RESEARCH REPORT

Residential Landscapes: Comparison of Maintenance Costs, Time and Resources

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Residential Landscapes: Comparison of maintenance costs, time and resources

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Ecological Outlook

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Executive Summary

Background

The residential garden is a great source of joy and pride for many Canadian homeowners, be it a manicured lawn, an intricate perennial border, a bed of carefully pruned flowering shrubs, or a combination of all of the above. For other homeowners, maintaining a garden is first and foremost a matter of civic duty. Either way, many homeowners have in recent years become increasingly aware of the potential impacts landscape maintenance can have on the environment. Consequently, many are now looking for ways to maintain attractive and functional residential landscapes while reducing the potential for environmental impacts in their yards, as well as saving costs and time by adopting low-maintenance landscape options. However, assertions about the time and cost savings and environmental benefits of the low-maintenance alternatives have not been substantiated with observed data collected from Canadian homes.

The purpose of this report is to begin the process of filling this gap, by comparing the various cost, material and time inputs associated with the maintenance of seven residential landscape types, both conventional and alternative. As well, the report includes an overview of the potential environmental impacts and benefits related to these seven landscape types and their maintenance.

Conventional landscape types reviewed in this study include:

- **Conventional lawns** made up of two or three turf grass species. They are neatly trimmed and regularly watered, fertilized and treated for pests (disease, insects, weeds) to achieve a green, consistent, manicured look.
- **Ornamental trees and shrubs** featuring primarily exotic species selected for their floral and foliage displays, form, shade, and other characteristics. They are regularly pruned, weeded, and watered, and may be fertilized and treated for pests as required.
- **Ornamental flowerbeds** featuring perennials and bulbs that are regularly weeded, watered, thinnned and divided, along with annuals that are replanted every year.

Alternative landscapes in the study include:

- **Xeriscapes** made of up of tree, shrub and perennial species – both native and exotic – that are adapted to suit local rainfall conditions and which require almost no watering. Plants are grouped in mulched beds according to water needs.
- **Woodland shade gardens** composed of native trees, shrubs and ground covers that mimic natural forests.
- **Wildflower meadows** featuring native grasses and wildflowers that mimic natural meadow or prairie landscapes.
- **Low-maintenance lawns** composed of broad selections of hardy, drought-tolerant, slow-growing grass and broad-leafed species such as clover that do not require frequent mowing, watering, or fertilizing. These lawns resemble conventional lawns but are slightly taller and less uniform in appearance.

Methodology

In 1998 and 1999, we monitored 30 gardens in southern Ontario, with at least four falling into each of these seven categories listed above. Survey participants kept records of all maintenance, including watering, fertilizing, pesticide application, mowing, mulching and so on. Each activity was recorded in terms of the time required to complete it, the money spent on materials and services and the materials used (including pesticides, fertilizer, water, gasoline, electricity, mulch and new plants). Given the small sample group and short survey period, the data generated through the survey cannot be construed as being statistically precise. It does, however, provide useful "ballpark" figures adequate for the comparative purposes of this report.

We then conducted a literature review to provide an overview of potential environmental impacts and benefits associated with the seven landscape types.

Finally, we developed seven designs for a hypothetical single family home, with each design highlighting one of the seven landscape types. We estimated installation capital costs for each design option and applied the maintenance data derived from the monitoring survey to enable a comparative ten-year life cycle analysis of the seven design options. Each option is compared in terms installation and 10-year maintenance costs, maintenance time requirements, and gasoline, water, pesticides and fertilizer use.

Results

a) Monitoring Survey

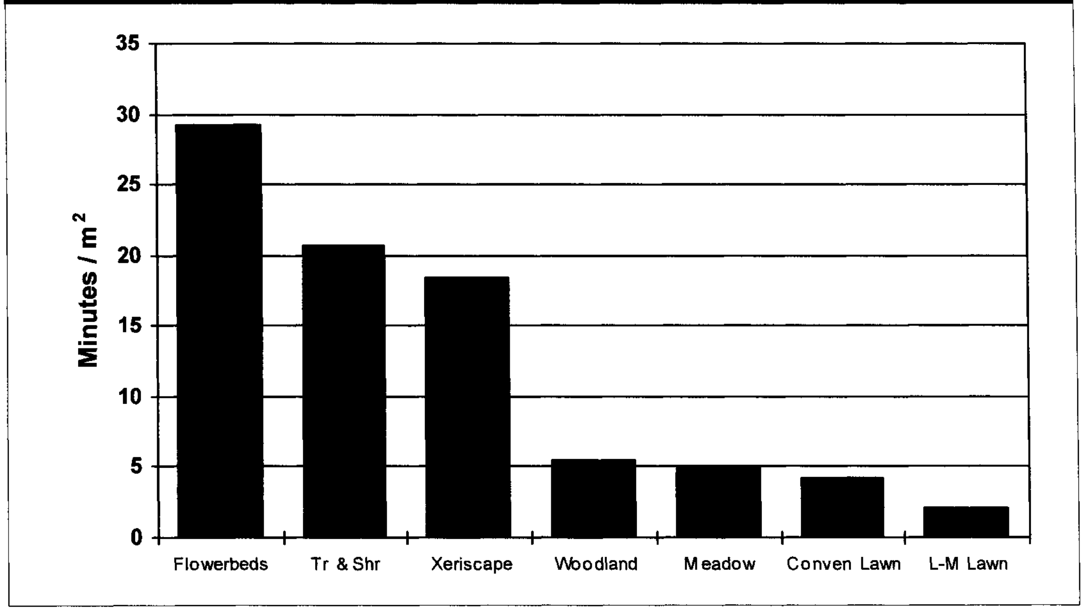
Based on the results of the survey, low-maintenance lawns were the most time-, material-, and cost-efficient of the seven types, whereas ornamental flowerbeds were the most consumptive.

Saving Time

Lawns, in general, were found to be the least time-consuming landscape types, with the low-maintenance lawns being the biggest time saver of all. It would appear that the use of power equipment makes lawn maintenance more efficient relative to the other landscape types, which all demanded more time. Among these, the woodland gardens and wildflower meadows were the big time savers.

It is important to note, however, that whereas conventional lawns necessarily demand consistent, regularly scheduled maintenance, the maintenance requirements for the naturalized alternatives (and other non-turf landscape types) are highly variable and ultimately up to the discretion and preferences of the individual gardener. For example, we saw a wide variation in the maintenance time requirements for the woodland and wildflower gardens, ranging from 14 min./m^2 to zero maintenance time inputs, whereas lawn maintenance consistently ranged between 2.5 and 6 min./m^2. It's up to the individual.

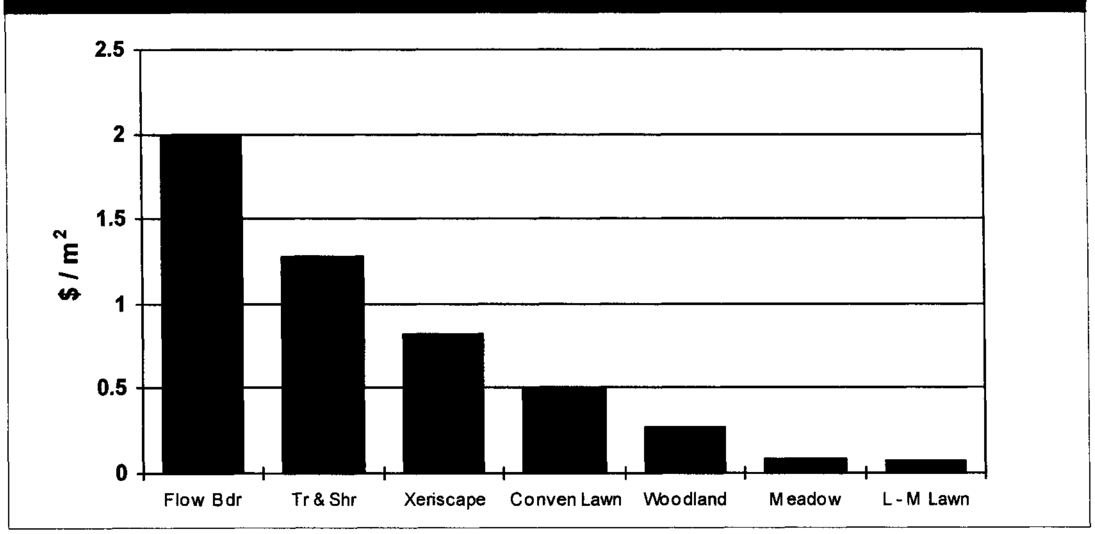
Figure ES-1: Annual Time Inputs / m^2



Maintenance Costs:

Based on the study results, low-maintenance lawn involved the lowest annual maintenance costs, followed closely by woodlands and wildflower meadows. Ornamental flowerbeds were the most expensive to maintain, with a significant percentage of that amount devoted to seasonal plant purchases (including annuals).

