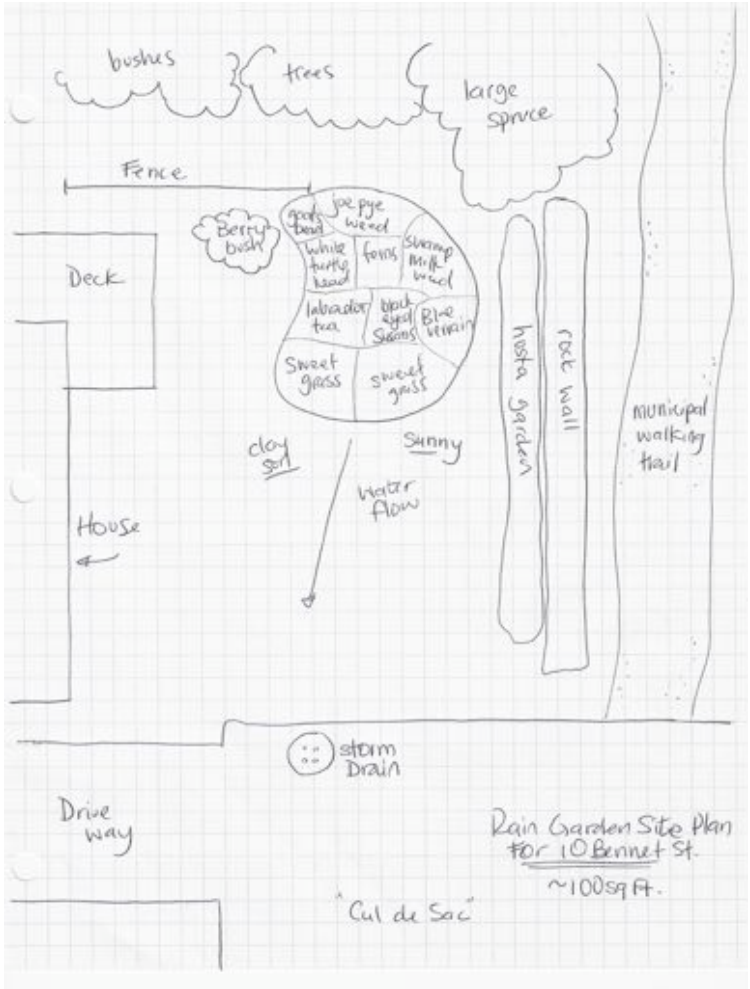
100 Bridge St

The garden will be placed at the edge of the driveway by the back field, visible from Starr Ave and will collect rain from overland and further uphill on Starr Ave. It will help to limit water and sediment making their way over the driveway to storm drains on Bridge St.



