



## GRASS TO SUSTAINABLE GARDEN CONVERSION • WHITE PAPER

AN APPLIED RESEARCH COLLABORATION BETWEEN WHITE OAKS RESORT & SPA  
AND NIAGARA COLLEGE RESEARCH & INNOVATION

## KEY TAKEAWAYS

The list below are key takeaways for people and organizations to create their own sustainable garden.

- Garden location – consider sunlight levels & exposure, water drainage (direction and location), and soil type
  - More sunlight is better for edible crops
  - Review your plant hardiness zone ([planthardiness.gc.ca](http://planthardiness.gc.ca)) and the best crops for that zone
  - Plan your crops based on the site's climate, sun exposure, and soil
- Current vegetation – what's currently growing?
  - Some plants can be beneficial for your garden, and others may complicate future growth
  - Soil – review the current site conditions, and consider taking one or more representative soil samples to determine the current soil needs, and if it needs amendments (ex: compost), it is easier to amend prior to planting
- Paper mulch can help to smother weeds, and save on chemical applications to build your new garden upon
- Use compost to provide additional nutrients and beneficial bacteria
- Irrigation – consider the size of your garden, budget, and availability of time (ex: will you be away for extended periods) to water before deciding if you should install irrigation, do regular watering by hand/sprinkler, or install a sprinkler timer
- Decide if you would like a large quantity of a few crops, or, if you would like a smaller yield but a larger variety of crops
- The Blog of the project can be found here: <https://growwithniagara.tumblr.com/>

## INTRODUCTION

Agri-food is a major industry sector in Canada. It contributes \$108 billion of economic impact annually. Canada is the fifth largest agricultural exporter in the world, and the agri-food industry accounts for approximately 2.2 million jobs nationwide.

The face of agriculture in Canada is beginning to shift. The competitiveness of the agricultural industry, more demanding consumers, increasing urbanization, and changing environmental standards has increased the need for more sustainable and efficient agriculture. This is creating a greater demand for sustainable produce, a larger variety of products, and the need to develop methods of sustainable food production that are suitable for use in urban areas.

Continuous research, innovation, and development is essential to maintain Canada's position as a leading nation in agricultural production; and sustainable urban food production is one of the most promising fields for new research and innovation.

The goal with the 'Grass to Sustainable Garden' applied research project was two-fold: showcase the potential of developed urban areas to be converted into useable growing space; and establish best practices to be used for sustainable urban food production. This paper is a valuable tool for those who wish to create their own urban garden.

First opening in 1967, Niagara College has established a reputation as a leader in applied education and training. The college provides ample opportunities to its students and graduates to use the knowledge gained from their programs in real-world situations. Niagara College's Research & Innovation Division collaborates with businesses to provide innovative research, ideas, and solutions to help them stay at the forefront of their market.

White Oaks Resort & Spa (White Oaks) is located on 13 acres in the heart of Niagara-area attractions and offers a world-class conference centre, four-diamond accommodations, award-winning dining options and a fitness and luxury spa club. This Niagara business in Southern Ontario welcomes about 250,000 clients each year.

## PROJECT PURPOSE AND GOALS

1. Convert 1,250 square feet of White Oaks' property from grass into a sustainable garden
2. Use organic methods of soil supplementation and Integrated Pest Management (IPM)
3. Produce vegetables and other edible items for use in White Oaks' new restaurant Grow
4. Use the garden as an educational tool to highlight sustainable gardening and land management
5. Determine best practices for White Oaks to maintain the garden in the future and convert additional property into gardens

## BACKGROUND

Niagara College was approached by White Oaks to oversee the conversion of a portion of their property into a functional and aesthetic garden space, with the purpose of providing wholesome fresh produce to their restaurant. The proposed location presented numerous challenges: consistent high winds, nearby heavy traffic, and it was previously a stretch of the adjacent Taylor Road, which left only shallow rocky soil in the wake of its removal. The challenges posed by this site are representative of a much larger issue; agricultural land is being used for development. The concept of farm-to-table food production is not new, but there is much to be learned about doing it sustainably in a developed landscape. This project took place between May and October 2016.