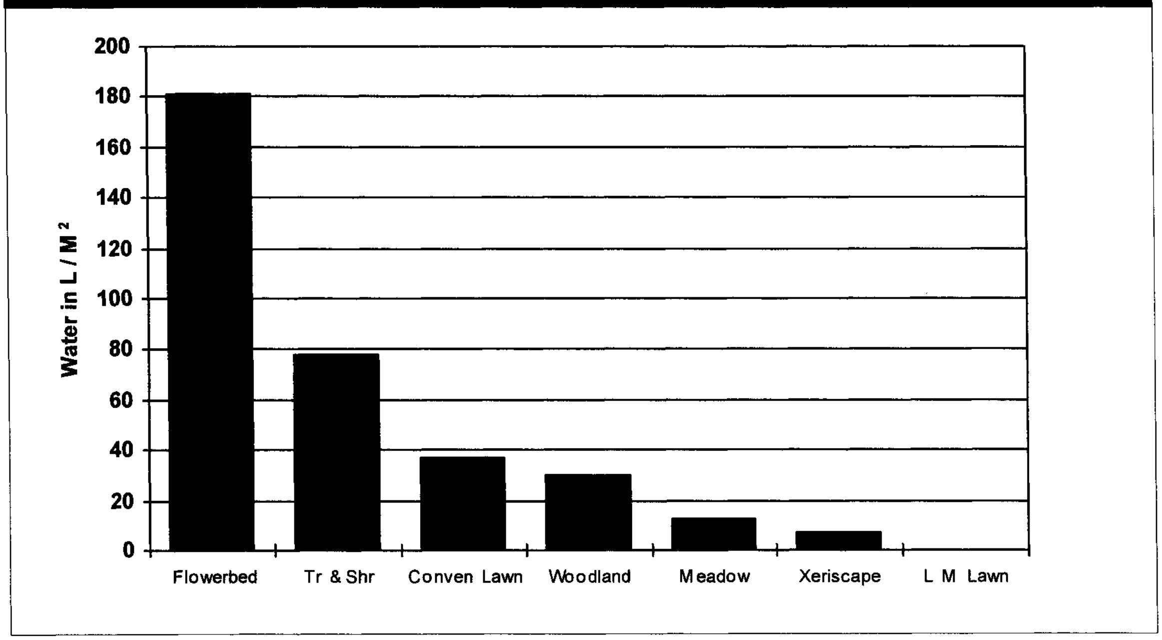
Figure ES-2: Annual Maintenance Costs / m^2



Water Consumption

Low-maintenance lawns were the most water-efficient and required no watering at all during the study. The xeriscapes came second, and woodlands and wildflower meadows were also very water-efficient. Ornamental flowerbeds consumed the most water by a large margin. Surprisingly, woodland gardens required an unexpectedly large amount of water, considering that these are generally assumed to be water-efficient landscapes relative to lawn (the prevailing drought likely dictated these higher-than-expected inputs, of which approximately one third was devoted to new plantings stressed by the dry conditions). Meadows and xeriscapes also consumed more water than expected. It must be noted that all of the water used in the xeriscapes was directed to new plantings, which required supplemental water to become established amidst the drought conditions, and thus is an unusually high amount.

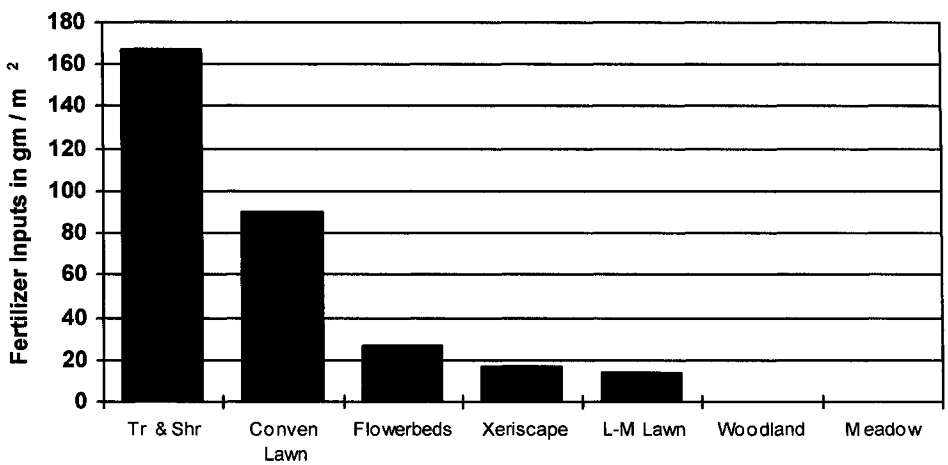
Figure ES-3: Annual Water Inputs /m^2



Fertilizers

The ornamental tree and shrub gardens monitored during the study needed the most fertilizer, followed closely by the conventional lawns. No fertilizer was recorded for the woodlands or wildflower meadows, and very little for low-maintenance lawns or xeriscapes.

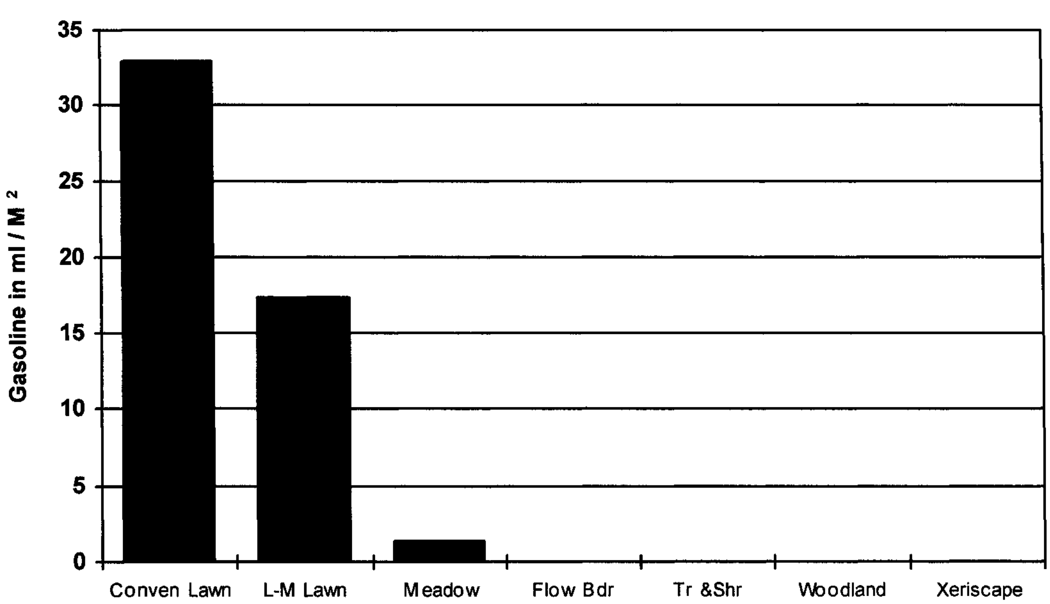
Figure ES-4: Annual Fertilizer Inputs / m²



Fuel

The woodland shade garden, xeriscape, flowerbed and ornamental tree and shrub options in this study required no expenditures in fuel. The two lawn options had the highest rate of fuel use, with the conventional lawn heading the pack, followed by the low-maintenance lawn. The wildflower meadows, which required only annual mowing, were very fuel-efficient. Electrical consumption was negligible in all of the seven garden options.

