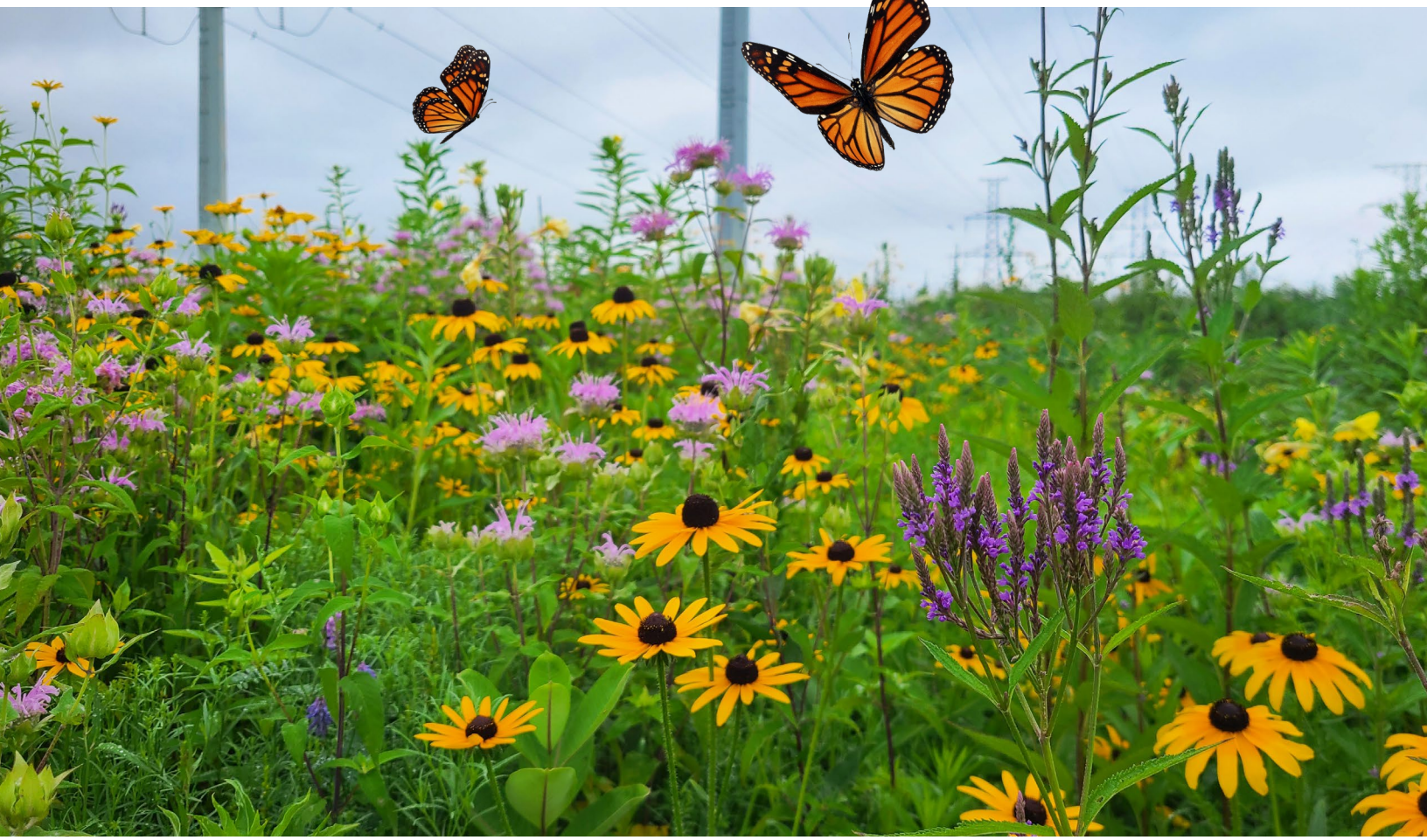
The Meadoway
COMMUNITY POWERED GREEN SPACES



A Blueprint for Naturalizing Infrastructure Corridors

A program of:

Toronto and Region Conservation Authority

As a groundbreaking initiative, The Meadoway has transformed a hydro corridor in Scarborough into a vibrant 16-kilometre stretch of urban greenspace and meadow lands that will become one of Canada's largest linear urban parks linking key community and tourism destinations across the Region.

The Meadoway, which is a vital component of Toronto and Region Conservation Authority's (TRCA) Trail Strategy for the Greater Toronto Region, is an innovative city building initiative that will provide a naturalized link between Rouge National Urban Park and downtown Toronto, stitching together more than 15 parks/greenspaces, seven watercourses, tourist destinations including the Toronto Zoo, employment centres, education facilities including Centennial College and the University of Toronto Scarborough Campus and transportation hubs. A multi-use trail network will enhance the connectivity of the existing urban fabric, which will be complemented by meadow habitat restoration.

TRCA has emerged as experts in the field of meadow restoration with the knowledge gained on The Meadoway. "A Blueprint for Naturalizing Infrastructure Corridors" has been written as a 'how to guide' for right of way restoration based on the lessons we have learned. Our hope is that we can share this knowledge far and wide for application across North America and beyond.

The Meadoway is the kind of ecological based community-building project TRCA is thrilled to be a part of. I am incredibly proud of the efforts spanning multiple teams across TRCA and the Toronto and Region Conservation Foundation (TRCF). We are thankful for the generous support of the Weston Family Foundation and partners including the City of Toronto and the Federal government through Parks Canada (Rouge National Urban Park), Infrastructure Canada, and Environment and Climate Change Canada. We are also thankful for the efforts of Hydro One and Infrastructure Ontario to facilitate restoration and trail work on provincially owned and managed lands. All of these agencies, numerous schools and institutions across Scarborough and thousands of community volunteers in local organizations have also played critical roles in achieving the vision of The Meadoway.

TRCA is honoured to continue to advance this work for the natural environment and the citizens of the Greater Toronto Region.

John MacKenzie,
Chief Executive Officer,
Toronto and Region Conservation Authority and
Director, Toronto and Region Conservation Foundation

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1.1 Introduction

Figure 1: *The Gatineau hydro corridor presents a unique opportunity to transform 16 km of mowed turf into meadow habitat that will provide many ecological, recreational and cultural services.*

Urban expansion and intensification are placing increased pressure on the remaining greenspaces of the Greater Toronto Area (GTA). Loss of natural habitat is the most significant factor contributing to the reduction of biodiversity, including native plants, birds, pollinators and other wildlife. Meadow habitats have been in decline throughout Ontario due to the expansion of urban areas, intensification of agriculture and the suppression of natural disturbances such as fire. The loss of meadow habitat has led to the loss of food sources, migratory staging areas, and overwintering or nesting areas for several bird and pollinator species.

However, across southern Ontario there are thousands of kilometres of infrastructure corridors maintained by private companies, government agencies and other entities. Showcasing alternative options like meadow restoration within these infrastructure corridors could help promote beneficial habitat that requires minimal maintenance compared to full removal of trees and shrubs during typical corridor maintenance.

Urban, suburban and rural areas in the GTA are crisscrossed by a complex network of infrastructure corridors – occupied by electric power lines, pipelines, telephone and fiber optics, and buried water and sewer lines. Many of these corridors feature non-native plants that must be mowed six to eight times a year to limit plant height and woody growth and facilitate access by utility vehicles to site equipment. The result is lengthy swaths of low-quality habitat and under-used manicured areas that provide little benefit to biodiversity, ecosystem function and ecosystem services.

Many of these corridors also offer an opportunity to expand and connect the trail network across the GTA, providing a wide range of recreational possibilities, including hiking, biking, jogging and other modes of active transport, as well as bird and butterfly watching, art and photography, nature study, and outdoor education (either group or self-guided).

Collectively, these corridors represent thousands of hectares of greenspace that could be better utilized to promote biodiversity, support climate change resiliency, and meet active transportation needs, while simultaneously meeting their primary infrastructure-related roles in, potentially, a more cost-effective manner. The naturalization and revitalization of infrastructure corridors is a "win-win-win" situation for municipal and utility stakeholders, residents and the natural environment.

With proper planning and ongoing maintenance and monitoring, many of these corridors have the potential to be transformed into vital pathways connecting natural heritage systems and supporting wildlife movement, while promoting biodiversity, natural functions and ecosystem health.

The infrastructure corridors in the GTA, southern Ontario and across North America provide an opportunity to rethink urban and near urban greenspaces by replacing kilometres of biologically barren, mown turf or low-quality non-native vegetation communities with ecoregion-appropriate native meadow habitats. The Meadoway restoration project offers an illustrative blueprint of how to do this in your area.

1.2 A SHORT HISTORY OF THE MEADOWAY PROJECT

Walking and biking trails within infrastructure corridors are already a significant component of the Greater Toronto Region Trail Network, as set out in Toronto and Region Conservation Authority (TRCA) Trail Strategy for the Greater Toronto Region. Approximately 182 kilometres, or some 38 percent of the total trail opportunities identified in the Trail Network, are located within infrastructure corridors. The Meadoway is a key component of that Network.

The Meadoway grew out of the Scarborough Centre Butterfly Trail (SCBT) project, launched in 2012, that saw a 40-hectare (99-acre) section of under-utilized space within the Gatineau Hydro Corridor lands transformed into a thriving native meadow community supporting a variety of butterflies, other pollinators, birds and wildflower species. Today, the SCBT stretches from Thomson Memorial Park (near McCowan Road and Lawrence Avenue East) 3.25 kilometres northeast to Scarborough Golf Club Road.

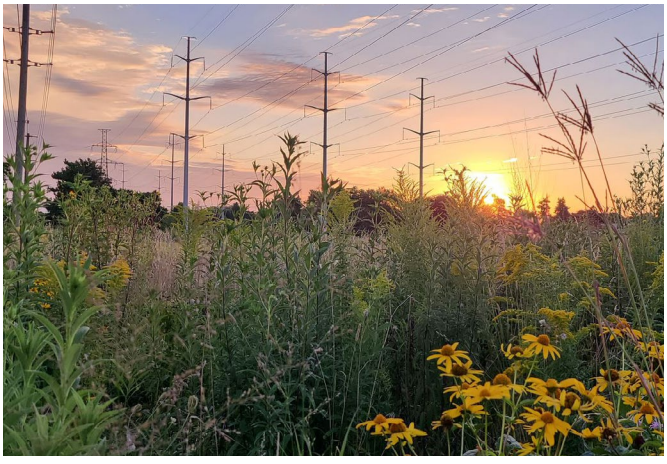


Figure 2:
Sunset views in The Meadoway.

Figure 3:
A. Site of the Scarborough Centre Butterfly Trail (SCBT) before meadow restoration in 2012.
B. SCBT location 4 years into meadow restoration. SCBT became the pilot project for The Meadoway and is now the central, most established section of meadow habitat in The Meadoway.

The success of the SCBT spurred its supporters and sponsors to investigate and advocate for a more ambitious revitalization program. As a result, The Meadoway project was launched in 2018, and the meadow restoration work has continued to date.

Led by TRCA, in partnership with City of Toronto, Hydro One, Infrastructure Ontario and The Weston Family Foundation, The Meadoway project is currently transforming 16 kilometres (comprising over 200 hectares) of that same hydro utility corridor in Scarborough into one of the largest urban linear greenspaces in Canada.

When complete, The Meadoway will connect seven watercourses and more than 15 parks, pass through 13 neighbourhoods, and provide an attractive, active transport link between the Don River ravine in downtown Toronto and Rouge National Urban Park in the east (i.e., west of Bermondsey Avenue to Meadowvale Road).

The Meadoway project is one of the most innovative meadow restoration and outreach projects in Canada. The Environmental Assessment (EA) for the trail network was completed in December 2019. By the fall of 2020, half The Meadoway was already seeded, and by the end of 2024, the entire 16-kilometre stretch of utility corridor will have been planted with native meadow species.

Throughout the planning and implementation, TRCA has worked to make The Meadoway project a model of how to successfully revitalize and repurpose utility corridors in both a local and international context. While the bulk of this manual is devoted to the processes used to plan, create and maintain meadow habits, it also provides a short summary of some of the community outreach, consultation and educational components that are vital to such a project's ultimate success.

The Meadoway project will:

- Connect 15 parks and seven river and ravine systems.
- Pass through 13 neighbourhoods.
- Connect 15 parks and seven river and ravine systems.
- Create over 200 hectares of healthy meadow habitat, home to more than 1,000 diverse species of flora and fauna.
- Open 16 kms of publicly accessible trails for biking, walking and other active transport.