## LOCATION

Selecting the right location for your garden will have effects on preparation, soil amendment, and management. Soil conditions, natural light levels, sun exposure, and drainage are all factors to consider, although the focus should be on the factors that are difficult to adjust, such as exposure and light. Unfortunately, in an urbanized environment, you may not have lots of choice. For this project, the location was fixed, presenting conditions that were not ideal.



Image 1: White Oaks' property adjacent to Taylor Road, in Niagara-on-the-Lake, Ontario. The garden area is in the red square in the central portion of the image.

As shown in Image 1, the proposed area was situated immediately adjacent to a large and busy roadway. The original location of the road can be seen in the swath of exposed dirt running across the full length of the boulevard. After the relocation of the road, the remaining soil was left heavily compacted and riddled with rocks and chunks of asphalt. The Queen Elizabeth, a 400-series highway, is located immediately north of this property, providing an additional source of vehicular pollution. The lack of windbreaks also means that the garden is subjected to near-constant winds; yet fortunately afforded the full sun exposure required for the success of most edible crops.

At the onset of the project, the site had a much higher percentage of vegetative cover (Image 2), primarily in the form of white clover. While often considered a weed, the clover provided several rehabilitative benefits to the site. The greatest benefit lay in the clover's ability to fix nitrogen from the atmosphere into nodules on the plant roots, which assisted in restoring some fertility to the area. In addition to fixing nitrogen, the strong root system helps penetrate the dense, compacted clay, to improve aeration and water penetration in the soil. Lastly, as the clover is mown it is left to decompose naturally on-site, adding nutrients and organic matter into the soil to improve the texture.



Image 2: Initial site status before any garden work, with flags to plan the garden bed and path locations.

## PROJECT TEAM

Niagara College Research & Innovation Team  
Faculty Lead: Tanya Blankenburg  
Research Associate: Meghan Beattie  
Research Assistant: Mackenzie Haines  
Research Project Manager: Gregor MacLean

White Oaks Team  
Chef Kyle Paton, Culinary Creative Director  
Michael Wakil, Co-Owner

## SELECTION OF CROPS PLANTED

- Anise Hissop
- Artichokes
- Carrots & carrot greens
- Cock's Comb
- Eggplants
- Kale
- Marigolds
- Nasturtium
- Okra
- Strawberries
- Shiso
- Sunflowers
- Tomatillos
- Tomatoes (Tiger Toms, Siberian Speckled, Osu Blue)

## ESSENTIAL ELEMENTS

In terms of producing plant growth, water, sunlight, and soil are of relatively equal importance. Too much or too little of these factors will drastically impede your ability to succeed. When it comes to producing flavour; however, soil becomes a much more important factor. Ensuring good nutrient availability and promoting a healthy network of beneficial organisms will result in a more productive garden with better-tasting produce.

### SOIL

Understanding the composition of your soil goes a long way in determining how successful your garden will be. Fruits, vegetables, and flowers can have vastly different preferences when it comes to growing conditions, and it is important to understand your soil so that the necessary amendments can be made. When looking to rehabilitate urbanized sites or those with questionable soil quality, taking one or more representative soil samples is recommended. To get the best information, have it analyzed at a reputable soil lab. This will give you an idea of what nutrient deficiencies or issues you may encounter. It is much easier to amend the soil prior to planting. Depending on the complexity of the analysis it will cost between \$50 and \$200. Many labs will offer recommendations on how to improve your soil quality depending on what areas are lacking.

Another option, to learn about the soil onsite, is to check regional/local soil maps, and property history, which can be found online or at the local library. If your existing soil is of poor quality or you want to create a garden on a site where there is little to no existing soil, you have the option of purchasing it from a supplier. Most reputable soil suppliers will provide a basic analysis of their soil at your request. This may not give you a detailed guideline of what nutrients are present in the soil, but it is likely to include the pH range, organic matter content, and soil type.