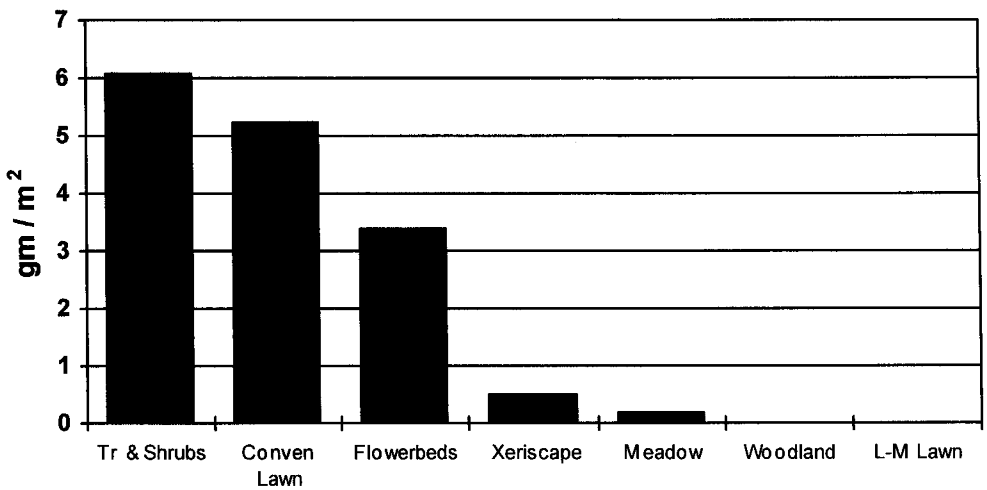
Figure ES-5: Annual Gasoline Inputs / m²



Pesticides

In terms of pesticides – herbicides and insecticides, both organic and chemical – the ornamental tree and shrub gardens in our study required the most, followed closely by the conventional lawns. No pesticides were used for the low-maintenance lawns, almost none for the woodland shade gardens and very little for the wildflower meadows and xeriscapes. It should be noted that the majority of the study participants, including those for conventional landscape types, were concerned about the potential impacts of pesticide use and preferred to minimize or avoid their use wherever possible.

Figure ES-6: Annual Pesticide Inputs / m^2



b) Literature Review of Potential Environmental Impacts and Benefits

The literature review considered a number of potential impacts on both human and ecosystem health that are associated with five common maintenance and landscaping practices: 1) the use of chemical pesticides; 2) the use of synthetic fertilizers; 3) unnecessary watering; 4) the operation of gas-powered equipment; and 5) the use of invasive exotic species in conventional ornamental landscapes.

Several secondary impacts include yard waste, noise, loss of habitat and biodiversity, and wild-digging and seed collection. Environmental benefits associated with the various landscape types include improved hydrological cycles, restoring and protecting habitat and biodiversity, temperature moderation, and improved air quality.

No attempt has been made to quantify potential environmental impacts or benefits as direct, measurable outcomes of landscape maintenance. However, the maintenance monitoring survey did generate comparative data on the quantities of pesticides, fertilizers, water and fuel used in each landscape type. Consequently, it was possible to assess which of the landscape types are most likely to result in some form of environmental impact. Of the seven landscape types, the alternative types (low-maintenance lawn, woodland, wildflower meadow and xeriscape) tended to rely the least on pesticides, fertilizers, water, and gas-powered equipment.

c) Life Cycle Analysis for Seven Residential Landscape Design Options

Installation and long-term maintenance costs, time requirements, environmental impact, aesthetics, and function are all important considerations when deciding on an appropriate residential landscape type. Homeowners should strive to make an informed choice, one that weighs these different factors and which ultimately reflects their specific set of priorities. Conducting a *life cycle analysis* of the various alternatives is one way to facilitate the decision-making process.

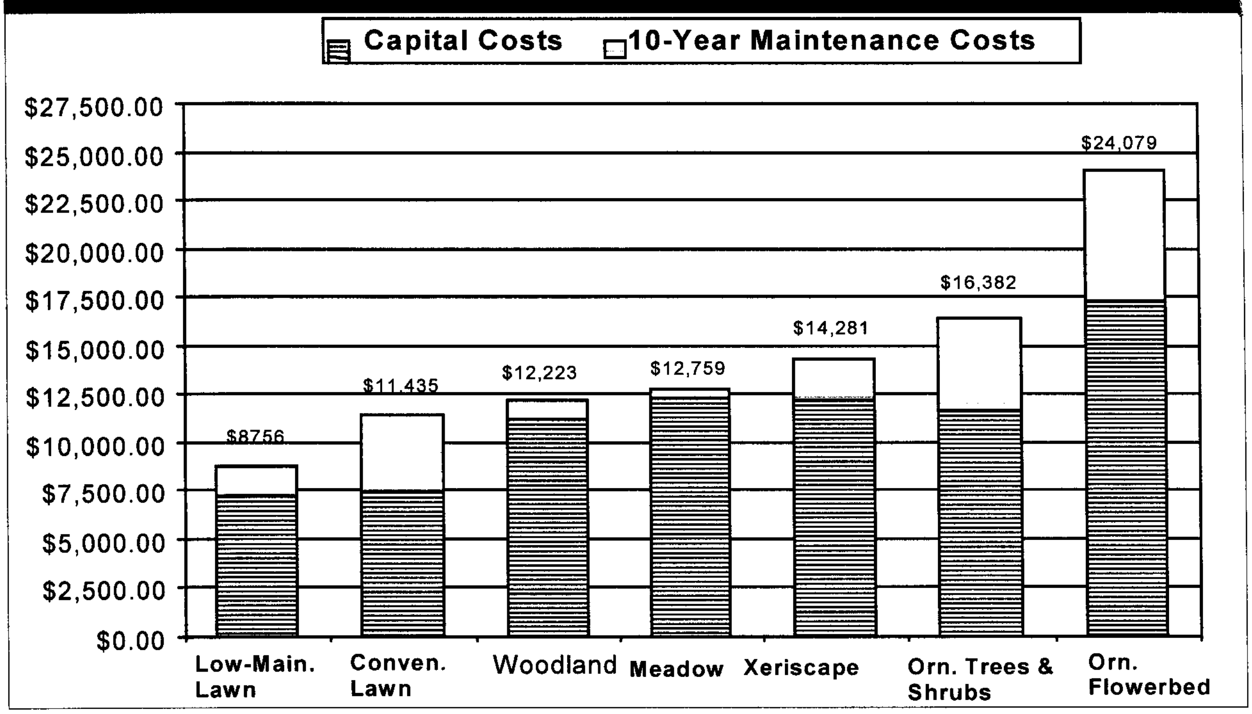
To demonstrate this process, analyses were prepared for seven different sample design options for a hypothetical single-family home. Each of the design options is based primarily on one of the seven landscape types considered in this report; smaller areas of two other landscape types are also included in each design. Using the results of the monitoring survey, the analysis considers:

- Cost estimates for the initial installation of each landscape option, as well as estimates of 10-year maintenance expenditures
- 10-year maintenance time commitments, and
- Estimates of water, gasoline, fertilizer and pesticides used over the ten-year period

Installation and 10-year Costs

In terms of installation and 10-year maintenance expenditures, the low-maintenance lawn option was the cheapest. The conventional lawn followed as the second least expensive, largely because of low installation costs. While the maintenance costs for the naturalized woodland and wildflower meadow were among the lowest, the capital installation costs were high, placing these options in the middle of the total cost range. The most expensive of the seven designs, in terms of installation, 10-year maintenance and total life-cycle costs, is the flowerbed option.

Figure ES-7: Total Ten-year Costs



The size of plant material and the use of seed over plants can have a dramatic impact on overall installation costs. In the case of the xeriscape, meadow, and woodland, significant amounts of mature plant stock were used. If cost-effectiveness is a criterion of major concern, homeowners should consider using seed and seedling stock to install alternative landscapes. While it takes longer for the landscape to become established, the savings can be substantial.

Time

Projected maintenance time requirements were lowest for the options composed of alternative landscape types. The most time-consuming was the ornamental flowerbed option. Conversely, the naturalized meadow option would require the least amount of time. The ornamental tree and shrub option would require almost 3 times more hours than the naturalized woodland. The two lawn options fell in the middle because the designs each combine 3 landscape types although they are primarily made up of lawn. The other more labour intensive types, such as ornamental flowerbeds and trees and shrubs, tended to increase the time requirements of those designs. If the lawns were combined with woodland and wildflower meadows, the time requirements would have been significantly lower.

Water, gasoline, pesticides and fertilizer

The life cycle analysis revealed that the three conventional design options would receive the heaviest pesticide, fertilizer, gasoline, and water inputs. Results would have been somewhat different had conventional landscape types been combined with the less resource intensive alternatives. This might be a viable option for a homeowner who prefers a conventionally manicured lawn, for instance, but would prefer to reduce (but not completely eliminate) potentially harmful inputs by choosing naturalized meadow or xeriscape over flowerbeds, or naturalized woodland over ornamental trees and shrubs. Sometimes, change can happen in small steps.

Conclusions

Choosing the right landscape type for the yard or garden means identifying priorities and making trade-offs. The most important thing for the individual homeowner may be saving time or protecting the environment or achieving a certain look. Readers can weigh the various options described here and decide what works best:

Time: For saving time, the best designs were those that featured wildflower meadows, woodland shade gardens and lawns. Before we combined landscape types in the seven hypothetical designs, the results of our survey showed that lawns were the most time-efficient, with low-maintenance lawns being the biggest time saver. But since lawns are usually found in combination with other landscape types, combining them with alternatives such as wildflower meadows and woodland shade gardens is a good way to save time.