1.3 BENEFITS OF MEADOW RESTORATION IN A UTILITY CORRIDOR

As urbanization continues to expand and encroach into natural areas that are critical for the survival of wildlife, meadow habitats are often the first to be lost. Meadows are usually located on unprotected tableland that is easy to service and build on. In addition, meadow habitats have been in decline across Ontario due to the intensification of agriculture and the suppression of fire and other natural disturbances.

Meadows are a unique ecological community dominated by herbaceous plants, such as grasses, sedges and forbs. Characterized by deep soils and a lack of trees and shrubs, a stable meadow has a maximum of only 25 percent tree canopy cover.

The loss of meadow habitat has led to a decline in food sources – as well as a loss of migratory staging, overwintering and/or nesting areas – for many bird, butterfly and pollinator species. Habitat loss is a primary reason why many native plant and animal species have been listed under the *Endangered Species Act, 2007.*

Creating meadows within infrastructure corridors is an excellent example of transforming underutilized, or degraded habitat into thriving ecosystems. Meadow restoration promotes the return of native bird and pollinator species to the local area and improves connectivity to existing natural habitats with resulting beneficial impacts on neighbouring communities, regional biodiversity and climate change resiliency.

LESSONS LEARNED

The basics of meadow restoration are well understood, but more research is needed to fine tune the approach with the tools, equipment and resources that are available to get the best results.

The Meadoway project will deliver such benefits as:

- Enhance ecological services (e.g., pollination) through increased biodiversity resulting in ecosystem resilience.
- Increase flora diversity (and therefore local genetic diversity) creating site resilience.
- Improve wildlife habitat and enhanced natural corridors supporting species movement.
- Increase water infiltration and groundwater recharge due to the deep roots of meadow plants.
- Improve flood attenuation via surface water uptake and reduced runoff, resulting in reduced soil erosion and compaction.
- Reduce pollution through air filtration by plant species.
- Increase carbon sequestration as meadow plants capture and store carbon in the soil.
- Reduce maintenance costs and lower emissions due to decreased mowing.
- Create a smaller carbon footprint through reduced annual mowing.
- Enhance recreational opportunities, including biking, walking, running, bird watching, etc. promoting residents' overall health.
- Improve aesthetic values throughout the seasons, with "nature in the city" promoting residents' mental and spiritual well-being.
- Provide educational opportunities for community and school groups.
- Provide opportunities for the public and residents to establish a stronger environmental connection through stewardship of these lands.
- Provide ongoing research opportunities.

Integrating The Meadoway with neighbourhoods, parks, public access points, access for a full range of users, and other trail systems will promote community connectivity and augment the city's bikeways network. Restoration of the existing corridor with meadow habitat will contribute to the city's urban greenspace and improve ecological diversity.

Figure 4:
A benefit of converting utility corridors into meadow habitat is a tremendous boost in local pollinator populations which will in turn lead to higher pollination in the surrounding area outside of just the meadow footprint.

2.1 Restoration Planning

Planning The Meadoway restoration project involved a series of steps, including:

- Determining and outlining project goals
- Obtaining permits and partnership agreements
- Undertaking field and desktop surveys and investigations
- Compiling data and detailed maps
- Designing and executing an implementation strategy

2.1.1 The Goals of The Meadoway Project

Identifying project goals helped determine The Meadoway's restoration design, practices and procedures. All projects must align with TRCA's Strategic Plan, which sets out TRCA's vision, mission, guiding principles and strategic directions.

Applicable to this project is TRCA's goal of ecological restoration, which aims to protect and restore ecosystem structure and processes to improve ecosystem function. The Meadoway goals include:

- Restoring a natural community
- Creating habitat and wildlife corridors
- Improving aesthetics
- Facilitating community outreach and engagement
- Providing recreational opportunities
- Using the site for ecological or social research

Each goal comes with a unique array of potential challenges and solutions that impact the restoration practices and procedures used for the site.

LESSONS LEARNED

When aligning your project team, aim for a diverse skill set, including researchers, biologists, restoration ecologists and construction experts.

Figure 5:
Evidence of The Meadoway's goal of creating ecological research opportunities being realized. This researcher is collecting bee species with a miniature vacuum to survey which pollinator species are present in The Meadoway.

2.1.2 Land Ownership and Partnership Agreements

The Gatineau Hydro Corridor lands are owned by Infrastructure Ontario (IO) and managed by Hydro One Networks Inc. (HONI). The City of Toronto has a Master Park License Agreement with HONI for The Meadoway portions of this corridor.

In 2012, TRCA determined that this corridor would benefit from meadow naturalization (including shrub node features) to complement the existing multi-use trail that was installed by the City of Toronto between Thomson Memorial Park and Scarborough Golf Club Road. A meadow ecosystem was deemed ecologically beneficial, as well as compatible with the management requirements of the hydro corridor. Hydro corridors are typically mowed six to eight times a year to maintain access to hydro towers/lines and to limit tree growth. The establishment of natural meadow habitat would reduce the frequency and extent of future mowing.

2.1.3 Site Inventory/ Analysis

In planning The Meadoway restoration work, TRCA employed its Integrated Restoration Prioritization (IRP) and Restoration Opportunity Planning (ROP) process to identify and record site-level information. The following activities were undertaken to assess the site and create an informed strategy and operational plan:

- Compilation of a detailed site inventory, including landscape features (hydrological and soil systems), soil analysis, invasive species, wet areas, etc.
- Preparation of comprehensive site maps, using commercial software, to support project designers and document site features, impediments, changes, biotic components, etc.

These activities are described in more detail on the following pages.

Figure 6:
Part of the initial site inventory process involves identifying wet and dry areas within the restoration site as these will require different seed mixes and may have varying site preparation and maintenance constraints.

Figure 7:
Initial assessment of the restoration site should include mapping areas of invasive species such as this dense patch of Dog Strangling Vine.

2.1.3.1 Field Assessment

A comprehensive on-site field analysis inventoried the abiotic, biotic and cultural conditions of the site. This information helped classify the site's current conditions (to analyze the steps and effort required to transition the lands to a meadow) and informed the meadow design process (such as seed species selection).

The analysis of landscape features, such as hydrological and soil systems, provided information on potential growing conditions, thereby informing species selection. Knowledge of soil type, depth, current vegetation cover, climate and geographic area was used to determine the Ecological Land Classification (ELC), Ecozone, Ecoregion and Plant Hardiness Zone.

Soil tests for chemicals and nutrients helps characterize the types of soil in the targeted area and provides insights on pH, fertility, organic matter content, prior herbicide use/residues, and salt residues.

Standard agricultural soil test:

- A trowel and a bucket are all that are needed to collect the soil.
- Randomly in the field, take three samples of soil and record sample locations in the field.
- Mix the soil in a clean bucket and put approximately one cup of soil into a resealable plastic bag. Label the bag.
- Package and send the samples to an agricultural test laboratory example: The Agriculture and Food Laboratory at University of Guelph guelphlabservices.com. Typical tests include: NPK (i.e., ratio of nitrogen/phosphorus/potassium), pH level and soil organic matter, as well as tests to determine the presence of certain persistent chemicals (that can affect germination).

Seedbank and germination tests for chemicals and seedbank:

- Collect enough soil to fill two nursery trays.
- Outside or in a greenhouse, fill the two trays and pack them down.
- In one tray, seed ½ radish and ½ lettuce (seeds that are fast germinating and sensitive to chemicals).
- In the other tray, leave ½ unseeded for a control (to see what weeds come up naturally which helps provide information on the soil's seedbank).
- In the other ½ tray, seed your native seed mix to see how they perform in the site's soil.
- Water regularly to get the ideal germination.

Documenting invasive species populations or areas that contain native species to be retained is also necessary.

Management of wet areas:
Wet areas should be identified to determine native seed suitability and to adapt proper maintenance procedures and implementation strategies. Ephemeral or vernal wet areas collect or hold water for only a certain time during the year; however, prairies and meadows can occur in seasonally wet areas. These areas may be characterized by higher concentrations of clay soils, plants that favour or tolerate moist-wet soil conditions, and seasonal standing water.

Awareness of the hydrologic conditions, water table heights and patterns, and topographical features, including man-made drainage features (e.g., ditches), should help to predict where these areas will occur. Once identified, wet areas should be mapped so maintenance procedures and implementation strategies can be adapted. These wet areas should be prepared in similar ways to drier areas but will have different native species targeted for the final seeding, including species adapted to wetter soil conditions. Also, care should be taken for these wet areas during site preparation and management, as the timing of procedures becomes more important to avoid damage to equipment and lost time.

LESSONS LEARNED

Plan for a three-to-five-year invasive species management plan and continue with adaptive management in future years.

2.1.3.2 Mapping

Field mapping was conducted using the ArcGIS Collector software (which was functionally replaced by ArcGIS Field Maps in October 2020) to enhance understanding of the site and determine the location of features that would affect implementation goals (i.e., natural or man-made features, like culverts, garbage dumping areas, high traffic areas, etc.).

Mapping with the ArcGIS software was also used:

- As a visualization tool to help project designers
- To record permanent photo monitoring points for vantage continuity
- To track changes and developments on-site,
- To capture hazards or workflow impediments that would need to be considered in the implementation plan
- To map wildlife, invasive species and any habitat structures placed

2.1.4 Utility Corridor Considerations

When working in a utility corridor, meadow restoration implementation requires unique considerations and approvals from facility owners and land managers. Some details to include in the project proposal package (concept plan and project outline) are as follows:

- The location of all utility facilities (towers, centerlines of conductors, poles, etc.) potentially affected by the proposal to be shown and clearly labeled
- The planned installation and location of any structures above or in-ground be documented and include design drawings for typical structures (that also shows any grounding rods), such as bird boxes, shrub and meadow habitat, wetlands, etc.

- All buffer zones to be mapped, including:
  - a 15-metre (50 ft) buffer around all towers that will be kept free of woody stems
  - a 6-metre-wide access road for maintenance vehicles that will be kept clear of woody material or debris other than meadow
  - a 3.25-metre (10.7 ft) mown buffer along trail edges
  - a 5-metre (16.4 ft) mown buffer bordering adjacent property
- It is preferable that trails and structures are located where there are gaps in the lines, not directly under utility lines if possible
- The swing of power lines must be considered for built infrastructure, such as bridges
- Native shrubs, forbs and grasses species mixes need to be reviewed as height restrictions with utility lines may be in place

Figure 8:
When submitting a project proposal for meadow restoration in a utility corridor, make sure to outline locations for any habitat structures such as bird boxes you hope to install. Their locations will need to be approved to ensure that site access and maintenance is not hindered by any planned structures.

2.2 **SPECIES SELECTION**

2.2.1 **Seed and Plant Selection**

Based on the findings of the site and habitat assessments, we can determine the ecosystem community that best reflects the project area. For The Meadoway, two comparable healthy areas close to the project site were selected for further investigation of species diversity: (1) the High Park Black Oak Savannah, and (2) the Rice Lake Prairies. Good species inventories were available for both communities and were compared to the species identified in the TRCA flora monitoring data for the Toronto region.

The following factors should be considered when selecting seed:

- Focus should be on native species that are indigenous to the area. Do not use cultivars or non-native plants.
- Seed selection should be determined by the abiotic components of the site (soil, hydrology, pH), as species preferences and tolerances need to match these elements.
- A wide variety of species with differing bloom times should be selected to provide higher biodiversity and increased resilience. Ideally, aim for genetic diversity in the seed stock.
- Acquisition of local stock or plants from within the same seed zone should be researched and considered. Seed from local sources is better adapted to local climatic conditions.
- Keep in mind potential environmental changes associated with climate change by looking outside your seed zone. Plants from a variety of sources and microclimates may be better at adapting to changing ranges and conditions. These plants would be from different ecotypes and would have a wider range of growing conditions, which could contribute to increased adaptability and resilience.
- Base species selection on growing requirements: sun, precipitation, tolerance to disturbance, required soil conditions, flowering ability, the timing of flowering and growth season.
- A decision on percentages of forbs vs grasses should be made before selecting individual species. This percentage will depend on the meadow habitat type you are trying to achieve.
  - Emphasize flowering species which promote pollinator habitat; a range of flowering plant species should be chosen to provide blooms throughout the entire growing season (from early spring through to fall). This way, food for pollinator species will be continuously available, especially during crucial shoulder season months (March to April and October to November) when there is a lack of abundant food types available.
  - Look to plant host species that align with local butterfly and moth species to increase beneficial use of meadow habitat (e.g., monarch butterfly (Danaus plexippus) to milkweed species (Asclepias sp.)
  - Note, grass species are important to meadow habitats as they provide suitable nesting habitat for grassland birds, act as a food source for insects and birds, and help outcompete non-native species.
  - Mixes should have a component of grass and forbs to promote a resilient ecosystem. This can range from a forbs-dominated mix (containing 70 percent forbs) to a grass-dominated mix (70 percent grasses), depending on the goals of the project.