Image 3: Sampling the original soil onsite to determine any issues, and decide on the best amendments.

Due to the site's proximity to a highway and the high-traffic road, there were concerns about potential soil contamination.

Soil samples were taken (Image 3) to review the soil conditions prior to developing the garden. To provide an accurate representation of soil quality, twelve samples were taken at random across the full area of the site. For a typical soil test, samples are collected using an auger to create a core with a depth of 4 to 6 inches; however, the rocky composition of the on-site soil only allowed us to reach a depth of 1.5 to 2 inches. The collected sample was sifted to remove rocks and other debris that would potentially alter the outcome of the soil test and was then sent to an accredited lab for analysis.

The test results were normal with no dangerous outliers. We expected to have a low percentage of organic matter, because the soil underwent minimal rehabilitation after the asphalt was removed. Elevated calcium, magnesium, and pH levels are common in Ontario topsoil. While within range, the total salt content of the soil was higher than average. This was easily explained by the history of the site, however, each winter the salt-filled slush would be ploughed from the road and parking lot onto the soil. The texture was classified as a Silt Loam, which is a light and airy texture that under normal circumstances would be excellent for growing, but at this location, had been heavily compacted. In most cases it is preferable and less costly to amend the existing soil; however, the lack of soil depth and dense dispersion of rock proved very difficult for growth, and led to the decision to purchase soil. Over time, the movement of water and infiltration of plant roots will help incorporate the new soil (rich in nutrients and organic matter) into the poorer subsoil; gradually relieving compaction and improving conditions.

## SOIL TEXTURES

There are three main particles present in soil that determine its texture classification:

- sand is the largest, followed by
- silt, and
- clay being the smallest

The differing particle sizes help determine the presence of pockets of emptiness called pore spaces. These are further divided into macropores and micropores, which allow the retention of air and water respectively. Due to the larger particles in **sand**, there is a greater percentage of macropores, leading to good aeration but poor water retention. Sandy soils are not as easily compacted as those with more silt or clay, but tend to be drier and require more frequent watering and have a reduced capacity for storing nutrients. The presence of sand in soil can be easily determined by the grainy texture.

**Silt** typically originates from quartz or feldspar that has been weathered or eroded. While somewhat similar in appearance to clay, silt lacks the sticky texture clay presents when wet. Silt will form a crust on the surface of the soil after a wet/dry cycle, but it is easy to break through.

**Clay** not only differs in size from the other particles, but in shape as well. Silt and sand are grains that are roughly the same size in all dimensions. Clay forms plate-like particles that overlap to form strong aggregates. An easy test to determine if clay is present in the soil is to squeeze a lightly moist handful of soil and see how well it sticks together. These particles are negatively charged and are usually very nutrient-rich, as minerals such as calcium, magnesium, and potassium are positively charged and bond with the clay particles. The disadvantage of this soil type is it is often poorly drained and when compacted produces a dense, solid structure that is difficult to work or amend. During periods of drought, soils with heavy clay percentage may exhibit deep cracks in the surface of the soil as the clay aggregates dry and pull away from each other. In the Niagara Region, the predominant soil type is clay.

## SOIL AMENDMENT

In following with organic growing guidelines, there were no synthetic fertilizers used for this project. The best option for adding nutrients to the soil is through the addition of compost. Compost is the result of breaking down organic materials such as vegetable peelings, weeds, and dead leaves into a product resembling soil. Proper preparation and management of a compost pile produces humus that is rich in beneficial microbes, nutrients, and worms. Incorporating this into the garden physically improves texture and water retention, as well as serving to crowd out potentially harmful bacteria. Image 4 below shows compost produced at Niagara College using food waste from food services.



Image 4: Compost produced at Niagara College, and used in the White Oaks garden.