Costs: The lowest capital and 10-year maintenance costs were realized in the lawn options, the lowest being associated with the low-maintenance lawn. Woodland shade gardens, wildflower meadows and xeriscapes followed as the least costly over 10-years.

Environment: For reducing gasoline, water, pesticides and fertilizers, the alternative options were the least consumptive. This includes the woodland shade garden, wildflower meadow, low-maintenance lawn and xeriscape options. The woodland shade garden and wildflower meadow were the best options for attracting wildlife, protecting bio-diversity, and minimizing the spread of invasive exotics. To protect local hydrological cycles and contribute to improved air quality in your region, the woodland, wildflower, xeriscape, tree and shrub and flowerbed options are the best.

Function and aesthetics are key considerations for many homeowners when choosing landscape options. Of course, these are highly subjective considerations. Many –but not all – homeowners prefer a manicured look with trimmed, uniform lawns, pruned shrubs and trees and ornamental flowerbeds. Lawns offer recreation opportunities that many are attracted to, particularly families with children. This type of landscape is the convention. However, some homeowners prefer the more natural aesthetic offered by woodland shade gardens and wildflower meadows. They like shady, private nooks and the songbirds and butterflies these gardens attract.

If homeowners wish to balance their aesthetic preferences with saving time and costs and reducing environmental impacts, they may want to consider the alternative landscape options. For example, if they want floral displays, but also want to save time, money and protect the environment, they could consider wildflower meadows or xeriscapes. If they want a lush, shady garden that's also time-efficient and eco-friendly, they could consider a woodland shade garden. If they want the passive play opportunities that lawns offer, but want to maximize time, cost and resource-efficiency, low-maintenance lawns are a good option.

Ultimately the decision is up to the individual. The purpose of this study is to provide readers with information to enable them to make an informed choice about which landscape options work best.

Contexte

Les jardins résidentiels, qu'ils soient constitués d'une pelouse soigneusement entretenue, d'une bordure de vivaces très élaborée, d'une plate-bande d'arbustes à fleurs finement élagués ou d'une combinaison de tous ces éléments, sont une grande source de joie et de fierté pour bien des propriétaires au Canada. Pour d'autres, l'entretien d'un jardin est d'abord et avant tout une question de sens civique. Quoi qu'il en soit, nombreux sont ceux qui, au cours des dernières années, ont été davantage sensibilisés aux répercussions que l'entretien d'un aménagement paysager peut avoir sur l'environnement. C'est ainsi que beaucoup de gens cherchent maintenant des moyens d'entretenir leur aménagement paysager pour qu'il soit à la fois attrayant et fonctionnel, mais permette aussi de réduire les impacts environnementaux potentiels dans leur cour. Ils veulent également économiser du temps et de l'argent en adoptant des aménagements faciles d'entretien. Cependant, les allégations concernant les économies de temps et d'argent et les avantages environnementaux associés aux aménagements d'entretien facile n'ont jamais été étayées par des données recueillies dans des foyers canadiens.

L'étude dont il est ici question avait justement pour but de commencer à combler ce vide en comparant l'argent, les matériaux et le temps investis pour entretenir sept types d'aménagement paysager, qu'ils soient traditionnels ou non. Le rapport faisant état des conclusions de cette étude offre un survol des impacts et des avantages potentiels, sur le plan de l'environnement, propres à ces sept types d'aménagement et à leur entretien.

Les aménagements traditionnels suivants ont été examinés lors de cette étude :

- **La pelouse traditionnelle**, composée de deux ou trois espèces d'herbe à gazon. Elle est toujours bien tondue et est régulièrement arrosée, fertilisée et vaporisée (contre les maladies, les insectes et les mauvaises herbes) pour lui procurer un aspect verdoyant, fourni et entretenu.
- **Les arbres et arbustes ornementaux**, qui se caractérisent surtout par des espèces exotiques choisies pour la beauté de leur feuillage et de leurs fleurs, pour leur forme, l'ombre qu'ils procurent et d'autres caractéristiques. Ils doivent être élagués, désherbés, arrosés et vaporisés de façon régulière et peuvent devoir être fertilisés et traités contre les ravageurs.
- **La plate-bande ornementale**, caractérisée par des plantes vivaces et bulbeuses qui doivent être désherbées, arrosées, éclaircies et divisées régulièrement, auxquelles on ajoute des annuelles qui doivent être replantées chaque année.

Les aménagements non traditionnels suivants ont aussi été examinés :

- **Le xéropaysage**, un aménagement caractérisé par l'emploi d'arbres, d'arbustes et d'espèces vivaces, tant indigènes qu'exotiques, adaptés aux précipitations naturelles d'une région et ne nécessitant presque aucun arrosage. Les plantes sont regroupées au sein d'îlots recouverts de paillis en fonction de leurs besoins en eau.
- **Le jardin d'ombre boisé**, réalisé avec des arbres, des arbustes et des plantes couvre-sol indigènes qui imitent les forêts naturelles.
- **Le pré de fleurs sauvages**, qui se distingue par ses herbes et ses fleurs sauvages indigènes tel qu'on en trouve dans les prairies et les prés naturels. La pelouse d'entretien facile, composée d'un vaste choix d'herbes rustiques à croissance lente résistant à la sécheresse et d'espèces à larges feuilles, comme le trèfle, dont la tonte, la fertilisation et l'arrosage sont peu fréquents. Ce gazon ressemble à la pelouse traditionnelle, mais il est un peu plus haut et d'aspect moins homogène.

Méthode

En 1998 et 1999, nous avons suivi l'entretien de 30 jardins du sud de l'Ontario, dont au moins quatre entraient dans chacune des sept catégories susmentionnées. Les personnes qui ont participé à cette étude ont tenu un registre de toutes leurs opérations d'entretien, notamment l'arrosage, la fertilisation, l'application de pesticides, la tonte du gazon, l'application de paillis, etc. Pour chaque activité, nous avons noté le temps requis pour l'effectuer, l'argent consacré aux matières et aux services ainsi que les produits utilisés (c'est-à-dire les pesticides, les fertilisants, l'eau, l'essence, l'électricité, le paillis et les nouvelles plantes). Compte tenu de la petitesse de l'échantillon et de la courte durée de l'étude, les données recueillies ne sauraient être statistiquement précises. Néanmoins, elles procurent des balises convenant tout à fait aux objectifs de comparaison visés par cette étude.

Nous avons ensuite réalisé une recherche documentaire afin de brosser un tableau des répercussions environnementales et des avantages pouvant être associés avec les sept types d'aménagement paysager.

Enfin, nous avons élaboré sept modèles d'aménagement hypothétiques pouvant convenir à une maison individuelle, chacun de ces modèles faisant ressortir l'un des sept types d'aménagement décrits plus haut. Nous avons calculé les coûts approximatifs pour la réalisation de chacun des aménagements et leur avons appliqué les données d'entretien obtenues lors de la première phase de l'étude afin de pouvoir effectuer une analyse comparative des sept options étalée sur une période de 10 ans. Chaque option est comparée en fonction de la réalisation initiale et des frais d'entretien, du temps d'entretien, de l'utilisation d'essence, d'eau, de pesticides et de fertilisants pendant 10 ans.