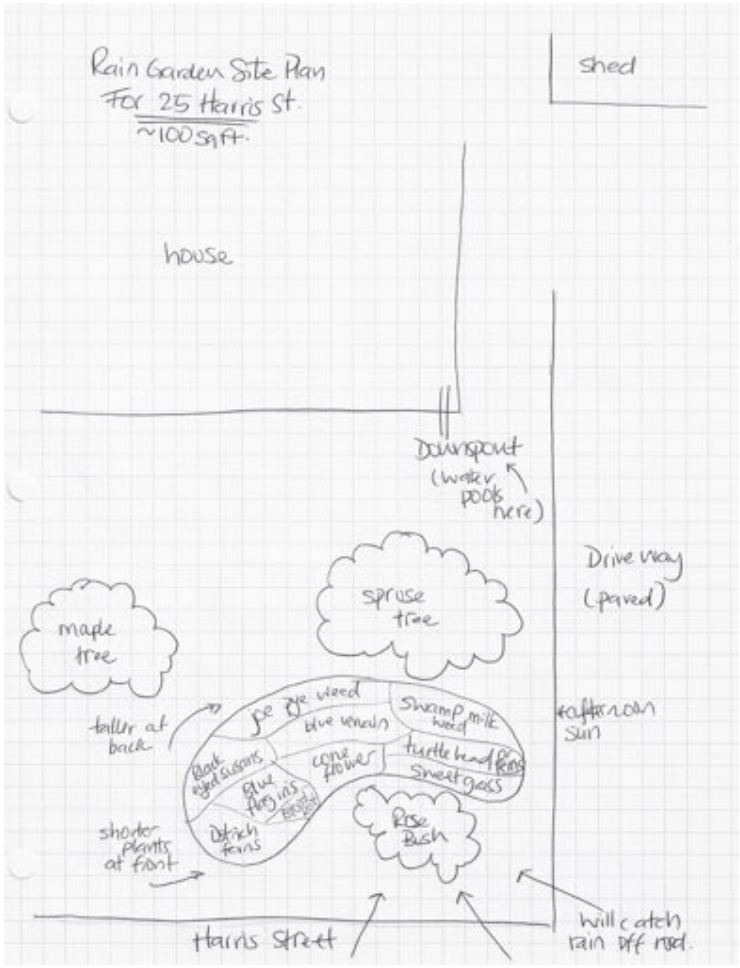
10 Bennet St

The rain garden will be located on the front lawn near where water is known to pool and then travel to storm drains on Bennet St. The area is also close to Lorne St. This garden will be highly visible as it is beside a walking trail.



25 Harris St

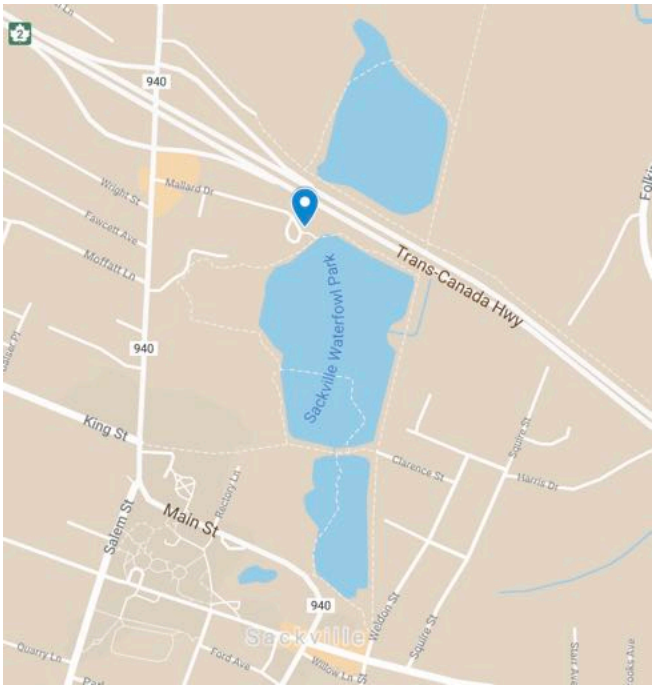
At this property water pools mostly in spring by front corner of lawn near driveway, and there can be water in the shed. It also pools by front eavestrough. The garden will be located in a highly visible area on the front lawn and will help catch rain from the front corner downspout. Flooding is known to occur further downhill on Squire St, near the Sackville Waterfowl Park.



Depaving Project for Year 2

For our first depaving event we have chosen the Sackville Visitor's Information Centre (VIC) at 34 Mallard Drive in Sackville, NB. This is a great location with lots of public exposure from people coming in off the Trans-Canada Highway to check out the VIC or walking by from the Sackville Waterfowl Park.