Developing an active, healthy compost pile is all about balance. The main components of compost can be separated into two broad categories: green nitrogen-rich material, such as kitchen scraps, grass clippings, or weeds; and brown carbon-rich material such as dry leaves, wood chips, and even newspaper. Nitrogen material decomposes quickly, and the process produces heat. Too much nitrogen in a compost pile can cause it to become so hot it kills the beneficial microbes and other larger decomposing organisms.

The easiest way to determine if there is an excess of green material is to smell the compost. If there is a foul odour, the pile has become anaerobic and requires more air and carbon. Using a pitchfork, pull the pile apart and spread it out to breathe and cool down. To rebuild the pile, alternate levels of nitrogen material with sticks, dry leaves, or large chunks of paper egg cartons. This will create pockets of space that allow air to circulate through the material. A compost system can take anywhere from one month to a year to produce usable humus, depending on how well it is managed. Turning the pile once a week and frequently adding new material will help to speed up the process. Take caution when using weeds as a green material, as seeds can survive decomposition and end up in your garden. If you do not have the space or time to make your own compost, you can purchase compost from a garden centre.

## MULCH

The use of mulch in a garden is completely optional but can provide major benefits for health and maintenance. Mulch can be as simple as dry leaves or as advanced as biodegradable sheets, but the purpose it serves remains the same. When properly applied, mulch suppresses weed presence by preventing sunlight from reaching the ground beneath. Mulching also helps moderate temperature and moisture in the soil, insulating against sudden temperature changes and slowing the infiltration and evaporation of water. When using mulch from organic sources such as leaves or shredded bark, it will gradually decompose and increase the organic matter content of the soil beneath. It is a particularly good option for pathways around the garden as well, reducing how much compaction the ground beneath will experience from foot traffic.

Due to the necessity of building the garden on top of the existing soil and vegetation, we first laid out a single layer of plain brown kraft paper beneath each bed. This layer helps to physically smother weeds to prevent them from growing up through the soil and mulch above to reach sunlight. Over time, the smothered plant material and the paper will decompose with no ill effects to the environment. The benefits are a cost-effective and sustainable way to smother weeds, and incorporate old vegetation with the new garden. Image 5 shows the garden plots with soil and surrounding areas with wood chips after the brown kraft paper was applied.



Image 5: Garden with soil plots for growing, and wood chips for buffer areas.

## IRRIGATION

Irrigation is one of the most important factors for success next to soil and site conditions. Water is vital for plants to grow, but it is important to find a balance between meeting the plants' needs for growth and over-watering. Plants send their roots further into the soil in order to search for more water. If plants are over-watered their roots will grow less, leading to stunted growth. Over-saturation can also cause the oxygen in the soil to be less available to plants, further stunting their growth, or in extreme cases can even cause roots to begin to rot, leading to the death of the plant. Without enough water, plants will be unable to maximize their growth, and in severe cases they will become unable to support themselves, as water is vital for helping plants maintain their structure. If plants are not watered, they can dry up, leading to their death, and plants in their early stages of their life are particularly vulnerable to this, so preventing your soil from drying out is vital.

Automated irrigation systems tend to work better for larger gardens as they provide more consistent watering rates and timing, and can be remotely activated/deactivated. For all their benefits these systems are only as useful as those operating them. A poorly utilized system set to run too often or not often enough, will frequently cause more harm than good, as automation can lead to complacency on the part of the growers. While these systems can be invaluable, they must still be observed frequently and often adjusted depending on weather conditions. Image 6 shows an irrigation head used for the project garden. For smaller gardens, automatic irrigation may present too great of a cost to install. In these cases, watering is best done by hand with a hose.



Image 6: The irrigation system operation at White Oaks.