Résultats

a) Suivi de l'entretien

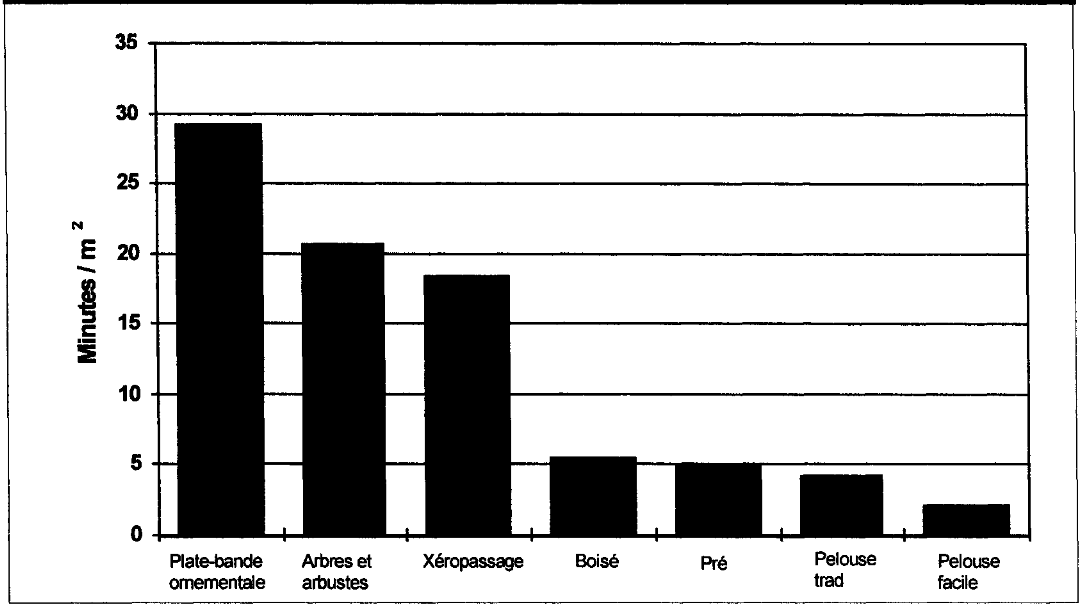
L'étude permet de conclure que la pelouse d'entretien facile est le plus efficace des sept types d'aménagement sur le plan du temps d'entretien, du matériel requis et des frais engagés, tandis que la plate-bande ornementale est le plus exigeant à cet égard.

Économie de temps

En général, les pelouses sont les formes de jardin les moins prenantes (la pelouse d'entretien facile l'emportant haut la main à ce chapitre). Il semble que l'emploi d'équipement motorisé rend l'entretien d'une pelouse plus efficace que les autres genres d'aménagement, lesquels exigent tous plus de temps. Parmi ceux-ci, le jardin boisé et le pré de fleurs sauvages sont les moins exigeants.

Fait important à noter, toutefois, bien que les pelouses classiques exigent nécessairement un entretien régulier et rigoureux, les exigences d'entretien des solutions de rechange dites « naturelles » (et d'autres types d'aménagement ne comportant pas de pelouse) sont très variables et il revient en fin de compte au jardinier de décider du temps qu'il consacrera aux travaux d'entretien. Par exemple, nous avons constaté une importante variation du temps passé à entretenir les jardins boisés et les prés de fleurs sauvages, soit de 14 min./m^2 à aucun entretien, alors que l'entretien des pelouses nécessitait toujours entre 2,5 et 6 min./m^2. Tout dépend vraiment de la personne chargée de l'entretien.

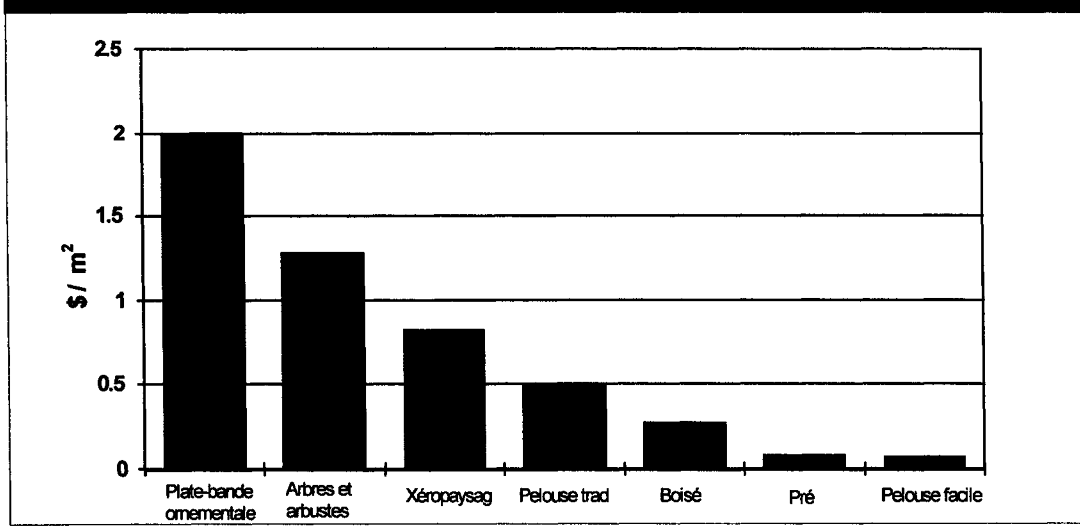
Figure ES-1: Temps investi par année / m²



Coûts d'entretien

Selon les résultats de l'étude, la pelouse d'entretien facile était la moins coûteuse à entretenir annuellement, suivie de près par le jardin boisé et le pré de fleurs sauvages. Par contre, la plate-bande ornementale était la plus coûteuse à cet égard, une part importante des frais devant être affectée à l'achat de plantes saisonnières (y compris les annuelles).

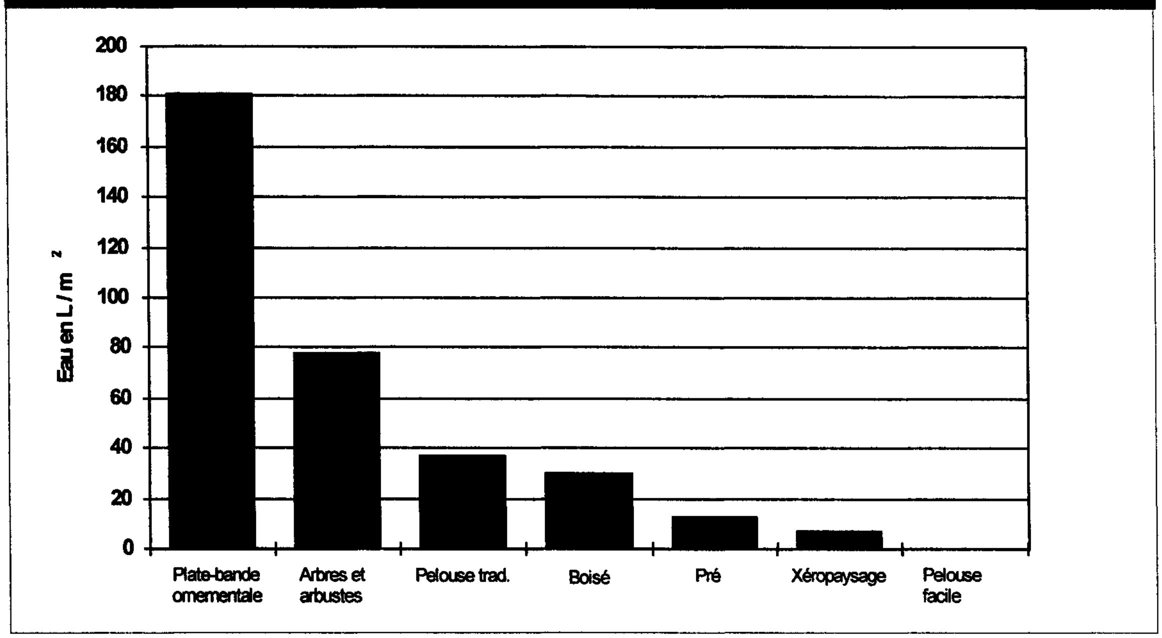
Figure ES-2: Coût annuel du matériel / m²



Consommation d'eau

La pelouse d'entretien facile est l'aménagement le plus efficace sur ce plan. Durant l'étude, les aménagements de ce genre n'ont nécessité aucun arrosage. Le xéropaysage est arrivé bon deuxième tandis que le boisé et le pré de fleurs sauvages se sont aussi avérés très économes en eau. La plate-bande ornementale a, de loin, consommé le plus grand volume d'eau. Étonnamment, le jardin boisé a consommé une plus grande quantité d'eau que prévu, étant donné que ces aménagements sont normalement considérés comme économes en eau par rapport aux pelouses (la sécheresse subie durant la période d'étude peut expliquer ces apports d'eau supérieurs à la normale, le tiers environ de cette consommation ayant été consacré à de nouveaux plants qui étaient stressés par les conditions sèches). Le pré et le xéropaysage ont aussi consommé plus d'eau que prévu. Il faut dire que toute l'eau utilisée pour les xéropaysages était destinée à de nouveaux plants, lesquels exigent davantage d'eau pour s'établir en conditions de sécheresse. La quantité mesurée était donc anormalement élevée.