LESSONS LEARNED

Matching local flora species from surrounding landscapes to project sites enhances resilience and biodiversity.

Site appropriate biodiversity is key to ecosystem resilience.

Figure 9:

A. Smaller forbs' seeds lie on top of larger grasses' seeds in a seed bag before being mixed thoroughly to ensure as consistent a mix as possible is spread over the site so that smaller forb seeds do not all fall to the bottom of the bag and get dumped all in one place at the end.

B. Meadoway staff collect local seed each season to introduce seeds adapted to local conditions into the gene pool within the meadow.

  - Seeding rates will vary depending on the mix but should aim for a consistent cover based on the number of total seeds per square meter rather than weight of seed (as there is a large variety of seed sizes).
  - Selecting a mix of both warm and cool-season species ensures year-long habitat resources and maintains visual interest for the public.
- Often seed availability is a limiting factor for many species; suppliers tend to choose species adapted for growing in large quantities. To increase species diversity, consider adding plants whose seed is difficult to locate. Community plantings and infilling with these species can enhance the diversity of the site.
- Avoid the tendency to use only easy-to-grow species and/or avoiding rarer species that have more specific requirements. This leads to large areas dominated by the same species and does not reflect the diversity of naturally occurring ecosystems.
- Knowledge of the growing patterns of each species will help managers anticipate the timeframe for occurrence and maturation within the restored meadow site. Some native plants may have more difficultly recolonizing due to complex reproductive strategies or seed dispersal methods, thus appearing late in the restoration process. Others will occur early following seeding and can act as placeholders as the meadow site evolves. Selecting a variety of species with different colonization and maturation times creates successional growth within the meadow, allowing for different habitat elements throughout its evolution.
- Use of different seed mixes in different areas can help promote adaptation, diversity and germination. Also match mixes to specific segment needs throughout the meadow: in areas of high public visibility, use a mix with more forbs; in areas with high levels of invasive species competition, use a more resilient mix.
- Final seeding of the meadow should be diverse and aligned with project goals.

2.2.2 **Woody Species Selection**

Although The Meadoway project is primarily concerned with restoring meadow habitat, shrub species have been planted throughout the corridor in small, designated nodes creating a variation in habitat. Shrub species were chosen based on the following criteria:

- Species should be native to the region and approved for height of growth by the utility company.
- Species should provide habitat and/or food source for wildlife. Many species selected have large showy flowers (e.g., purple-flowering raspberry, ninebark and elderberry) that add aesthetic value and, more importantly, provide a food source for pollinators and birds and other wildlife.
- Mid-sized shrubs provide perching spots for songbirds and raptors, as well as places to build their nests. The shaded ground beneath these shrubs is home to a variety of small mammals, and the shrubs provide camouflage for burrows, dens and deer beds.
- When planning locations of shrub nodes, keep in mind trail placement and sight lines for maintaining public safety. Keep vegetation short within 3.25 metres of the trail edge on both sides to allow sight lines to be clear for users. Shrubs should only be planted beyond the 3.25 m grass buffer.

Figure 10:
Shrub species for shrub nodes are selected for their habitat and food source value for wildlife, appropriate height for the utility company, and aesthetic aspects such as fall colours or showy flowers. Pictured here are Ninebark flowers, Nannyberry fruit, and fragrant sumac fruit, three shrub species planted in The Meadoway shrub nodes.

3.1 Implementation

3.1.1 Implementation Schedule

Use of an implementation schedule tool is important for planning and tracking work activities, as well as meeting timelines during the field season. Gantt charts were used for The Meadoway project (see an example of this kind of scheduling bar chart in Appendix 1). Due to the successive nature of meadows, as well as the duration and size of the project, thorough planning was needed to ensure deliverables and objectives were achieved on time. Each activity needs to be well understood to ensure the accurate prediction of duration and timing.

3.1.2 The Location of Buried Infrastructure

Before starting any excavation, detailed buried infrastructure locates must be completed to ensure the safety of staff and prevent potential damage to infrastructure and equipment.

Meadow restoration work generally occurs at shallow depths; however some infrastructure, such as buried vital gas mains, have specific regulations preventing excavation within a certain setback. For example, a vital gas main runs through some sections of The Meadoway, which precluded any tilling within 3.5 metres (11.5 ft) of the pipeline; therefore, alterations were made to the plan to employ no-till techniques within these setbacks.

In Ontario, most locates on infrastructure corridors can be completed through the Ontario One Call website www.ontarioonecall.ca. However, if the worksite includes sections of privately owned land, separate private locates may be required.

LESSONS LEARNED

When starting the planning phase, collect all utility locates.

3.1.3 **Equipment Considerations**

Site safety is imperative in any restoration process both for staff and members of the public with access to the space. Place signage and/or fencing to inform the public of the work and to delineate safe distances. Staff operating machinery need to be properly trained and follow specific policies and procedures regarding equipment particularly around the public. Other helpful tips include:

- Working in urban utility corridors may require moving a lot of equipment along corridors crossed by roads, railways, bridges and ravines. To reduce costs, select equipment that is narrow enough for single lane travel and that can be driven on the road.
- When choosing equipment, look at access points and note potential impediments, such as utility poles, light posts, road-crossing fixtures, bollards, signage and low wires that may limit access by larger/taller equipment. This information will help in planning potential routes or alternative movement options that may need to be considered.

Figure 11:
The Meadoway field staff perform a daily safety check on a tractor to ensure equipment is in good working order in case of damage caused by tampering overnight.

- Equipment storage and availability is a determining factor in the pace/timing of the project. Meadow restoration involves many activities; access to a variety of equipment is needed to complete these tasks. Budgets and stakeholder partnerships may influence these decisions.
- Equipment should be well maintained in good working order. Daily inspections should be undertaken, particularly in urban areas where the public has access to the equipment overnight and tampering could occur.
- Spill kits should be kept on hand in case of incidents; fueling should take place on nonpermeable surfaces in case of accidental spillage.
- Clean equipment protocols should be followed through best management practices.

3.2 **SITE PREPARATION**

3.2.1 **Garbage Cleanup**

At the beginning of the implementation phase of the project, remove all the garbage within the work area. Garbage removal will avoid equipment damage and foster greater public and neighbourhood acceptance of the restoration project. To discourage the illegal dumping of trash on a site, try to eliminate areas hidden from public view, increase visibility of the site, and post signage.

Figure 12:
The critical first step of preparing a site for restoration is garbage clean up. Any debris or garbage left in the meadow footprint can damage equipment used to prepare the site and at the very least take away from the aesthetic value of the site when it is broken up into many small pieces by a mower or tiller.

3.2.2 **Site Delineation**

Once garbage collection has been completed, delineate the site boundary by placing posts with temporary signage every 50 metres (164 ft) around the meadow footprint boundary. This will help mark the site border and inform the public on the meadow restoration process. The posting of bold "No Mow" signs will also help prevent accidental buffer mowing (for examples of such signage, see Appendix 3).

Figure 13:
Bucket loaders are useful during the clearing stage as they can help dig out and remove stumps from the site.

3.2.3 **Clearing/Mowing**

Once the layout of the site is marked, some initial clearing may be required, including the removal of invasive species, grubbing of the site (which entails the removal of non-native trees, shrubs, stumps and excess thatch), and undertaking an initial mow. Additional tips include:

- Use a tractor or skidsteer with a bucket for light grading and removing small shrub stumps.
- Use an excavator with thumb attachment for larger brush that needs grubbing, for removal of an entire tree and stump, and for piling of wood debris. Be sure to get approval from utility company prior to using an excavator in the corridor; there may be concerns about proximity to infrastructure.
- If land use will allow, wood debris can be stored on site and utilized for a variety of habitat features, such as brush piles and snake hibernacula. For utility corridors that require emergency access, this may not be permitted.
- There may also be concerns about habitat features being hidden in vegetation and vehicles colliding with woody habitat.
- Chainsaws can be used to fell trees, but stumps should be either removed or marked as they could pose a potential hazard during the preparation cycle or to utility service vehicles. Use a stump grinder to prepare the ground if tilling is to take place; otherwise, cutting the stump flush to the ground will prevent damage to vehicles. The removal of any large standing trees needs prior approval from the utility company due to the hazard of contacting overhead lines.
- If the site is in a highly public area – that may have trails or open grassed/treed areas that will remain manicured – removal of tree limbs to the height of the mowing equipment will make future management easier. Tree bases will often become hotspots for invasive vegetation and access will allow easier management.
- Depending on the initial site status, mowing with a heavy-duty brush mower can be beneficial. This will reduce the residue for tillage work, prevent equipment binding and aid herbicide application (if such use is planned).

3.3 PREPARING FOR SEEDING

3.3.1 Depleting the Weed Seedbank

Site preparation is the most critical step in ensuring the ultimate success of a meadow revitalization project. It is designed to create the ideal grounding conditions for the establishment of native wildflower and grass seeds. The time and amount of work involved may vary depending on current site conditions, but proper preparation is a necessity.

The primary goal of site preparation is to deplete the seedbank of weed species and invasives (i.e., the seedbank comprises the places in the soil or attached to the mother plant where seeds collect and reside until germination). Without good site preparation, the native meadow seedlings may be overrun with weeds, requiring more extensive and expensive invasive species management in the future. Removal of non-native vegetation will reduce competition and give native seeds the best possible start.

There are multiple ways that site preparation can be accomplished by using a variety of equipment types, techniques, and repetition of soil preparation practices. Methods to prepare the soil may include tilling, plow, smothering, solarizing, and herbicide applications or a combination of these activities. The overall goal of site preparation is a flat, firm seedbed, with little to no weed/invasive species growth remaining.

Figure 14:
As pictured above, the end goal of site preparation is a flat, packed seedbed that has been depleted of invasive and undesirable species seeds and has limited to no weed or invasive species growth.

3.3.2 **Site Preparation Scenarios**

For illustrative purposes, examples of site preparation schedules and tasks, based on (1) a low budget scenario, (2) for corridors outside the city, and (3) inside the city using a least chemical method, are set out in the Site Preparation Scenarios table.

Figure 15:
Discs can be used in tandem with other techniques to break up the soil (eg. harrows, tilling). This technique is faster than tilling and does not require a packed seedbed, but it is not as thorough and may leave some large soil clods behind.

Site Preparation Scenarios

OPTION 1	OPTION 2	OPTION 3
Low budget (in trial 2021)	**Rural method**	**Urban and "least chemical" method**
• Mow the site and then plow the field • Wait 2-3 weeks to dry the soil and kill the roots, then harrow, disc or fast rototill to flatten the furrows • Wait 3-4 weeks, then broadcast spray (optional) • Wait 3-4 weeks, then broadcast spray (optional) • Fall broadcast seed with native seed and a cover crop and pack down • Next year, seed a spring nurse crop, spot spray for invasive species in late May; follow with an August mow • Spot spray for invasive species for 2-3 years and then as needed • Ongoing maintenance: spring mow every 3-4 years or periodic burn	• Mow the site and then plow the field (burn and till is also a good option if it is possible to get a burn permit) • Wait 2-3 weeks to dry the soil and kill the roots, then harrow, disc or fast rototill to flatten the furrows • Seed and pack Roundup Ready™ soybeans (70 kg/ha); farmer could get a crop • Spray as needed (approximately twice) • Fall mow to take down the crop or harvest the soyabeans and seed with a native seed mix • Next spring, broadcast spray before native germination if needed • Seed a spring nurse crop, spot spray for invasive species late May; in August, mow to knock down weeds (set mower above the tops of the native herbaceous species) • Spot spray for invasive species for 2-3 years and then as needed • Ongoing maintenance: spring mow every 3-4 years or periodic burn	• Mow the site and then plow the field • Wait 2-3 weeks to dry the soil and kill the roots, then harrow, disc or fast rototill to flatten the furrows • Seed and harrow oats cover crop in to hold the soil • Wait 3-4 weeks (until the oats are 10 cm tall) then rototill, harrow or disc the oats in and reseed the oats (75 kg/ha) • Repeat 3-4 times to deplete the seedbank • In the fall, seed the native seed mix with an oat cover crop and pack the soil for good seed-to-soil contact • Next spring, seed oats or millet as a nurse crop; broadcast spray before native germination if needed to control early weeds • Spot spray for invasive species; in August, mow to knock down weeds (set mower above the tops of the native herbaceous species) • Spot spray for invasive species for 2-3 years and then as needed • Ongoing maintenance: spring mow every 3-4 years or periodic burn

3.3.3 **Cover Cropping Protocols**

3.3.3.1 **Tillage**

Physically uprooting vegetation and turning over soil (allowing it to desiccate), followed by seeding of a low-density cover crop to reduce soil erosion, will decrease the seedbank, level the soil profile and prepare a seedbed.