Location of Sackville Visitor's Information Centre & Future Depaving Site



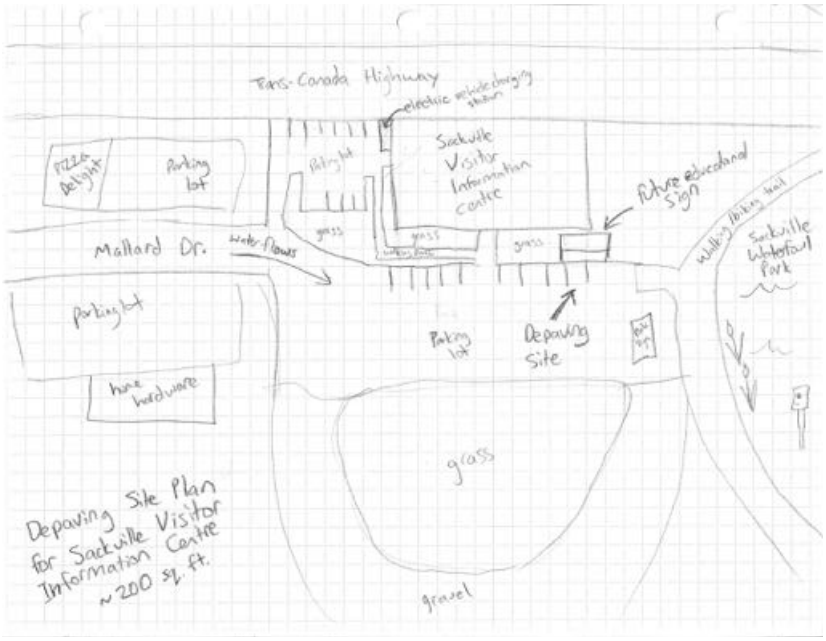
An educational sign will be put in place to help the public understand what permeable surface cover is used and why. This site will be used as a demonstration/ educational site for depaving and permeable pavement. In addition to the proposed depaving site, EOS has previously put in an electric vehicle charging station at the VIC and has helped plan a 3D interactive watershed model that will be available to the public at the VIC for educational purposes.

EOS plans to depave at least 1 parking space (9 x 18 ft, or 162 sq ft) in front of the VIC and the Sackville Waterfowl Park entrance. These spots receive runoff from the parking lots from up slope businesses (as seen in the photos below). We plan to remove the existing pavement and replace it with permeable asphalt so that the parking area can still be used for parking. Permeable asphalt is one of the few products that will allow the area to still be cleared of snow easily by plows in the winter without ruining the surface. The town of Sackville has agreed to provide a pavement cutter to chunk up the pavement, disposal/recycling of the asphalt, and preparation of the fill for under the permeable asphalt.

Parking area by the Sackville VIC is the site of our first proposed depaving project.

Looking up Mallard Drive from the parking space to be depaved. The parking area is in a lower lying area that receives runoff from further uphill.

Further downhill is the Sackville Waterfowl Park. Permeable surface cover will help reduce runoff reaching the Park.



Site plan for proposed depaving project at Sackville VIC.

See the Appendix for a summary of research into depaving work including types of surface covers, and sourcing for the products in the southeast New Brunswick area.

Summary of Water Quality Report

The EOS Eco-Energy long-term water quality monitoring program started in the Tantramar River Watershed. Water samples were collected from 12 sites across the Tantramar River Watershed from June to September and sent to the RPC Laboratory in Moncton for analysis. In addition, in-situ measurements were taken (pH, temperature, conductivity, dissolved oxygen, total dissolved solids, salinity) from the 12 sites from May to October using a Hanna Multiparameter Meter. This water quality report compiles and summarizes these results which will be used as a baseline of water quality moving forward.

The objective of this report is to establish a baseline of water quality in the Tantramar River Watersheds, with the intention to continue with a long-term water quality monitoring program. This data will help us gain a better understanding of our watersheds and could lead to the undertaking of any necessary restoration or protection activities, ultimately ensuring healthy watersheds, sustainable ecosystems and resilient communities. This knowledge could also be used to educate the public on local watershed issues and how they connect to climate change in our region.
The Tantramar River Watershed is focused around the Tantramar River whose headwaters start northwest of Cookville and wind down to the Highway 2 (TCH) near Sackville, New Brunswick. The watershed also has another > 4th order river, the Aulac River. Both rivers ultimately flow into the Cumberland Basin of the Inner Bay of Fundy. The rest of our watershed is made up of a series of brooks and creeks.