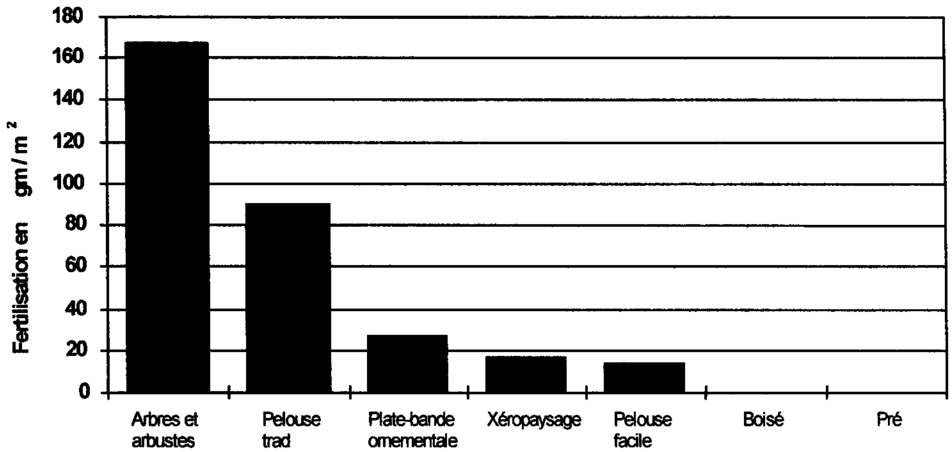
Figure ES-3: Consommation d'eau annuelle /m^2



Fertilisants

Les jardins d'arbres et d'arbustes ornementaux observés durant l'étude ont nécessité l'apport de fertilisants le plus important, suivis de près par les pelouses traditionnelles. Aucune fertilisation n'a été enregistrée pour les jardins boisés ou les prés de fleurs sauvages et très peu pour les pelouses d'entretien facile et les xéropaysages.

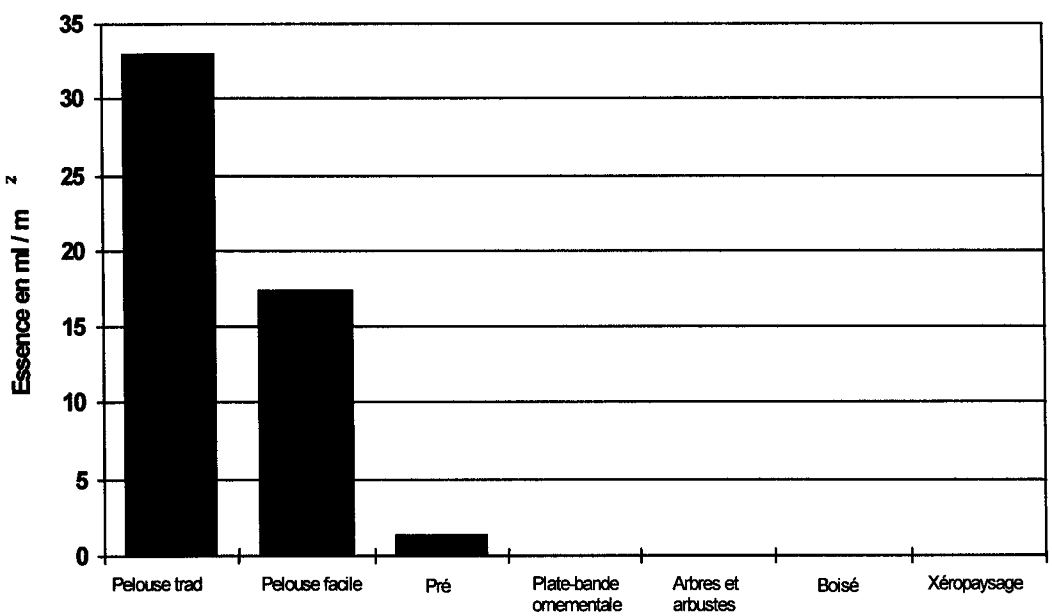
Figure ES-4: Application annuelle de fertilisants / m²



Combustible

Le jardin boisé, le xéropaysage, la plate-bande ornementale et les arbres et arbustes ornementaux de cette étude n'ont nécessité aucune dépense de combustible. Les deux types de pelouse ont affiché les utilisations de combustible les plus élevées, la palme revenant à la pelouse traditionnelle, suivie par la pelouse d'entretien facile. Le pré de fleurs sauvages, qui ne requiert qu'une tonte annuelle, s'est donc révélé très efficace au chapitre de la consommation de combustible. La consommation d'électricité était négligeable pour les sept types de jardin.

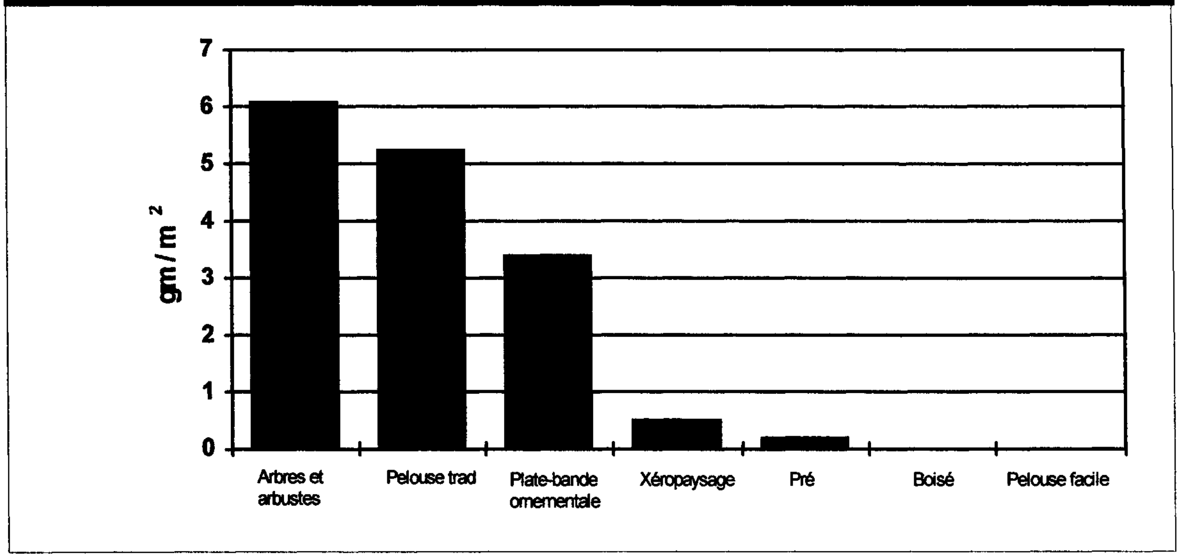
Figure ES-5: Consommation d'essence annuelle / m²



Pesticides

En matière de pesticides (herbicides et insecticides, tant organiques que chimiques), les jardins d'arbres et d'arbustes ornementaux étudiés avaient le taux de consommation le plus élevé, suivis de près par les pelouses traditionnelles. Aucun pesticide n'a été appliqué sur les pelouses d'entretien facile, presque pas dans les jardins boisés et très peu pour les prés de fleurs sauvages et les xéropaysages. Il importe de noter que la majorité des personnes qui ont pris part à l'étude, y compris celles qui possédaient des aménagements classiques, étaient préoccupées par les répercussions potentielles des pesticides et préféraient réduire leur utilisation au minimum ou les éviter dans la mesure du possible.

Figure ES-6: Application annuelle de pesticides / m^2



b) Recherche documentaire concernant les impacts et les avantages environnementaux possibles

La recherche documentaire qui a été effectuée a examiné un certain nombre des conséquences que peuvent avoir cinq pratiques courantes d'entretien et d'aménagement paysager pour la santé humaine et la qualité de l'écosystème, soit 1) l'usage de pesticides chimiques, 2) l'usage de fertilisants synthétiques, 3) l'arrosage inutile, 4) l'utilisation d'équipement motorisé à essence et 5) l'utilisation d'espèces exotiques envahissantes au sein d'aménagements ornementaux traditionnels.

On note plusieurs autres répercussions secondaires comme les résidus de jardin, le bruit, la perte d'habitat et de biodiversité, le prélèvement de plantes sauvages et la cueillette des semences. Les divers types d'aménagement paysager comportent différents avantages environnementaux, notamment l'amélioration des cycles hydrologiques, la restauration et la protection de l'habitat et de la biodiversité, la modération de la température et l'amélioration de la qualité de l'air.