Our experience with an automated irrigation system stresses the importance of the grower having control over the system. The growing team did not have irrigation system control, which led to issues with overwatering due to our inability to adjust irrigation levels as required. The method of dispersion used was also not ideal for the garden. The system consisted of 7 irrigation heads situated on the outer perimeter of the garden that projected a jet of water in a large arc, rotating to cover the full area. The major drawback of this setup was that the high winds resulted in drastically uneven spray. Some beds would receive a high volume of water while others were barely damp. This non-selective broadcast also soaked the mulch borders of the beds, causing it to compact and decompose much more quickly than it would naturally. Water use should be considered as it relates to the garden sustainability.

The best irrigation option for a similar garden is a dripline system. Connected to a single output source, multiple driplines can be run parallel to the beds with individual driplines staked into each bed. This could be set to a timer or manually activated, providing a slow, steady supply of water directly to the plant roots. Installing the lines below the pathways would also eliminate a potential tripping hazard.

In the interest of sustainability, the most environmentally-friendly method of irrigation is hand watering in conjunction with a rain barrel or other rainwater conservation system. The disadvantage of this is that in extreme conditions such as a 4-month drought as experienced during the project work in the summer of 2016, there must be an alternative source of water. To further reduce the potential for wasted water, correctly timing water application is important as well. Early morning is the best time to water a garden, or at the very least, before noon. Watering during the hottest part of the day can result in water loss due to evaporation. If using an overhead watering method such as a sprinkler or hose, the droplets left on leaves can magnify the light from the sun and cause scorching. On the other hand, evening irrigation applications do not always have sufficient time for excess water to evaporate from the leaf surface, creating an ideal situation for the growth of molds or fungi.

To determine if your garden needs water, the first step is doing a visual inspection. If the soil is dark or visibly moist, it is unlikely that you need to water. If the soil appears dry or plants are looking wilted, the easiest way to test soil moisture is to stick your index finger into the soil. The soil should be moist within the top few inches, if you cannot detect any dampness on the full length of your finger, it needs water.

## SHIFTING STRATEGIES

Our system was initially set much too high, running for an hour before the White Oaks Club opened to avoid spraying clients. Even with the blistering heat and nearly constant winds, too much moisture accumulated in the soil and mulch, resulting in poor root system development, stunted growth, and rot. Puddles appeared in low-lying areas of the garden, and mushrooms began cropping up in the wetter beds. The irrigation was adjusted to run at two 15-minute intervals set one hour apart, which proved to be too much as well. The irrigation was then set to one 15-minute interval every other day. Even at this setting we continued to experience puddling in the mulch and decided to shut off the irrigation completely, and we manually watered as needed. Due to the timing, it took more than two weeks for the system to be disabled. Many of the beds that had been receiving a higher volume of water showed increased growth as they dried out and the root systems recovered.

Hand watering, while more time consuming than an automated system, also affords the advantage of ensuring a closer, more observant relationship with your garden. Manual watering requires you to get down to plant level to check soil moisture, which is a perfect opportunity to check for any signs of pests or diseases and catch them before it becomes a larger problem. Regardless of what irrigation method you choose, it is important to pay attention to the weather forecast and adjust your system as needed.

## WEATHER

The unpredictability of the weather means that the only real option for control is mitigating the effects it has on the garden. Over the course of this project, Southern Ontario experienced 4 months of almost unbroken drought, with temperatures consistently in the 30s (Celsius), reaching into the 40s with the humidex. This presented incredibly difficult growing conditions, as the majority of plant material selected for this garden is not well-suited for such hot, humid environments.

The Niagara Region is almost exclusively hardiness zone 6a or 6b, as determined by the average minimum winter temperature. Knowing what hardiness zone you are planting in is the first step to determining what can be successfully grown in your garden. What you want to grow and what you can grow may be two completely different things. When gathering seeds, seedlings, or other plants for your garden from a garden centre or seed supplier, you can usually find the hardiness zone on the label. This is more important in the case of perennial plants that persist throughout the winter. In the case of annual plants, the timing of planting becomes more important. Most lettuces do best in the cooler weather of spring or fall, as hot summer days will cause them to bolt or flower before producing much of a crop. As with perennial plants, following the care instructions on the label is the best way to ensure success.