Water samples were collected from 12 sites across the Tantramar River Watershed from June to September which resulted in 52 samples being collected. Samples were analyzed at the RPC Laboratory in Moncton. The lab analyzed the samples for 58 parameters for each sample resulting in 3016 data points. In addition to water samples, in-situ measurements were collected using a Hanna Multiparameter Meter from the 12 sites from May to October resulting in 432 additional data points, for a total of 3448 data points collected over the course of the field season.

The water quality results were compared to provincial water quality guidelines, CCME water quality guidelines for the protection of aquatic health, and Health Canada Guidelines for Recreational Activities. While we could speculate on some of the potential causes for variations between sites and fluctuation in parameter concentrations, this is just the first year of data collection in our monitoring program. More years of data are required to look at trends and relationships within the water quality data.

The summer of 2018 was warm and dry resulting in water levels being generally low across sites. This likely led to the higher water temperatures that exceeded the CCME guidelines of 20oC we saw in July to September. Generally, we saw the temperatures exceeding the guideline in our more impacted waterways. In-situ water pH was within CCME guidelines (6.5 –

9) for the most part, with the exception of East Brook with was below the CCME guideline from May to October. Dissolved oxygen was below the New Brunswick guideline (6.5 mg/L) in June to September which could correspond with the high temperatures as DO decreases with increased temperature. There are no water quality guidelines for conductivity, TDS, and salinity. However, all three were typically higher in our more impacted rivers and creeks, with the exception of Harper Brook. All three were also significantly higher in our Aulac River site. E. coli levels only surpassed the Health Canada Recreational Guidelines on 4 occasions. From June to September total phosphorus levels frequently exceeded the New Brunswick guideline (0.03 mg/L) 63.8% of the time (30 samples exceeding the guideline and only 17 coming out below the guideline). Most of our sites are considered eutrophic. Surface water metals were well below the detection limits, aside from iron and aluminum which were both above the CCME guidelines for 7 of the sites.

Overall, EOS had a very successful first year of water quality monitoring that provided us with valuable baseline data that can be used to ensure the health of our watershed. Alongside this it has given us the opportunity to better understand our watershed and the opportunity to have it documented. This project was a great first step towards building a long-term water quality monitoring program within the watershed. As we continue to collect more data we will be able to see trends in the water quality and develop a better understanding of what the "normal" water quality is in our waterways as well as how climate change may impact them.

EOS Eco-Energy believes that this long-term water monitoring program should extend to the Cape Tormentine Peninsula Watershed in 2019-2020 to obtain information about the current state of water quality within that watershed in our region. EOS recommends that the knowledge gaps in our watersheds continue to be addressed through our long-term water quality monitoring plan. We would also like to expand our knowledge of our watersheds through the collection of CABIN data, hydrological data, riparian health data, and fish & habitat data.

The full water quality report on the Tantramar River watershed is available on the EOS website at: https://eosecoenergy.com/en/wp-content/uploads/2019/03/High-res-EOS-Water-Quality-Report-2018-19.pdf.

Education, Outreach and Climate Workshops

During 2018-2019 we hosted and organized a number of workshops related to adaptation, eco-anxiety and climate change topics. These included:

- Two guided hikes about Mi'kmaq medicinal plants and wild edibles with Fort Folly First Nation

- Ham Radio and storm readiness workshop with WestCumb Amateur Radio Club and Meteorologists
- Ways to cope with climate stress in partnership with Iris Community Counselling
- An expert panel discussion on carbon pricing
- A workshop for the Chignecto Climate Change Collaborative on adaptation, infrastructure, risk management and relocation

We also organized a number of other educational events including:

- Dorchester School's outdoor day - we made seed bombs and taught students about rain gardens
- Salem School's outdoor day – we taught student about nature appreciation
- Summer camps – we taught local area campers about water quality monitoring and took samples in Silver Lake
- Silver Lake Fun Day – we organized a citizen science blitz where local residents learned about water quality monitoring and helped grab water samples at the lake
- Information booths – we also provided information about rain gardens and gathered names for the program at local community events and fairs

Below is a selected of photos from these events:

Making seed bombs and talking about rain gardens at Dorchester School's Outdoor Education Day.