Nous n'avons pas tenté de quantifier les impacts environnementaux ou les avantages possibles en tant que résultats directs et mesurables de l'entretien des aménagements. Toutefois, le suivi des travaux d'entretien a permis de recueillir des données comparatives sur les quantités de pesticides, de fertilisants, d'eau et de combustible utilisées pour chaque type d'aménagement. Il a donc été possible de déterminer lesquels des aménagements paysagers étaient le plus susceptibles d'avoir des répercussions sur l'environnement. Sur les sept aménagements étudiés, les types non traditionnels (pelouse d'entretien facile, jardin boisé, pré de fleurs sauvages et xéropaysage) avaient tendance à nécessiter le moins de pesticides, de fertilisants, d'eau et d'entretien mécanique à l'aide d'équipement à essence.

c) Analyse du cycle de vie de sept aménagements paysagers sur terrains résidentiels

Les coûts d'installation et d'entretien à long terme, le temps requis, les répercussions environnementales, la beauté et la fonction des jardins sont tous des éléments à considérer au moment de décider du type d'aménagement que l'on veut réaliser chez soi. Les propriétaires devraient chercher à prendre une décision éclairée en pesant tous ces facteurs de manière que leur choix corresponde à leurs priorités. En menant une *analyse du cycle de vie* des diverses possibilités, on peut faciliter le processus de décision.

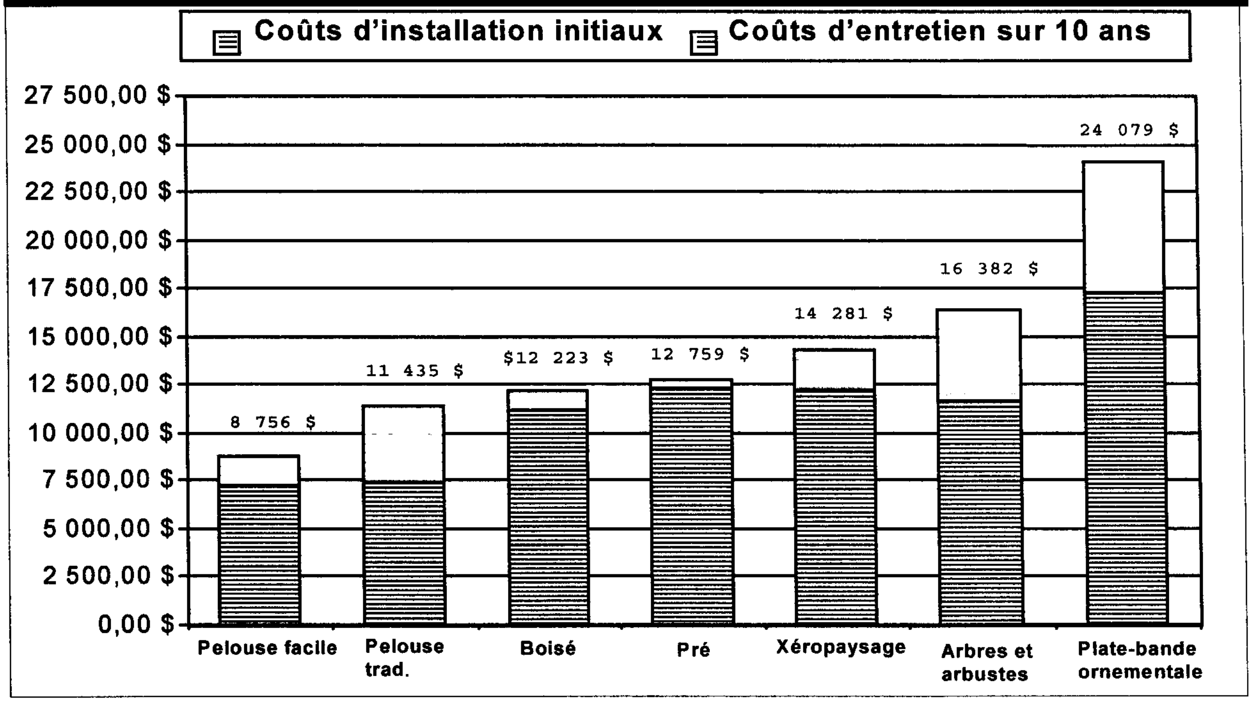
Pour en faire la démonstration, nous avons analysé sept options d'aménagement différentes convenant à une maison individuelle hypothétique. Chacune de ces options est principalement fondée sur l'un des sept aménagements étudiés dans le rapport dont il est question. On a aussi inclus de petites sections de deux autres types d'aménagement dans chaque concept. Prenant appui sur les résultats du suivi, l'analyse évalue:

- les coûts requis pour l'installation initiale de chaque type d'aménagement ainsi que les dépenses d'entretien nécessaires pour une période de 10 ans;
- le temps requis pour entretenir l'aménagement pendant 10 ans;
- l'utilisation d'eau, d'essence, de fertilisants et de pesticides pendant une période de 10 ans.

Coûts d'installation et d'entretien pendant 10 ans

À ce chapitre, la pelouse d'entretien facile s'est avérée la plus économique. Vient ensuite la pelouse traditionnelle, surtout en raison de son faible coût de mise en place. Bien que les coûts d'entretien du jardin boisé et du pré de fleurs sauvages naturalisés soient parmi les plus bas, les coûts d'installation initiale étaient élevés, ce qui les a placés au milieu de la fourchette de coûts. Le plus coûteux des sept aménagements, tant sur le plan de la réalisation et de l'entretien étalé sur 10 ans que du coût global est la plate-bande ornementale.

Figure ES-7: Coût global



La taille des plantes et l'emploi de graines au lieu des plantes peuvent avoir une incidence énorme sur les coûts d'installation initiaux. Dans le cas du xéropaysage, du pré et du boisé, des quantités considérables de plantes matures ont été utilisées. Si l'économie d'argent est un critère important, les propriétaires devraient envisager de recourir aux graines et aux semis pour établir des aménagements non traditionnels. Même si l'aménagement requiert plus de temps pour prendre forme, les économies peuvent être substantielles.

Temps

Les aménagements non traditionnels étaient les moins exigeants en ce qui concerne le temps d'entretien projeté. L'option la plus prenante serait la plate-bande ornementale. À l'opposé, le pré naturalisé nécessiterait le moins de temps. Les arbres et arbustes ornementaux exigeraient presque trois fois plus d'heures que le boisé naturalisé. Les deux types de pelouse se trouveraient entre ces deux extrémités parce que les concepts comportent trois genres d'aménagement, bien qu'ils soient principalement constitués de gazon. Les autres options exigeant beaucoup d'entretien, tels la plate-bande ornementale et les arbres et arbustes, ont tendance à accroître le nombre d'heures d'entretien pour ces concepts d'aménagement. Si les pelouses étaient combinées avec le boisé et le pré de fleurs sauvages, l'exigence de temps serait beaucoup moindre.

Eau, essence, pesticides et fertilisants

L'analyse du cycle de vie a révélé que les trois aménagements classiques nécessiteraient les apports de pesticides, de fertilisants, d'essence et d'eau les plus importants. Les résultats obtenus auraient différé quelque peu si les aménagements classiques avaient été combinés avec les solutions de rechange peu exigeantes en matière de ressources. Cette option pourrait s'avérer une solution viable pour un propriétaire préférant une pelouse entretenue de manière traditionnelle, par exemple, mais qui souhaiterait réduire, sans les éliminer complètement, les apports potentiellement dangereux en choisissant le pré naturalisé ou le xéropaysage plutôt que les plates-bandes ornementales, ou le boisé naturalisé plutôt que les arbres et arbustes ornementaux. Parfois, le changement peut se faire très graduellement.

Conclusions

Choisir le bon type d'aménagement pour un terrain ou un jardin passe par l'établissement des priorités et par l'acceptation de compromis. Le principal pour un propriétaire est peut-être d'économiser du temps ou de protéger l'environnement ou encore d'obtenir un certain aspect. Les lecteurs peuvent peser les diverses options décrites et décider de ce qui leur convient le plus :

Le temps : Pour ceux qui n'ont pas beaucoup de temps à consacrer à leur aménagement, les meilleurs concepts sont le pré de fleurs sauvages, le jardin d'ombre boisé et la pelouse. Avant de combiner des aménagements au sein de sept concepts hypothétiques, nous avons constaté que les pelouses étaient les plus efficaces en ce qui concerne le temps d'entretien requis, la pelouse d'entretien facile venant évidemment au premier rang à ce chapitre. Mais puisque les pelouses sont habituellement combinées avec d'autres types d'aménagement, le fait de les associer, par exemple, à un pré de fleurs sauvages ou à un jardin d'ombre boisé constitue une bonne façon d'économiser du temps.

Les coûts : Les pelouses coûtent le moins cher à l'investissement et sur 10 ans, les économies les plus importantes étant réalisées avec la pelouse d'entretien facile. Le jardin d'ombre boisé, le pré de fleurs sauvages et le xéropaysage suivent au chapitre des économies d'entretien sur 10 ans.