It is recommended that several repeated rounds of tilling and cover crop be completed throughout an entire growing season. Each round should allow the cover crop and seedbank to germinate. Allow it to grow for a three-to-five-week interval, or before weeds and cover crop reach a height of 10 cm (4”), then repeat additional tillage rounds afterward. Do not let cover crops grow over 20 cm (8”) to prevent birds nesting during site preparation.

If completed with enough frequency (i.e., three to four cycles from April to October), the seedbank can be dramatically reduced and result in good establishment of native seed through fall or spring seeding.

Multiple tilling will increase costs, so confirm the size of your site preparation budget prior to selecting your process.

Many different tools can be used for turning the soil, all with different associated benefits and costs. Some will be better at fully removing the root systems or chopping up the soil to create an even seedbed. The tool used will also depend on your soil conditions, underground utilities, ground cover and terrain.

Figure 16:
Four tractors tilling (turning over the soil) in a section of The Meadoway where oats have been planted as a cover crop to hold soil in place.

LESSONS LEARNED

After several years working on successive sections in The Meadoway, and to reduce the amount of herbicide application, site preparation techniques were refined. The current site preparation process consists of a minimum of four (up to five) cycles of mowing, tilling and seeding a cover crop of annual oats. Herbicide applications are only used in specific instances where tilling is not permitted, such as buried infrastructure setbacks.

LESSONS LEARNED

Where no-till spaces run through a standard till area (gas pipeline), the no till area is sprayed with herbicide just prior to tilling the remaining areas that are tillable. The entire section is then seeded with a cover crop of oats by broadcast seeding (two weeks after spray) and a chain harrow is dragged over both tilled and un-tilled (sprayed) sections to incorporate the seed. Results have shown that greater than two cycles of tilling are more effective at reducing the competitive weed and invasive seedbank than herbicides and will result in more successful establishment of the native seed.

Advantages and Disadvantages of Various Site Preparation Equipment Options

Method	When to use	Advantages	Disadvantages
Rototiller	• Can be used at any stage of repeated tilling	• Adjustable depth • Destroys soil clumps • Good manoeuvrability	• Very slow • Requires packing to firm the seedbed
Moldboard Plow	• Dense grass/heavy weed pressure • Large sites • Relatively flat open areas	• Effectively breaks up turf • Reduces compaction	• Leaves an uneven surface needing additional secondary tillage (disc/rototiller)
Discs	• After initial turf has been broken up and repeated rounds of cultivation	• Relatively fast • Usually used in combination with other equipment	• May leave clumps behind
Herbicides	• A few weeks before any cultivation starts or early spring (after fall seeding) before warm season emergence	• Kills off non-native weeds	• Herbicide can stay in soils for a few weeks (try to move away from herbicide use where possible)
Solarizing	• Small sites (<0.25 ha) • Lower weed pressure • UV-stable plastic available	• Once installed, needs little repetitive maintenance throughout season	• Not effective on some weed species (e.g., Canada thistle) • Damage by animals (deer)

Additional tips learned during The Meadoway project include:

For hard soil surfaces (i.e., mowed turfgrass), use of a tractor-mounted rototiller works well. Turn under the existing vegetation/ soil in one pass. Great for use in smaller or tight areas or on steep slopes.

For a dense field of mowed grass, use a moldboard plow as it will invert the soil profile to a preferred depth and allow the weeds and roots to decompose and dry out. This method does not break up the soil and leaves the ground rough and uneven. Follow by discing, rototilling or using a cultivator to break up and level the soil (note, this may require more than one pass).

Offset discs, can be used to scrape surfaces and bury weeds or cut deeper and break up the soil crust. The weight of the unit will often control how deep it works the soil; additional weight could be added if looking to cut deeper. Often used in conjunction with the moldboard plow for levelling and breaking up large clumps.

Some meadow restoration work may be sited in a former agricultural field that has been in crop.

If a former agricultural site has no weeds (i.e., it is covered with only minor stock stubble from a freshly harvested agricultural crop), there is no need for site preparation as weed competition is minor. Sow seeds directly into site in November/December (frost seeding) after crop harvest. Consult with the previous farmer to learn if herbicides were used in the past, as these might affect the germination of native species (depending on what product was used).

If a site has limited weeds (interspersed within remaining agricultural vegetation), undertake a light/shallow cultivation with discs, harrows or other single pass cultivators. This may be sufficient to uproot vegetation and turn over the soil. Limit cultivation to 5 cm (2") in depth so as not to access the hidden seedbanks in soils.

Older, abandoned fields or mowed turf with high weed pressure (or aggressive species) will require initial tillage using a rototiller or plow to flip the soil. Depending on budget and location, a local farmer may be able to assist with the cultivation stages of the work.

Many other cultivation tools exist (such as: sweep cultivators, a spring tooth harrow, chisel plows, etc.), which may be an option for your site. Meadow site preparation techniques are always adapting and evolving, while research is continuously fine-tuning the best management practices for site preparation.

3.3.3.2 Cover Crop Seeding Methods

Following the tilling, a cover crop is seeded in the prepared soil bed. Generally, annual oats (Avena sativa), proso millet (Panicum miliaceum) or winter rye (Secale cereale) serves as a cover crop, depending on temperature and the time of year seeding occurs. Annual species are used due to their rapid germination and maturation timing, low cost, and ease of removal.

Seeding of a cover crop is intended to reduce the impact of soil erosion by wind or rain, while still allowing the seeds present in the soil room to germinate. The use of a cover crop also improves the aesthetics of the site, increases soil moisture retention due to shading and, when tilled under during the next round of preparation, acts as green manure.

Best management practices (BMPs) for seeding, as set out by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), are to broadcast seed (oats for spring/summer seeding or rye for fall seeding), and then harrow the seed into the soil. This helps break up soil clumps, makes a finer seedbed, and incorporates the seed so that germination is faster and the length of time soils are exposed to wind erosion is minimized.

LESSONS LEARNED

Oats are used primarily for cover cropping in The Meadoway at a rate of 75 kg/ha. This level of seeding produced germination rates that were dense enough to prevent colonization by new invasive species, while also allowing seeds from the current seedbank to sprout. Additionally, oats are allelopathic (i.e., they produce compounds that suppress the growth of other plants). Depending on how much cover is desired, the seeding rate can be reduced or increased. Lower application rates will encourage greater weed growth, but still hold the soil in place.

Figure 17:
Cover crops, such as oats seen here, are permitted to grow for 3 – 5 weeks or until they reach 4 inches (10 cm) in height, and then a round of tilling is conducted followed by re-seeding of the cover crop. This is done 4 – 5 times in a growing season to deplete the weedy / invasive species seed bank before seeding the site with native seed mix.

Figure 18:
Chain Harrows are a simple implement that do not require connection to hydraulics and can be dragged behind a tractor. They work to prepare the soil by levelling the ground and pulling out root wads and are often used in tandem with other techniques.

Figure 19:
Cultipacker rollers (with knobs/ spikes) as seen above help to incorporate seed into soil in addition to compacting the soil and removing air pockets. They are essential to ensure adequate seed-to-soil contact during fall seeding so that seeds are not washed or blown away.

3.3.3.3 **Harrowing**

Chain harrows are useful in:

- Levelling the ground to prepare the seedbed
- Pulling up root wads to assist in desiccation (especially if the tilling is done in damp/wet soil)
- Incorporating the cover crop seed

They do not help with compacting the soil to ensure good seed-soil contact, so they may need to be used in conjunction with a packer if using a seed drill. The mounts tend to build up with thatch and debris, so a clean site is essential before pulling these around the field.

3.3.3.4 **Rolling/Packing**

The use of a roller or packer is not necessary with each round of site preparation but is a good alternative to using the chain harrow after broadcasting a cover crop.

Air pockets, large dirt clods and an uneven planting surface can all negatively impact seeding success. A packer roller will downsize clumps and firm the soil to create a seedbed that has uniform density and set the stage for good seed-to-soil contact.

The cultipacker rollers (knobbed or spiked roller) are effective at both firming the soil and incorporating the broadcast cover crop seed, which is essential for fall seeding with a seed drill.

LESSONS LEARNED

The Meadoway project conducted a variety of trials on cover crop application processes involving various combinations of methods, including seeding by hand, using a seed drill, broadcast seeder, harrow and tow-behind roller.

These trials found that the use of a broadcast seeder combined with a chain harrow or a packer roller worked best to increase seed-soil contact. This combination also produced the most successful germination rates and required minimum staff/equipment time.

Both the harrow and the packer will break up dirt clumps and incorporate the seed into the soil, speeding germination time, as well as reducing the amount of seed lost to wildlife.

3.4 HERBICIDE APPLICATION

Figure 20:
The Meadoway spray team has found that setting up 'lanes' for each spray technician marked out by tall flags helps to efficiently conduct herbicide application over large areas using backpack sprayers.

It has been our practice in The Meadoway project to minimize the use of chemical herbicides wherever practical. However, herbicide application may be used as a tool to assist with site preparation, depending on certain factors, including: the initial site assessment, location of the site, proximity to neighbours, invasive species pressure, and/or the presence of equipment (such as buried infrastructure) that precludes the use of mechanical clearing and tillage.

Prior to using any herbicide, all best management practices (BMPs) should be reviewed and weighted to provide the best practice for each site and reduce the need for herbicide applications. Additionally, all regulatory aspects of herbicide application must be adhered to.

Two chemical herbicides have been employed on a limited basis in The Meadoway: (1) glyphosate and (2) triclopyr. The invasive species most often targeted for spot treatment sprays with glyphosate include (but are not limited to): Canada thistle (Cirsium arvense), dog-strangling vine (Cynanchum rossicum) and spotted knapweed (Centaurea sp.). Triclopyr-targeted spot treatment has been used on European buckthorn (Rhamnus cathartica).

3.4.1 Glyphosate

Glyphosate, the active ingredient in Roundup™, is the most widely used herbicide in Canada for controlling many weeds and invasive plants. Glyphosate is a non-selective, systemic herbicide that is applied directly to plant foliage and moves systemically through the plant once it has entered the waxy leaf cuticle. Since it is highly water soluble, it does not penetrate waxy cuticles well and requires the use of a surfactant (a detergent) to support the transfer across this protective barrier.

Plants exposed to glyphosate display stunted growth, loss of green colouration, leaf wrinkling or malformation, and tissue death. Glyphosate kills plants by inhibiting a specific enzyme that allows plants to make amino acids. Plants will start to die off approximately nine days after being sprayed.

For sites with very high invasive presence or containing buried infrastructure (that does not permit tilling), an initial blanket spray of glyphosate is often used to reduce non-native/invasive/weedy vegetation on the site. This can significantly improve the success of meadow seeding and restoration.

3.4.2 **Triclopyr**

Triclopyr can be sprayed on the trunk/stem of smaller shrubs and will be absorbed into the roots to prevent suckering and regrowth. Cutting of larger trees can be done, followed by spray application to the stump. Alternatively, during a maintenance mow, a crew can follow along behind the mower and spray the stumps.

Figure 21:
Basal application of Triclopyr (Garlon) to young Common Buckthorn.

Figure 22:
Trial plots such as this one have been established in dense patches of invasive species to test effectiveness of organic herbicides like agricultural vinegar and Finalsan® (ammonium soap of fatty acids).