One of EOS' summer information booths.


Citizen science at Silver Lake Fun Day. Residents helped gather water samples.


20 people attended our fall guided hike at Fort Folly First Nation to learn about edible and medicinal plants and traditional knowledge.

Our ham radio workshop attracted 40 participants including quite a few youth interested in the technology and learning about storm prep and communications.

Over 200 people attended the carbon pricing panel during Climate Change Week 2019 at the Vogue Cinema in Sackville.

60 people attended a nature hike at Fort Folly First Nation to learn about indigenous perspectives on climate change during Climate Change Week 2019.

Over 40 people attended the Infrastructure, Adaptation and Risk Management Workshop in January 2019

Challenges

We did not experience any major challenges in locating and designing the rain garden and depaving projects and we look forward to implementing our plans in year 2.

Summary of Year 1 and Next Steps

In summary, 10 rain garden projects were located and designed in partnership with homeowners in downtown Sackville, NB. A depaving site was also planned at the Sackville Visitor Information Centre. We conducted water quality monitoring of the Tantramar River Watershed in the greater Sackville area and organized workshops on climate stress and climate change adaptation. We look forward to year 2 of the project which involves planting 8 to 10 gardens and depaving the parking area as well as collecting and planning additional project sites for year 3.

Appendix – Background Resources for Depaving

Permeable Paving

Pros:

Reduces storm water runoff
Storm water storage/filtration
Supports the design traffic loads
Promotes high run off volume
Reduction in nutrient removal
Less prone to Frost heave (longer lifespan)
Does not leave seams in paving
Lower volume
Does not normally require additional space
Replenishes aquifers
Protects streams and lakes
Allows water and oxygen to reach plant roots
Reduces urban heat island effect
Random cracking is not considered negative on the textured surface (is less noticeable)
Reduces glare of wet pavement, and requires less lighting than dark, conventional asphalt – safer driving conditions
Reduces ponding, and hydroplaning and skidding
Experiences crews require less time to install (but have to wait a week before using i

Cons:

Must carefully consider each site – hydraulically and structurally
Must consider storage capacity and permeability
Is Most efficient on flat surfaces, and not as efficient on elevated areas
Requires a different knowledge than conventional concrete pouring – requires special handling and placement (stiff consistency and short setting time)
Must have plastic left on it for a week after laying – curing is much more important/continuous
Control joints used to prevent cracking – larger than conventional pavement (6m spacing)
Careful sediment control is needed in run on areas to avoid clogging
Soil types determine if under drain is needed (impermeable soils in Hydrologic Soil Groups C/D.
Have to test on-site soil infiltration rate (minimum rate of 0.5 inches per hour)
Native soils have to have a slit/clay content less than 40% and a clay content less than 20
A little maintenance is required to prevent it clogging with debris – annual vacuuming/power blowing/pressure washing (can design site to minimize leaves and debris falling onto the pavement
Crews must be certified – 1 day course with a closed book exam 75% or more to pass

Varieties:

Type	Description	Details
Pervious Concrete 	Aggregate with the majority of the fine material removed = creates void space of about 30%. Allows storm water to be stores in a gravel bed and then seep out into surrounding soil/drains	Formed on location
Porous Asphalt 	Same as above but with pavement	
Interlocking Concrete Pavement 	Concrete blocks designed with gaps in between them filled with small stone. Gaps = about 10% of the surface and allow	Manufactured in a factory and not on site