Another way to ensure the plants you get are suitable for the growing conditions in your area is to purchase them from local farmers or heirloom suppliers. While heirloom varieties may not be as resistant to pests as commercial crops, they offer a larger variety of flavours and colours. Some heirloom plants may have the added benefit of being open pollinated, which means you can collect the seed and grow the same plant year after year. Image 7 below shows the mid-season growing progress.



Image 7: Flourishing crops from the support of the irrigation and close team care.

## WORKING WITH AND SUPPORTING FOOD SERVICE OPERATIONS

The contents of our garden were the result of a collaboration between the Niagara College's Research & Innovation team (Tanya Blankenburg, Faculty Lead; Meghan Beattie, Research Associate; Mackenzie Haines, Research Assistant; and Gregor MacLean, Research Project Manager) and Chef Kyle Paton (Images 8 and 9), the creative culinary director of White Oaks' restaurant *Grow*. During the planning stage of the garden, Chef Paton presented us with a list of plant material that he was interested in having in the garden, with a focus on varieties different than those offered by local suppliers or particular edible plants that suppliers did not sell, like Anise Hyssop. Certain items on the list, such as Kefir lime trees and other citrus, will only successfully grow outdoors in warmer, more tropical climates. Other plants such as Sichuan berries and exotic herb varieties were simply too difficult to find. We worked closely with Chef Paton to find as many of the requested items as possible, offering insight on alternatives for those we were unable to plant.



Image 8: White Oaks Grow Chef Kyle Paton, and Meghan Beattie, Niagara College Research Associate, in the Sustainable Garden

The Chef's vision for the restaurant included shaping the menu around what produce is currently in season. This resulted in frequent updates from us as to what was available in the garden and what plants we would be producing next. Every morning we would meet with the kitchen staff to replenish their stores of herbs, flowers, and vegetables as needed, including issuing fair warning when something was reaching the end of its season. Occasionally, we experienced a surplus of produce that would spoil if it was not harvested. To combat waste, the chef created different methods of preserving the garden's bounty such as canning, fermentation, or dehydration. This also created some options for featuring produce from the garden during the winter when nothing is actively growing.



*Image 9: Chef Paton in the garden reviewing harvest options for White Oaks Grow restaurant*

## LESSONS LEARNED

The biggest takeaway for this project was primarily the sense of scale it provided. *Grow* is a small restaurant with a selective menu, yet the volume of produce required on a daily basis far surpassed what we were able to produce in the garden. The primary factors limiting this were available growing space and budget. We wanted to offer a broad variety of plant material, but it meant reducing the quantity we were able to provide. The ability to save seeds from individual heirloom tomato plants will allow us to produce many seedlings next season, greatly increasing the volume of fruit for harvest. The garden is an aesthetic installation as well as a practical one, which prevented it from having too much of an agricultural look, the beds were planted in random patterns. This structure is less efficient than typical rows, which would maximize the use of the garden space. We now have a much better idea of what quantities will be required to ensure a steady supply of fresh ingredients for the kitchen.

## SUCCESSES

Overall, the garden was a great success. Many members of the White Oaks Club came out to ask questions about the garden and compliment its growth. White Oaks was very pleased with the initial garden, and we collaborated to expand the garden, effectively doubling the original size. Meghan Beattie presented the project's work and outcomes at the Colleges and Institutes Canada Student Showcase Forum, and was a top 3 finalist, as seen in Image 10. The collaboration between Niagara College Research & Innovation and White Oaks supported by the Natural Sciences and Engineering Council of Canada was a valuable applied research venture to demonstrate and explore the viability of a sustainable garden for a hotel and food service organization in a developed suburban/urban area.



*Image 10: Meghan Beattie, Research Associate showcasing the project results at the Colleges and Institutes Canada Student Showcase Forum*

## ACKNOWLEDGMENTS

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