3.4.3 **Addressing Public Concerns**

During The Meadoway project, there was significant public concern about – and resistance to – the use of herbicide applications for site preparation and/or the control of invasive species. Completing a herbicide communications plan can help address such concerns; refer to invasive species BMPs, (specifically herbicide alternatives) as a guide to avoid use where possible. When concerns inevitably arise, face-to-face conversations with the public are suggested, to explain why the spray is needed and to address any concerns.

It is recommended that soil samples be used to highlight glyphosate degradation curves over six months in the soil near homes and community gardens; this also helps to showcase the lack of movement of glyphosate once dry in the soil. Herbicide amounts used in meadow restoration operations are far less than what are used in industrial agriculture or forestry practices. Within The Meadoway project, glyphosate was applied at 5% concentration for spot sprays and blanket sprays.

3.4.4 Use of Organic Herbicides

The Meadoway team has been researching and field testing a variety of organic herbicides, including: agricultural vinegar, chelated iron (Scotts® Weed B Gon MAX), and an ammonium soap of fatty acids (Finalsan® Non-Selective Organic Weed Killer). While trials are ongoing, thus far Finalsan appears to be the most effective in reducing dog-strangling vine and could potentially be a good alternative to glyphosate spray. More testing is required.

3.4.5 Alternatives to Herbicide Use: Mulching and Solarizing

Smothering the ground by placing layers of nitrogen and carbon-rich mulches 30 cm (12") thick over a weed barrier (such as cardboard) can be an effective way to prepare small sites and works well when the site is going to be planted with potted stock. However, this requires a lot of material and is not recommended for larger areas due to cost.

Solarizing involves placing clear UV-stable plastic over a site to "cook" the vegetation during the growing season. This method can be effective for smaller sites with low initial weed pressure. However, it is not effective on some weed species, such as Canada thistle. Solarizing requires large sheets of UV-stable plastic and a full sun-exposed site. This cover material is easily damaged by animals (especially deer) that will puncture the material reducing its effectiveness. Solarizing is not recommended in utility corridors.

4.1 Flora Establishment

The process and equipment selected for a meadow restoration project will vary depending on existing soil conditions, the presence of invasive species and prior land use. Once the area has been fully prepared, it can be seeded with a native wildflower and grass seed mix or planted with species chosen to match soil moisture content and texture.

4.2 SEEDING/PLANTING METHODS

Many methods of planting can be employed to introduce new vegetation to a site, including hand or mechanical seeding, bare root or scion planting, and the transplanting of potted plants. All three were used on The Meadoway project; however, due to the size of the meadows being created, seed drilling was the primary method used.

The use of a seed drill is the most practical for large projects, as it can: cover larger areas, ensure even distribution of fine seeds, and provide the good seed-soil contact necessary for germination. The drill must be specially adapted or designed for native seed (such as a Truax or Land Pride native seed drill). Unlike standard agricultural drills, these have special agitators and feed adjustments that will distribute fluffy native grasses and fine forbs at even rates.

4.2.1 Tips for Seed Drilling

- Weather considerations: do not use after rain or heavy dew. Wet soil sticks to the discs or rollers, picking up seed and/or causing the cutters to stop spinning.
- Terrain: hills and uneven terrain may change the application of the seed.
- Vehicle transport: it is important to understand how the equipment will be used within the site and how it will be moved from location to location.
- Soil preparation: ground must be firm.
- Sites that have rocky terrain or very thin soils, suggest broadcast seeding as a better option to protect seed drill equipment.

Figure 23:
Seed drills are advantageous for their even distribution of seeds but do require packed, flat and relatively dry soil.

4.2.2 Tips for Broadcasting Seed

- Seed can be broadcasted directly on the site by hand or power-driven broadcaster.
- Due to the very fine nature of many seeds, it is recommended that the native seed be mixed with a bulking agent at a ratio of 5:1 (bulking agent to seed) for more even distribution. The bulking agent could be sand, vermiculite, or a nurse crop of annual oats.
- The power broadcaster will need to have a modified agitator to pull the fluffy seed down to the feed hole, and calibration can be difficult.
- For smaller sites (e.g., less than one hectare), hand seeding may be a preferred option to reduce equipment costs. When broadcasting seed, one half of the seed should be spread in parallel lines and the other half in a perpendicular direction for even distribution.

4.2.3 Tips for Potted Plant or Bare Root Planting

- Potted or bare root planting is an effective way to increase cover quickly. However, this method is more expensive and is likely only practical for smaller, garden-style projects. Once planted, watering may be required to promote their establishment.
- Potted or bare root plants can provide a great opportunity for organized planting events utilizing the support of the public and/or private sector (e.g., involving the local community, school groups or corporate sponsors).

Figure 24:
Meadoway staff mix native seed with a bulking agent (e.g vermiculite or cover crop seed) when broadcast seeding to ensure that fine native seeds are more evenly distributed around the site by the seeder.

Figure 25:
Potted plants recently planted by volunteers at a Meadoway community outreach event.

4.2.4 **Timing of Native Seed Application**

Native seeding should occur during spring or late fall. Both these seasons typically experience increased rainfall and moderate temperatures. Lower heat and less chance of drought will reduce stress on the vegetation.

Up until 2020, The Meadoway was primarily seeded in the spring. Experiments were started in 2019 to look at the efficacy of fall seeding or frost seeding to increase forb germination rates. The results to date are promising; fall seeding may be as effective as spring seeding in The Meadoway. Time is still needed to determine if one method is more advantageous than the other, and trials will continue with both application methods to track progress.

4.2.4.1 Spring Planting

Planting in the spring is beneficial as growth rates improve with increasing exposure to sunlight and warmth, particularly for grass species.

One challenge to spring planting is that many forbs require a cold moist stratification period that will not be achieved until the following spring, so there is potential for forb seeds to remain dormant until the following year. Depending on your seed supplier, asking for seed to be cold stratified could help speed this process up.

With spring planting, the winter freeze/thaw will have firmed up the soil surface making it ready for a seed drill, eliminating the need to pack the site.

4.2.4.2 Fall Planting

Fall planting also has its advantages. During this season, plants are entering a state of dormancy and do not put energy into growth or reproduction, making transplanting at this time less stressful on the plant. Additionally, forbs that require a cold moist stratification to germinate will overwinter in the ground and be ready to emerge in spring.

Timing your fall seeding must be done carefully, as soils will start to get wet come November; seed drills have trouble seeding if soils are not dry. Seed drilling directly into a light frost will help with this process.

Figure 26:
A front mounted seed drill on a skid steer spreading native seed in the spring.

Figure 27:
Fall seeding of native seed in The Meadoway ensures that forb species' seeds that require winter stratification will be able to germinate the following spring.

Figure 28:
Native forb seeds go in their own hopper (compartment) within the seed drill implement, separate from the larger grasses' seeds. This ensures that the large and fine size seeds are both released at appropriate rates.

4.2.5 Development of Seed Mixes

In the early stages of The Meadoway project, seed mixes were originally dry and wet mixes composed of 60 to 70 percent forbs and 30 to 40 percent grasses. Over time, additional seed mixes were created to:

- Increase species diversity
- Better match the various soil characteristics found across the project area
- Increase the benefit to wildlife and pollinators

Wet areas received seed mixes containing a mesic/wet-mesic mix of meadow species, chosen for their tolerance to wet/moist soils. A mix of the hardiest and fast-growing native meadow plants were chosen for areas with high amounts of invasive species to better combat their spread and establishment (see Appendix 2: The Meadoway Seed Mixes).

Based on the results of The Meadoway seeding practices, a mix with approximately 650 seeds/m^2 will produce a good stand. At this rate, mixes would be put down at the following rates:

- 13 kilograms/hectare (11.6 lb/acre) for forb-dominated mixes containing mostly small seed
- Nearly 20 kg/ha (17.8 lb/acre) for mixes with a greater portion of larger grass seed

4.2.6 Use of Nurse Crops

Nurse crops are cover crop species (such as annual oats or millet) that are planted prior to the native seeding and, once established, help shade the emerging native seeds so they do not dry out as fast. Separate trials using either oats or millet were undertaken and reviewed during The Meadoway project. For this specific project, oats were the preferred cover crop within The Meadoway.

Figure 29:
In The Meadoway nurse crops such as oats or millet are allowed to grow to 5 – 10 cm before native seeding. These nurse crops provide beneficial shading to emerging native seedlings preventing desiccation.

The nurse crop was seeded before the application of native seed and was allowed to grow 5-10 cm (2-4") in height prior to native seeding. This allowed the crop to germinate and become well established before the disturbance caused by the seed drill. As these nurse crop species are types of grass, they are better able to withstand the compaction and disturbance of the drill.

Over time, it may be possible to use seed collected from well-established sections of the meadow to seed newly prepared areas. Use of this local seed would ensure that it was produced within the targeted seed zone and it is adapted to local environmental conditions. The ability of these established species to successfully grow and reproduce in the area is both a measurement of success for those specific species and clear indication of a self-sustaining ecosystem. Seed collection should be undertaken ethically, limiting the amount that is collected and avoiding collection of the same species or within the same area year after year.

4.3 SHRUB NODES AND TURFGRASS BUFFERS

4.3.1 Design and Maintenance

Shrub nodes and mowed turf buffers were included in the initial planning and are recommended in urban areas where public use is authorized within the meadow (e.g., trails). In The Meadoway, shrub nodes are typically included: at the edge of water features, in ravines, and in other areas that already feature native shrub cover, as well as in nodes along the edge of the meadow to add habitat diversity.

Shrub nodes are kept away from the actual meadow to increase the meadow footprint while minimizing the edge effect of the shrubs. Turfgrass buffers surround the meadow and shrub footprints serving to primarily ensure access and maintenance. They also help to prevent the spread of invasive species, delineate boundaries of naturalized versus manicured vegetation communities, and separate the trail from the meadow.

Figure 30:
Beautiful sunset views from The Meadoway.

All shrub nodes species must be approved by utility corridor managers and restrictions are in place on the height of species that can be used. In The Meadoway, TRCA works closely with City of Toronto to plan and design the shrub nodes, and the city implements and maintains them.

Buffers help create a defined space between trail-users, neighbouring properties and the meadow footprint. A larger buffer width (of five metres) between the meadow and the fence lines of properties was chosen to ensure that residents did not feel as though the meadow was encroaching on their property. Smaller widths were assigned to trail edges (3.25 m) and shrub node borders (a single mower width of 2 m).

With respect to mowing, regular placement of posts and signage depicts where the meadow footprint begins and helps delineate the exact route for buffer mowers, helping to prevent them from mowing into the meadow area. This signage is especially important when multiple agencies and/or contractors may be responsible for mowing.

A larger, rotary tow-behind mower on a tractor is best for large sections of grass and straightaways. A smaller ride-on mower can navigate turns easier and is better for maintaining shrub node buffers and border areas that curve. Line trimmers are used to clean up around signs, trees and fence lines. A backpack blower can be used to remove cut grass from trail surfaces after mowing.

Conspicuous "No Mow" signs help both the public and mowing contractors recognize the meadow footprint and modify their mowing actions. Pairing these "No Mow" signs with informational signage can provide a reasonable explanation for the limitation on mowing, as well as serving as an educational and regulatory tool.

Informational signs are placed and updated over a three-year timeframe:

- The Year 1 Sign indicates site preparation is occurring.
- The Year 2 Sign indicates that native meadow seeding has occurred.
- The Year 3 Sign advocates patience to allow the new native meadow to germinate and become established.

These signs are critical in the explanation of the environmental changes that residents and trail-users will be witnessing as The Meadoway project proceeds. (Note, examples of the "No Mow" and informational signs are displayed in Appendix 3.)

Figure 31:
A turf buffer such as the freshly mown one pictured above provides a 'neat and tidy' feel to trail-users as well as a small buffer zone to hinder encroaching invasive species from infiltrating into the meadow footprint.

5.1 Post Restoration

Figure 32:
Invasive species management is a continuous adaptive process in meadow restoration. Here The Meadoway field staff target a dense patch of Canada Thistle with manual removal instead of herbicide application or tilling because the patch is of a manageable size for hand pulling.

5.2 ADAPTIVE MANAGEMENT

Meadows and other natural systems are dynamic in nature and, if unchecked, experience subsequent stages of natural succession. To help ensure the original restoration objectives continue to be met following restoration, and that the site remains suitable for the operation of the utility, it will be necessary to prepare and implement an ongoing management plan. Management direction should conform to the goals and objectives of the site plan and will be informed by monitoring activities.