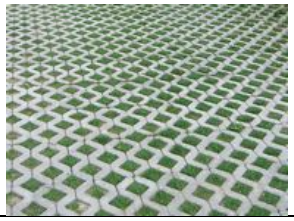
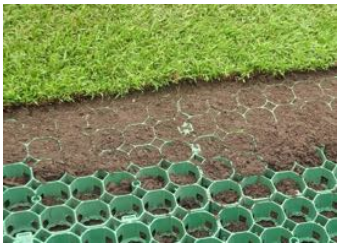
	stormwater to infiltrate the reservoir below	
Concrete Grid Pavers 	Concrete or cement is embedded into green areas to allow vehicles to drive on it.	
Reinforced Turf Pavers 	Reinforced vegetated surfaces supported by a durable plastic or concrete grid structure for root protection while supporting vehicle or pedestrian traffic	Best for low traffic or pedestrian areas.

Table 7.2. Comparative Properties of the Three Major Permeable Pavement Types
From: https://www.vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec7PERMEABLEPAVEMENT_clip_image004.jpg

Design Factor	**Porous Concrete (PC)**	**Porous Asphalt (PA)**	**Interlocking Pavers (IP)**
Scale of Application	Small and large scale paving applications	Small and large scale paving applications	Micro, small and large scale paving applications
Pavement Thickness 1	5 to 8 inches	3 to 4 inches	3 inches 1, 8
Bedding Layer 1, 8	None	2 inches No. 57 stone	2 inches of No. 8 stone
Reservoir Layer 2, 8	No. 57 stone	No. 2 stone	No. 2 stone 3-4 inches of No.57 stone
Construction Properties 3	Cast in place, seven day cure, must be covered	Cast in place, 24 hour cure	No cure period; manual or mechanical installation of pre-manufactured units, over 5000 sf/day per machine
Design Permeability 4	10 feet/day	6 feet/day	2 feet/day
Construction Cost 5	$ 2.00 to $6.50/sq. ft.	$ 0.50 to $1.00/ sq. ft.	$ 5.00 to $ 10.00/ sq. ft.
Min. Batch Size	500 sq. ft.		NA
Longevity 6	20 to 30 years	15 to 20 years	20 to 30 years
Overflow	Drop inlet or overflow edge	Drop inlet or overflow edge	Surface, drop inlet or overflow edge
Temperature Reduction	Cooling in the reservoir layer	Cooling in the reservoir layer	Cooling at the pavement surface & reservoir layer

Colors/Texture	Limited range of colors and textures	Black or dark grey color	Wide range of colors, textures, and patterns
Traffic Bearing Capacity 7	Can handle all traffic loads, with appropriate bedding layer design.		
Surface Clogging	Replace paved areas or install drop inlet	Replace paved areas or install drop inlet	Replace permeable stone jointing materials
Other Issues		Avoid seal coating	Snowplow damage
Design Reference	American Concrete Institute # 522.1.08	Jackson (2007) NAPA	Smith (2006) ICPI

1 Individual designs may depart from these typical cross-sections, due to site, traffic and design conditions.
2 Reservoir storage may be augmented by corrugated metal pipes, plastic arch pipe, or plastic lattice blocks.
3 ICPI (2008)
4 NVRA (2008)
5 WERF 2005 as updated by NVRA (2008)
6 Based on pavement being maintained properly, Resurfacing or rehabilitation may be needed after the indicated period.
7 Depends primarily on on-site geotechnical considerations and structural design computations.
8 Stone sizes correspond to ASTM D 448: *Standard Classification for Sizes of Aggregate for Road and Bridge Construction*.

Local Sources:

Shaw Brick - concrete grass & cement semi-permeable pavers, Unilock products
329 Collishaw Street
Moncton, NB E1C 9R2
1 (506) 857-8886
moncton@shawbrick.ca
https://shawbrick.ca/products/grassstone80/

Core Systems – Grass grid pavers, gravel grid pavers

Dexter Construction - permeable asphalt pavers, aggregate

Oakspavers – products available at All Stone Landscape & Masonry Products
81 Greenock Street
Moncton
New Brunswick
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