5.3 KEY PERFORMANCE INDICATORS

Understanding key performance indicators (KPIs) can aid in adaptive management, inform reporting deliverables within the organization, and support funding applications. KPIs are measurable results that indicate whether goals are being met and aid tracking the progress of the project. KPIs help to create qualitative and quantitative measurable matrices.

Examples include:

- Biodiversity index targets
- Terrestrial natural heritage system targets
- Surface temperature changes over time
- Climate change resiliency
- Additional natural cover
- Improved natural cover quality

5.4 SPECIES INVENTORIES AND BIODIVERSITY CONSERVATION MEASUREMENTS

Having a baseline inventory of the species present on the site pre-restoration is essential to understand changes in species assemblages and assessment of biodiversity targets. Species richness and abundance are expected to increase with time, but these changes need to be monitored (and be reported to funders and the public). Monitoring activities will be covered in more detail later in this manual.

Typical conditions to be monitored and/or documented include:

- Number of native trees and shrubs planted
- Kilograms of native seed used
- Quantity of invasive plants removed
- Changes in habitat connectivity
- Changes in the diversity of native species
- Changes in abundance and distribution of selected species (especially species-at-risk)
- Amount of carbon sequestered in plants and soils

Figure 33:
It is a good idea to keep a species list of all the species you observe each year at your site to be able to report to the public, partners and funders which species, such as this little Red-bellied Snake are benefitting from your meadow restoration project.

5.5 **BIOMASS REMOVAL**

To ensure native seed establishment and promote biodiversity, meadow restoration projects require a maintenance regime that is appropriate to the site and project objectives. In the absence of natural disturbance, meadows will typically evolve into shrub and forest communities. Under natural conditions, this succession may be prevented either by periodic fires, animal grazing or by a very dry or very wet climate that discourages the growth of woody-stemmed trees and shrubs.

Mowing or burning is beneficial in the first years of establishment, followed every three to five years afterward to prevent succession. These activities are generally carried out in the very early spring or fall when the plants are not growing.

Early spring mowing or burns allow the standing cover to remain as habitat and food sources over the winter, but spring maintenance can be hampered by oversaturated soil conditions if using larger tractors for mowing. In The Meadoway, burning is not an option, so mowing and discing are used to break up the thatch in the spring.

Depending on the size of the project, maintenance should be planned on a rotating schedule that leaves a portion of meadow untouched each year. These areas will remain as refuge for many species that use the standing vegetation for food and shelter.

5.5.1 **Mowing**

The meristems (i.e., growing parts) of most meadow plants are situated close to or underneath the ground surface, so mowing does not affect the re-growth of the plant. Infrequent mowing can work to stimulate the growth of these well-adapted plants.

Mowing is generally done in the spring or fall using a rotary mower or flail bar mower attached to a tractor. The height of the cut can differ, but generally a low mow is used within The Meadoway.

If mowing in the spring, care must be taken to ensure that this is done before bird nesting season to avoid the impact on nests and conform with the regulations under the federal Migratory Birds Convention Act, 1994. More information regarding the scheduling of mowing operations can be found using the Nesting Calendar Query Tool, an app available on the Birds Canada website birdscanada.org/apps/rnest/index.jsp?lang=EN.

Thatch may begin to build up after successive mowing, which is not ideal for meadow health. If your site will allow, rake and pile the thatch into compost piles; otherwise, baling and off-site disposal may be needed to keep the thatch layer to a minimum. In cases where a heavy thatch layer is developing, scarification using a disc plow, rotary mower or flail mower may help to break up thatch layers. This can be accomplished after a maintenance mow to further break up some of the thatch layer, burying some and opening bare soil.

Figure 34:
A thick thatch layer as seen above can build up after maintenance mows of the meadow footprint. Discing can be done after maintenance mows to try and break up some of the thatch layers and incorporate it into the soil, or if possible raking or baling may be done to remove thatch from the site.

5.5.2 **Burning**

Historically, fire was a natural agent that maintained meadows. Prescribed burning can be a very effective method of removing thatch buildup, as well as shrubs and trees that start to grow in the meadow. It will also help encourage the growth of native species, stimulating fire-adapted meadow species to spread and fill out. Burning may not be practical or even allowed depending on jurisdiction and, in any event, will require special burn permits. While fire is an excellent management tool, overuse of fire will bias the species composition toward grass dominance.

5.5.3 **Herbivores**

Rotational grazing with animals (such as cows, sheep or goats) can be another method to limit succession. Grazing should be done in rotations at low to moderate intensities. Grazers typically do not eat below the meristematic tissue of native plants at these intensities, allowing the plants to re-grow following grazing.

High intensity grazing can negatively affect native grasses, as grazers typically eat the plants right down to the ground (below the meristematic tissue), preventing the plant from growing back. Some grazers can also be trained to prefer certain invasive species. In The Meadoway, grazers have not been used, but it is a technique that TRCA is interested in exploring, pending approvals from landowners.

5.6 **INVASIVE PLANT REMOVAL**

Management strategies will be required to deal with the re-establishment of invasive plants within the meadow site and prevent them from outcompeting and replacing native species. This can be an ongoing challenge in urban meadows, especially if numerous species are targeted.

Special focus should be given to site borders and trail edges, as these areas have greater potential exposure to seeds of invasives. Utility corridors are vulnerable to re-introduction of seeds carried by wildlife and from adjacent properties that are colonized by invasive species. It is important to communicate and collaborate effectively on this problem with neighbouring stakeholders.

Frequent, accurate monitoring and mapping of high-density spots or new populations can help determine priority areas to be managed. Both baseline and follow-up data are needed to refine future control practices.

The lifecycle of the target species should be understood and used to inform the planning of the control program. Early summer spot mowing can reduce the number of seeds produced by one species but stimulate growth of another. Mechanical removal activities are best performed prior to seed development to avoid dispersing unwanted seeds.

The timing of herbicide applications, if any, also depends on the target species, though land managers may have to optimize spot spray activities based on the resources available.

The projected timeline for the complete removal of invasive plants is a minimum of three to five years and should initially focus on high-density areas and species that present the greatest threats.

Priority species that are currently being removed or otherwise managed within The Meadoway include: garlic mustard (Alliaria petiolata), dog-strangling vine, Canada thistle, spotted knapweed (Centaurea stoebe), white sweet clover (Melilotus albus), European or common buckthorn, phragmites (Phragmites australis) and common tansy (Tanacetum vulgare).

Figure 35:
A field staff manually removes a large seed-bearing cluster of Dog Strangling Vine before seeds mature and spread within the meadow footprint.

Individual species are managed in accordance with the applicable Invasive Species Best Management Practices (BMPs), as published and regularly updated by the Ontario Invasive Plant Council (OIPC). Management is typically achieved through a combination of mechanical, biological and chemical controls. Each control method has advantages and disadvantages that should be weighed against the resources available.

LESSONS LEARNED

- Create a mown buffer between the meadow restoration footprint and adjacent shrub/forested areas.
- Over-seed invasive species management areas after BMPs are completed.
- A well-established meadow is effective in keeping out invasive species.
- Young plants are much easier to manage (either by pulling or the use of herbicide).
- Extreme heat reduces glyphosate intake.
- A refined ArcGIS Field Maps app is available for mapping, tracking and coordinating an invasives program.
- Organize community/corporate weed pulling events.
- Use of chemical rather than mechanical methods can be more cost effective, but not always the best method environmentally.

5.7 **PUBLIC USE**

Monitoring of public use within the restoration site is ongoing during the restoration process. In addition, an array of tools is being developed and used to help educate the public and encourage stewardship of The Meadoway. These include:

- Signage (both informational/interpretive signage)
- Educational tools (brochures and social media)
- Informational events (walks, seminars, online live chats, etc.)

Interpretive signage along trails and meadow borders provides a description of the work and goals for the site. The contents and messaging of these signs are updated according to which phase of the restoration process a particular worksite has reached. Together, this information provides the public a deeper understanding and appreciation of the project goals and objectives. (See Appendix 3 for examples.)

Figure 36:
The recreational trail that runs through The Meadoway is frequented by many cyclists, runners, and walkers who enjoy exercising in the natural space the meadow corridor provides within Scarborough.

6.1 **Monitoring**

Ongoing monitoring is used to: continually track and reassess the establishment of the meadow community; measure the subsequent growth in wildlife diversity (both flora and fauna); and ensure minimal succession is occurring. Pre-implementation data collected before the site preparation phase serves as a baseline to monitor changes occurring during and after restoration.

Monitoring is done every year in Years 1 through 4, followed by every three years. This will ensure continuity in data and allow TRCA to accurately measure its success in meeting the restoration goals. Monitoring data typically includes:

- Vegetation plots or transect monitoring protocols
- Butterfly transects
- Bird transects

In addition, frequent monitoring of human activities by field staff is highly recommended. This can increase awareness of potential emerging issues or damage occurring to the meadows. The establishment of permanent photo monitoring points is also highly recommended to help track long-term changes.

More Information:

Monitoring activities are described in detail in the TRCA report: *The Meadoway: Vegetation, Bird and Butterfly Monitoring 2016, 2018-2020*. The report summarizes the results of the vegetation plot, breeding bird and butterfly surveys conducted in 2016, 2018, 2019 and 2020, as well as a review of the effectiveness of invasive species management efforts, and preliminary results of several experimental seeding plots.

6.2 VEGETATION MONITORING

The establishment of a vegetation monitoring protocol will allow staff to monitor the species diversity (richness and evenness) of the site and quantify and ensure that the overall restoration goals are met. The data collected can help monitor both natural and artificial (i.e., human-caused) changes at the population and community level.

To effectively create and carry out a vegetation monitoring plan, workers should be proficient in plant identification and understand both the ELC system and the restoration objectives of the site. The vegetation community should be evaluated based on: composition, diversity, density, frequency, structure, percent cover, and dispersion parameters.

This information will be crucial for evaluating the completion of the restoration goals, compliance with the ELC classification, and the control of invasive species, as well as informing future management decisions.

Special attention should be paid to any invasive plants found, particularly non-native invasive plants. The population of invasive plants could explode rapidly if left unchecked as they outcompete native species. If found, these unwanted individuals or populations should be geo-tagged with information, such as the life stage of plant, its relative abundance, and the size of the invaded area. Long-term patterns will be tracked to document the ratio and composition of native to non-native or unwanted species within the sampling quadrants. This will aid in the development and re-evaluation of a management plan to control these species.

The methodology for monitoring meadow ecosystems used by TRCA is based on the Ecological Monitoring and Assessment Network (EMAN) endorsed terrestrial vegetation biodiversity monitoring protocols identified by Roberts-Pichette and Gillespie (1999). As the EMAN protocol was originally intended for forest communities, adaptations to the protocol were made specific to The Meadoway's ecosystem.

Figure 37:
It is a good idea to keep a species list of all the plant species found within the meadow footprint as transect and quadrat sampling / monitoring techniques are less likely to pick out rare species occurrences such as this Hairy Beardtongue found in only a few isolated locations across The Meadoway site.

6.3 BUTTERFLY MONITORING

Butterfly surveying in The Meadoway consists of slowly walking a specified path (transect) through the meadow and identifying and counting all stages of butterfly species observed. Start and end times should be recorded and kept generally consistent over the long-term. Butterflies should be identified to species level (where possible) or to genus (if species-level identification is not possible). In The Meadoway, four visits were made each year to capture variation in adult emergence dates among species and migratory species. Surveys were conducted between 09:00 and 16:00 and only in good weather conditions (i.e., greater than 20°C, no rain, light winds).

Figure 38:
Butterfly monitoring within The Meadoway is conducted by walking transects throughout the site at specific times throughout the field year to target various species such as this Black Swallow Tail (male pictured here).

6.4 **BIRD MONITORING**

Meadow bird monitoring in The Meadoway has followed an adapted Ontario Forest Bird Monitoring Protocol. This protocol is also used for meadow bird surveys conducted through TRCA's Terrestrial Long-term Monitoring Program TRCA 2011.

Meadow birds are monitored twice during the field season with the first visit occurring between May 15 and May 30, and the second visit between May 30 and June 15, with at least 10 days between visits. Counts are conducted between 05:00 and 10:00 and at approximately the same time of day on subsequent visits from year to year. Counts are only conducted in good weather conditions (i.e., no rain, light winds). All birds seen or heard within a 100-metre radius and during a 10-minute period are recorded.

Bird data were interpreted using TRCA's local ranking and scoring system (L-rank) for fauna. Fauna L-ranks are based on scores for six criteria: local occurrence, population trends, habitat dependence, area sensitivity, patch isolation sensitivity and sensitivity to development. Ranks from L1 – L3 represent those species most at risk within the jurisdiction (being highly sensitive to habitat loss and disturbances), while L4 are species found more widespread regionally, and L5 species are presently not of conservation concern.

Figure 39:
Regular bird monitoring will reveal when breeding birds start to lay nests. A frequent resident of The Meadoway is the Killdeer who can lay multiple clutches in one growing season. Meadoway staff use tall flags to mark nests so they are protected during site maintenance activities involving equipment. Savannah Sparrow (top), sparrow eggs (middle) and Killdeer (bottom).

Figure 40:
The Meadoway drone operations team before the next flight.

6.5 RESEARCH OPPORTUNITIES

Ecological restoration projects offer many research opportunities for collaboration with universities/colleges, institutions, non-governmental organizations and the private sector. Research can involve investigations of invasive species BMPs, biodiversity enhancement techniques, seed research, root density sampling and literature reviews.

Additionally, unique urban naturalization projects such as The Meadoway also afford an opportunity to study the social and biocultural aspects of restoration and increased exposure to healthy natural areas. These efforts expand our collective ecosystem management knowledge, while raising and broadening awareness of and attention to The Meadoway project. A list of the research that has taken place at The Meadoway is presented in Appendix 4.

6.6 MONITORING UNSANCTIONED ACTIVITIES

Ongoing monitoring by restoration workers can help identify and document instances of vandalism, encroachment and other potentially harmful activities, including:

- Illegal dumping of trash
- Dumping of yard clippings and other organic wastes
- Unauthorized mowing within the meadow footprint
- Creation of new trails (such as mountain bike trails) through the meadow footprint
- Intentional introduction of exotics and invasives
- Use of off-road vehicles, motorbikes and other motorized vehicles

Use of the ArcGIS Field Maps app allows staff to record and geo-reference these issues, as well as append a photo to further illustrate the problem and direct appropriate action to address the issue(s). Field reporting and mapping can also highlight the need for additional communication and educational opportunities.

Figure 41:
Illegal garbage dumping is monitored, reported and cleaned up. Mapping problem areas allows for further outreach to reduce the frequency of these issues.

Figure 42:
Establishing fixed location photo monitoring spots at your site will allow you to track meadow restoration progress at your site.

6.7 **LONG-TERM PHOTO MONITORING**

Permanent photo monitoring points are specific, geo-referenced locations that offer a defined and permanent view of the restoration site. Taking numerous site photos over time from the same vantage point(s) can help:

- Track long-term changes wrought by restoration processes.
- Inform on progress toward restoration goals.
- Track succession of the vegetation community.
- Show evidence of invasive plant growth/removal.

Defined monitoring locations will allow the compilation of sequential and comparable photos and data points that can be used in reports to the public or stakeholders.

Footage captured by a drone or from a helicopter is another valuable way to document the meadow restoration project. Again, it is important to maintain the same vantage points and routes so changes over time can be visualized and documented. Within The Meadoway, all drone flights had to be pre-approved by HONI before TRCA could move forward with flights. Once approved, HONI or your electrical company will outline specific height restrictions for how low the drone can fly above the towers.

7.1 Community Engagement

Figure 43:
Community volunteer team posing with their impressive haul from an invasive species removal event.

The Meadoway provides opportunities for community groups, school groups and the public to engage with and learn about the project. From the start, outreach and informative events are important to educate and capture the imagination of residents and the general public. They also offer an opportunity to voice questions and recruit long-term stewards of these restored lands. Outreach at The Meadoway is ongoing and uses a variety of platforms to connect with the widest audience, including: newsletters, blogs, Twitter, Facebook, and Instagram (see Appendix 5 for examples of public communication examples). Documenting outreach efforts will also help with funding and with tracking the societal and community impacts of the project.

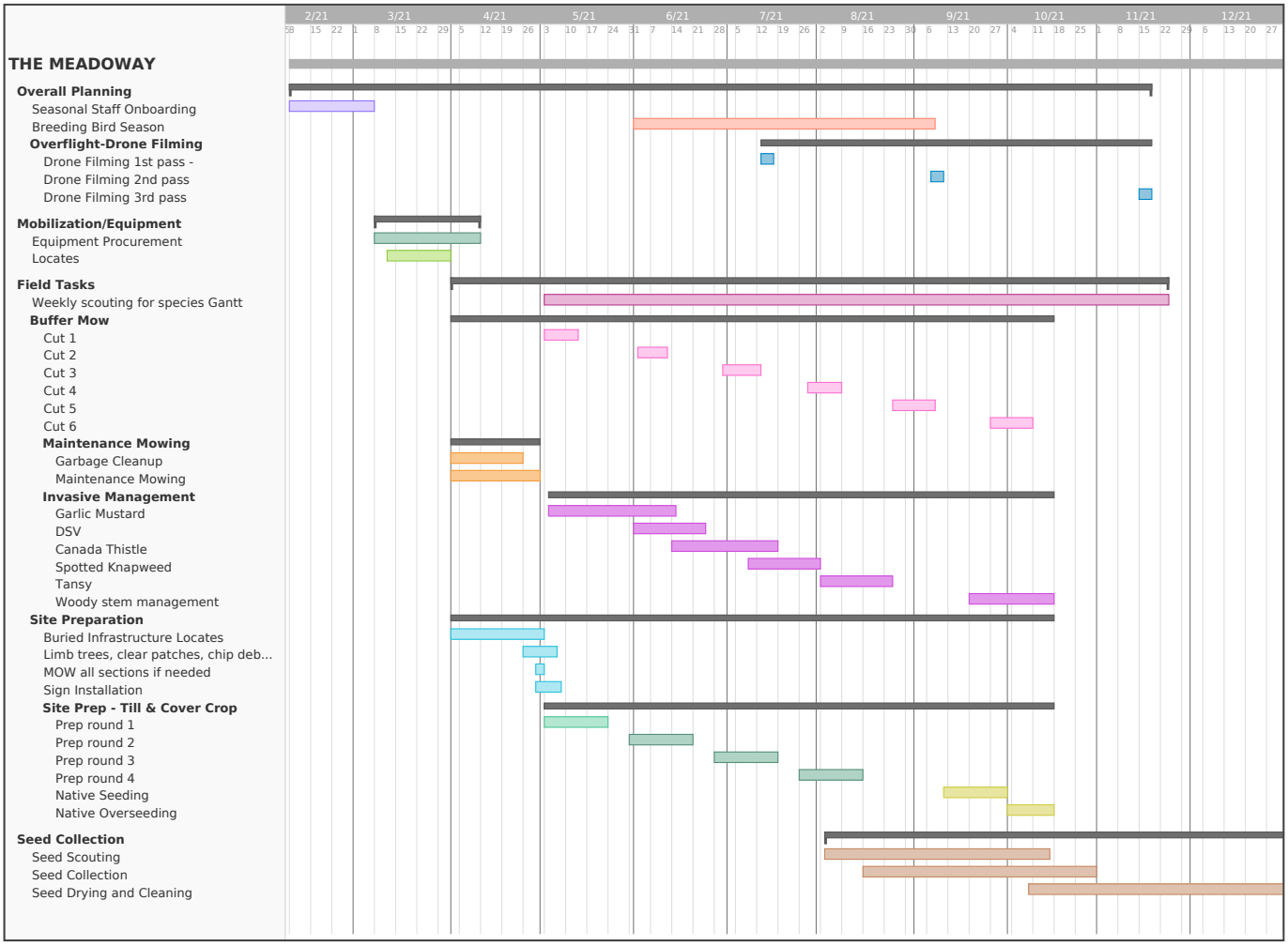
8.1 Consultation

Figure 44:
Homeowners whose properties border The Meadoway are important stakeholders that we work to engage and educate on the benefits of the meadow restoration.

Public and stakeholder consultation is a necessity from the start and throughout the entire course of the project in order to build appreciation and support. At The Meadoway, consultation was initiated as a component of the Class Environmental Assessment (EA) process. The use of engagement tools (such as the Visualization Toolkit) is highly effective and provides the public and stakeholders with a compelling image of the plan's concepts and how they may ultimately appear in the landscape.

Appendices

Appendix 1: Implementation Schedule



Appendix 2: The Meadoway Seed Mixes

Appendix 2.1

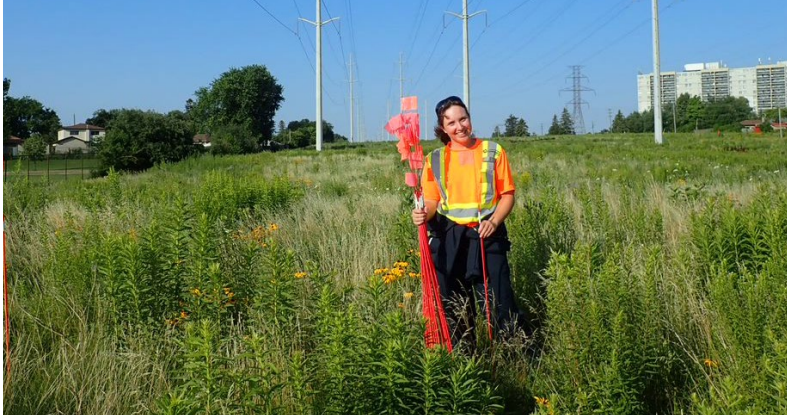
Ontario Butterfly Meadow *(For areas of high public visibility and needing high wildflower diversity)*		
Species	**Common Name**	**%**
Andropogon gerardii	big bluestem	6.0%
Apocynum cannabinum	Indian hemp	1.0%
Asclepias tuberosa	butterfly milkweed	3.0%
Asclepias syriaca	common milkweed	2.0%
Aster azureus	sky blue aster	3.0%
Aster ericoides	heath aster	3.0%
Aster novae-angliae	New England aster	3.0%
Desmodium canadense	showy tick-trefoil	2.0%
Elymus canadensis	Canada wild rye	5.0%
Helanthum autumnal	marsh sneezeweed	3.0%
Heliopsis helianthoides	oxeye	5.0%
Lespedeza capitata	round-headed bush-clover	3.0%
Liatris cylindracea	dwarf blazing star	2.0%
Monarda fistulosa	wild bergamot	6.0%
Oenothera biennis	evening primrose	3.0%
Panicum virigatum	switch grass	5.0%
Penstemon digitalis	foxglove beardtongue	4.0%
Penstemon hirsutus	hairy beardtongue	2.0%
(Potentilla arguta) Drymocallis arguta	prairie cinquefoil	2.0%
Pycnanthemum virginianum	Virginia mountain mint	5.0%
Rudbeckia hirta	black-eyed Susan	8.0%
Schizachyrium scoparium	little blue stem	6.0%
Siphilium perfoliatum	cup plant	1.0%
Sisyrinchium montanum	blue-eyed grass	1.0%
Solidago graminifolia	grass-leaved goldenrod	1.0%
Solidago nemoralis	grey goldenrod	2.0%
Sorghastrum nutans	Indian grass	8.0%
Sporobolus cryptandrus	sand dropseed	0.0%
Verbena hastata	blue vervain	2.0%
Verbena stricta	hoary vervain	3.0%
	Grass	**30.0%**

Appendix 2.2

Ontario Wet Meadow *(For areas wet in spring; may be dry in summer)*		
Species	**Common Name**	**%**
Asclepias incarnata	swamp milkweed	2.0%
Aster ericoides	heath aster	2.0%
Aster novae-angliae	New England aster	1.0%
Aster pilosus	hairy aster	2.0%
Aster puniceus	swamp aster	2.0%
Aster umbellatus	flat-topped aster	1.0%
Bromus ciliatus	fringed brome	2.0%
Carex bebbii	Bebb's sedge	1.0%
Carex stipata	awl-fruited sedge	1.0%
Carex vulpinoidea	fox sedge	5.0%
Elymus riparius	riverbank rye	10.0%
Elymus virginicus	Virginia wild rye	10.0%
Eupatorium maculatum	spotted Joe Pye weed	3.0%
Eupatorium perfoliatum	boneset	2.0%
Glyceria striata	fowl manna grass	3.0%
Juncus articulatus	jointed rush	2.0%
Juncus balticus	Baltic rush	1.0%
Juncus effusus	soft rush	1.0%
Juncus tenuis	path rush	2.0%
Juncus torreyi	Torrey's rush	2.0%
Lobelia cardinalis	cardinal flower	1.0%
Lobelia siphilitica	blue lobelia	1.0%
Mimulus ringens	monkey flower	1.0%
Monarda fistulosa	wild bergamot	3.0%
Oenothera biennis	evening primrose	2.0%
Panicum virigatum	switch grass	10.0%
Penstemon digitalis	foxglove beardtongue	2.0%
Physostegia virginiana ssp. virginiana	false dragonhead or obedient plant	2.0%
Rudbeckia hirta	black-eyed Susan	5.0%
Rudbeckia laciniata	green coneflower	1.0%
Scirpus atrovirens	green bulrush	3.0%
Scirpus cyperinus	woolgrass bulrush	3.0%
Solidago graminifolia	grass-leaved goldenrod	1.0%
Sorghastrum nutans	Indian grass	7.0%
Verbena hastata	blue vervain	3.0%
	Grasses	**61.0%**

Appendix 2.3

Ontario Short Wet Meadow *(Shorter mix for sight lines – wet in spring, dryer in summer)*		
Species	**Common Name**	**%**
Asclepias incarnata	swamp milkweed	2.0%
Bromus ciliatus	fringed Brome	4.0%
Carex bebbii	Bebb's sedge	4.0%
Carex stipata	awl-fruited sedge	4.0%
Carex vulpinoidea	fox sedge	5.0%
Elymus riparius	riverbank rye	15.0%
Elymus virginicus	Virginia wild rye	15.0%
Glyceria striata	fowl manna grass	5.0%
Juncus articulatus	jointed rush	2.0%
Juncus balticus	Baltic rush	2.0%
Juncus effusus	soft rush	2.0%
Juncus tenuis	path rush	7.0%
Juncus torreyi	Torrey's Rush	2.0%
Lobelia cardinalis	cardinal flower	1.0%
Lobelia siphilitica	blue lobelia	2.0%
Mimulus ringens	monkey flower	1.0%
Monarda fistulosa	wild bergamot	3.0%
Oenothera biennis	Evening primrose	2.0%
Penstemon digitalis	foxglove beardtongue	2.0%
Physostegia virginiana ssp. virginiana	false dragonhead or obedient plant	2.0%
Rudbeckia hirta	black-eyed Susan	5.0%
Scirpus atrovirens	green bulrush	10.0%
Verbena hastata	blue vervain	3.0%
	Grasses	**75.0%**



Appendix 2.4

Ontario Dry Grass Mix *(Grass mix for dry/mesic sites or bobolink habitat)*		
Species	**Common Name**	**%**
Andropogon gerardii	big bluestem	15.0%
Asclepias syriaca	common milkweed	2.0%
Asclepias tuberosa	butterfly milkweed	1.0%
Aster ericoides	heath aster	1.0%
Aster ooentangiensis	sky blue aster	1.0%
Aster novae-angliae	New England aster	1.0%
Desmodium canadense	showy tick-trefoil	1.0%
Elymus canadensis	Canada wild rye	5.0%
Helanthum autumnal	marsh sneezeweed	1.0%
Heliopsis helianthoides	oxeye	2.0%
Lespedeza capitata	round-headed bush-clover	1.0%
Monarda fistulosa	wild bergamot	5.0%
Oenothera biennis	evening primrose	3.0%
Panicum virigatum	switch grass	13.0%
Pycnanthemum virginianum	Virginia mountain-mint	2.0%
Rudbeckia hirta	black-eyed Susan	5.0%
Schizachyrium scoparium	little blue stem	15.0%
Solidago nemoralis	grey goldenrod	4.0%
Sorghastrum nutans	Indian grass	20.0%
Sporobolus cryptandrus	sand dropseed	2.0%
	Grass	**70.0%**

Appendix 2.5

Ontario Short Dry Mix (50 cm) *(Hydro tower buffers only – not a strong mix)*		
Species	**Common Name**	**%**
Asclepias tuberosa	butterfly milkweed	2.0%
Aster lateriflorus	calico aster	1.0%
Symphyotrichum laeve	smooth aster	2.0%
Symphyotrichum oolentangiense	sky blue aster	2.0%
Symphyotrichum urophyllum	arrow-leaved aster	2.0%
Danthonia spicata	poverty oatgrass	10.0%
Elymus trachycaulus	slender wheatgrass	5.0%
Lespedeza capitata	round-headed bush-clover	2.0%
Lespedeza hirta	hairy bush-clover	2.0%
Liatris cylindracea	Cylindrical or dwarf blazing-star	2.0%
Penstemon digitalis	foxglove beardtongue	5.0%
Penstemon hirsutus	hairy beardtongue	4.0%
Potentilla arguta	prairie cinquefoil	3.0%
Rudbeckia hirta	black-eyed Susan	10.0%
Schizachyrium scoparium	little bluestem	40.0%
Sisyrinchium montanum	blue-eyed grass	1.0%
Solidago nemoralis	grey goldenrod	2.0%
Sporobolus cryptandrus	sand dropseed	5.0%
	Grass	**60.0%**

Appendix 2.6

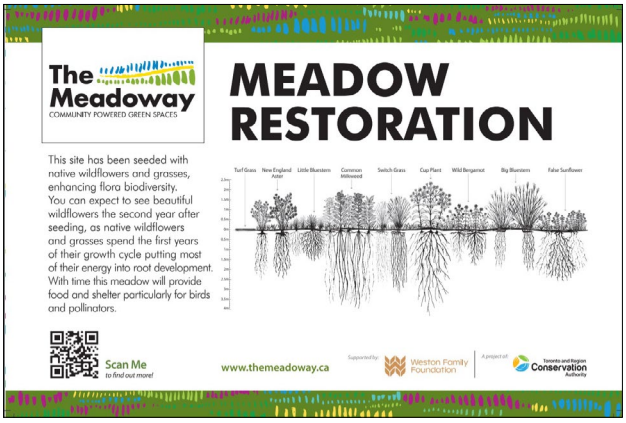
TRCA Upland Slope Mix *(Add 50-100% rate of oats as cover crop; use on dry slopes)*		
Species	**Common Name**	**%**
Andropogon gerardii	big bluestem	16.0%
Asclepias syriaca	common milkweed	2.0%
Aster novae-angliae	New England aster	1.0%
Desmodium canadense	showy tick-trefoil	2.0%
Elymus canadensis	Canada wild rye	15.0%
Heliopsis helianthoides	oxeye	3.0%
Monarda fistulosa	wild bergamot	3.0%
Panicum virigatum	switch grass	15.0%
Pycnanthemum virginianum	Virginia mountain-mint	2.0%
Rudbeckia hirta	black-eyed Susan	3.0%
Schizachyrium scoparium	little bluestem	15.0%
Solidago canadensis	Canada goldenrod	1.0%
Solidago juncea	early goldenrod	1.0%
Sorghastrum nutans	Indian grass	20.0%
Symphyotrichum laeve	smooth aster	1.0%
	Grass	**81.0%**

Appendix 2.7

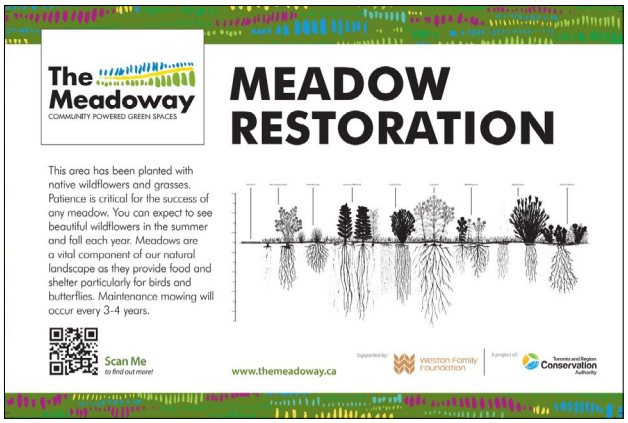
Ontario Resilient Area Meadow Mix *(Used in areas with high invasive species pressure or flat compacted soils)*		
Species	**Common Name**	**%**
Andropogon gerardii	big bluestem	25.0%
Asclepias syriaca	common milkweed	2.0%
Desmodium canadense	showy tick-trefoil	3.0%
Elymus canadensis	Canada wild rye	5.0%
Heliopsis helianthoides	oxeye	3.0%
Monarda fistulosa	wild bergamot	7.0%
Oenothera biennis	evening primrose	2.0%
Panicum virigatum	switch grass	10.0%
Pycnanthemum virginianum	Virginia mountain-mint	4.0%
Rudbeckia hirta	black-eyed Susan	8.0%
Solidago canadensis	Canada goldenrod	Possible addition
Schizachyrium scoparium	little bluestem	10.0%
Siphilium perfoliatum	cup plant	1.0%
Sorghastrum nutans	Indian grass	20.0%
	Grass	**70.0%**

Appendix 3: The Meadoway Signage

Year 1 Sign:
Place this sign when just starting the project, prior to site preparation, signs placed every 30 metres along meadow edge.



Year 2 Sign:
Replace Year 1 sign with this one after site has been seeded with native meadow species.



Year 3 Sign:
Replace Year 2 sign with this one after site has had one year of adaptive management.

Install this sign in Year 1 with the meadow restoration sign above.

Appendix 4: Currentics at The Meadoway

- Investigation of hydrologic-regulating services provided by non-woody grassed and meadow urban landscapes
- Effects of plant mix, restoration year and management regime of urban meadows on plant-pollinator network size, structure and diversity

TRCA Ecosystem Management Field Research conducted in Year 2020-2021

Biodiversity

- Species Gantt charts
- Terrestrial monitoring plots errestrial monitoring plots
- Transects for birds, butterfly, flora

Climate Change

- Soil organic matter
- Plant biomass

Meadow Restoration Techniques

- Seeding mix trials
- Seed packing/preparation

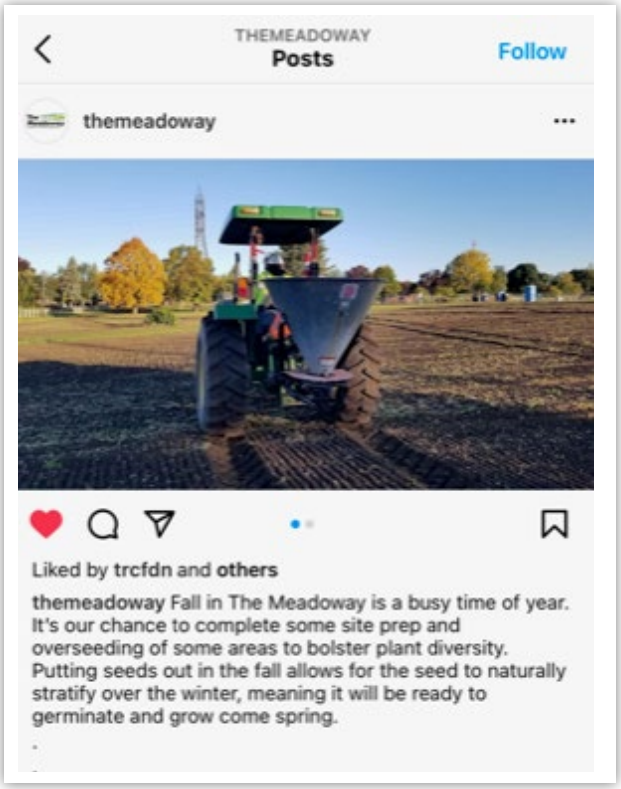
Invasive Species Management

- Glyphosate degradation curve
- Mechanical control methods
- Herbicide alternatives
- Installing a milkweed barrier for dog-strangling vine

Key Performance Indicators, creating qualitative and quantitative measurable indices for:

- Biodiversity index
- Terrestrial natural heritage system targets
- Surface temperature changes
- Resiliency for climate change
- Adding natural cover
- Improvements to habitat quality

Appendix 5: Public Communications



Appendix 5: Public Communications

[Link to The Meadoway Resource Page]

For more information visit
www.themeadoway.ca

The Meadoway
COMMUNITY POWERED GREEN SPACES

A program of:

Toronto and Region Conservation Authority