L'environnement : Pour réduire l'usage d'essence, d'eau, de pesticides et de fertilisants, les aménagements non traditionnels sont les plus efficaces, à savoir le jardin d'ombre boisé, le pré de fleurs sauvages, la pelouse d'entretien facile et le xéropaysage. Le jardin d'ombre boisé et le pré de fleurs sauvages sont les meilleurs aménagements pour attirer la faune, protéger la biodiversité et réduire au minimum la propagation des espèces exotiques envahissantes. Pour protéger les cycles hydrologiques et contribuer à améliorer la qualité de l'air de votre région, le boisé, les fleurs sauvages, le xéropaysage, les arbres et arbustes ainsi que les plates-bandes ornementales sont les meilleurs choix.

La fonction et l'esthétisme sont des considérations clés pour bien des propriétaires lorsqu'ils arrêtent leur choix. Bien sûr, celles-ci sont très subjectives. Nombreux sont les propriétaires, mais pas tous, qui préfèrent un aménagement élégant dont les pelouses, les arbres, les arbustes et les plates-bandes sont soigneusement entretenus. Les pelouses offrent des possibilités récréatives qui plaisent à plus d'un, surtout dans le cas des familles avec enfants. Ce type d'aménagement constitue la norme. Toutefois, certains propriétaires optent pour la beauté naturelle du jardin d'ombre boisé et du pré de fleurs sauvages. Ces personnes apprécient les coins d'ombre et l'intimité que leur procurent ces aménagements ainsi que les oiseaux chanteurs et les papillons qui y sont attirés.

Si les propriétaires souhaitent atteindre un certain équilibre entre les préférences esthétiques, l'économie de temps, la réduction des coûts et des impacts environnementaux, ils pourraient très bien envisager les aménagements paysagers non traditionnels. Ainsi, s'ils veulent des fleurs, mais ne veulent pas leur consacrer le temps et l'argent qu'il faut tout en protégeant l'environnement, ils pourraient faire l'essai du pré de fleurs sauvages ou du xéropaysage. S'ils souhaitent un espace ombragé et luxuriant aussi facile d'entretien qu'écologique, ils pourraient envisager un jardin d'ombre boisé. S'ils veulent se doter d'un espace de jeu gazonné, mais tiennent à maximiser l'utilisation de leur temps, à réduire les coûts et à optimaliser l'efficacité des ressources, la pelouse d'entretien facile représente un bon choix.

Au bout du compte, il revient à la personne de choisir. Le but de cette étude était de fournir aux lecteurs l'information susceptible de leur faire prendre une décision éclairée quant aux aménagements les plus appropriés à leur situation.

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Chapter 1: Introduction - study context

The conventional manicured lawn - lush, green, and closely cropped – dominates Canada's communities. It is the groundcover of choice throughout parks and open spaces, playing fields, playgrounds and schoolyards. It lines roadsides and boulevards, ditches and storm ponds, and is a green mantle across institutional and corporate landscapes. And, most significantly, lawns are woven throughout residential neighbourhoods and around Canadian homes. The lawn, in turn, is a canvas for decorative ornamental plantings of specimen trees, shrub masses, hedges, perennial borders and annual flowerbeds, all designed to embellish the residential landscape.

There are many practical reasons for this. Lawns are easy to establish - simply roll out the sod, water for a few weeks, and start mowing. Turfgrass is soft underfoot, yet highly resistant to a variety of uses. It safely cushions playing fields and play spaces, and carpets picnic areas and other public greenspaces where people gather and recreate outdoors. In urban areas, lawns and ornamental plantings offer cool respite from harsh concrete and asphalt environments, while helping to remove some pollutants from the air and storm runoff. Ornamental trees, shrubs and flowers offer colour, shade, screening and visual interest. Lawns allow sweeping vistas and views, and provide a foreground against which to display our buildings, trees, and flowerbeds. Around our homes, the lawn offers a refuge and place for families and friends to gather, and for children to play.

Grooming and manicuring these lawns and ornamental plantings to stringent horticultural and aesthetic standards is considered by many to be both a duty and a matter of civic pride. A community's self-image and quality of life are often equated to the ornamental qualities of its public and private greenspaces. Thus, expectations are that turfgrass in parks and streetscapes be kept green, weed-, pest-, and litter-free, and neatly mown and trimmed, so as not to look neglected. Along these lines, favoured parklands and civic gardens are those that exhibit colourful, bountiful displays of flowering trees, shrubs, perennials and annuals flowers. By extension, private landowners and homeowners are also expected to adopt this manicured "look" (at least for those portions of the yard that are open to public view); indeed, many communities have adopted property maintenance by-laws that dictate certain minimum property maintenance standards. Maintaining residential landscapes to such aesthetic standards can be a resource- and labour-intensive endeavour, often requiring large quantities of fertilizer, pesticide, fuel and water.

Certainly, Canadian homeowners exhibit a wide range of attitudes towards their lawns and gardens. Some homeowners - gardeners at heart - view their lawn and garden maintenance work as a labour of love. They value the time spent in the outdoors tending to the yard, working the soil, nurturing plants, and "editing" the garden. These gardeners gain a great deal of satisfaction from their efforts, and take great pride in displaying their landscapes to the neighbourhood.

Many other homeowners are more ambivalent about their relationship to the lawn and garden. For them, yard work is simply another household chore. The house came with the lawn (and likely a shrub bed and tree or two), and so they dutifully mow, fertilize, trim, and weed as required, more out of a sense of civic duty and obligation to their neighbours than a particular affection for the lawn and garden.

Regardless of individual homeowners' particular set of values and attitudes, one fact remains clear: the conventional lawn and ornamental garden are widely accepted as the horticultural status quo. Without a second thought, most (but not all) homeowners unquestioningly go about the maintenance work, oblivious to the fact that they in fact do have a choice, that there are low-maintenance, resource-efficient alternatives.

Why should homeowners even be concerned about choices and alternatives? Consider the costs incurred through the maintenance of these resource-intensive landscapes. First, there are the financial costs. Significant cash outlays are needed to purchase, operate and regularly service maintenance equipment, and buy and apply fertilizers, pesticides, mulches, and water. A second set of costs can be assessed in terms of time commitments. In a stressed out and time constrained world, lawn and garden maintenance can eat up a fair amount of free time (unless a maintenance contractor is hired, in which case financial costs increase).

Finally, and perhaps most significantly, there are the many potential environmental costs. It is somewhat ironic that garden and lawn maintenance can contribute directly and indirectly to the on-going deterioration of the environment. These impacts include harmful emissions from gas-powered equipment, excessive water consumption, the potentially adverse human and ecosystem health effects of pesticides and fertilizers, the spread of invasive exotic plant species, and the loss of biodiversity. In light of these concerns, and in the spirit of thinking globally and acting locally, Canadian homeowners have an opportunity to aid in the process of environmental restoration, by reconsidering how they maintain and manage their yards.

PURPOSE OF THIS REPORT

The purpose of this report is to provide a comparative analysis of the various costs, inputs, and environmental impacts associated with the maintenance of both the conventional and alternative landscape types[1]. Conventional landscape types include conventional lawn, ornamental flowerbeds, and ornamental trees and shrubs; alternative landscape types include low maintenance lawn, xeriscape, naturalized woodland and naturalized meadow. To this end, a landscape maintenance monitoring survey was conducted over the summers of 1998 and 1999. The survey, completed by a number of homeowners and institutions from across southern Ontario, generated a variety of field data that was subsequently used to derive mean annual values for the material, energy, time, and cost inputs associated with each of the landscape types considered in this study. This data serves as the basis for a quantitative analysis of the maintenance requirements associated with the conventional and alternative types.

The seven landscape types are described in chapter 2 and the results of the monitoring survey are presented in Chapter 3. Chapter 4 provides a overview of the potential ecological and human health impacts - and benefits – associated with the various landscape types and their specific maintenance regimes. Finally, Chapter 5 synthesizes this data through a comparative life cycle analysis of seven different landscape design options for a hypothetical single-family home, with each option highlighting one of the seven landscape types.

It is not the intent of this report to condemn the conventional lawn and ornamental garden. After all, these reflect a long cultural tradition and are cherished by many Canadians. The intent is to provide readers with an understanding of the costs, time and environmental impacts of different landscape options so that they can make informed decisions about new residential landscaping possibilities if they share these concerns.

---

[1] Practical, "how-to" aspects of creating and maintaining these various landscape types are not discussed. There already exists a number of informative and useful guides, manuals, and other resources available to interested homeowners, many of which are listed in Appendix 2.

Chapter 2: The Seven Landscape Types

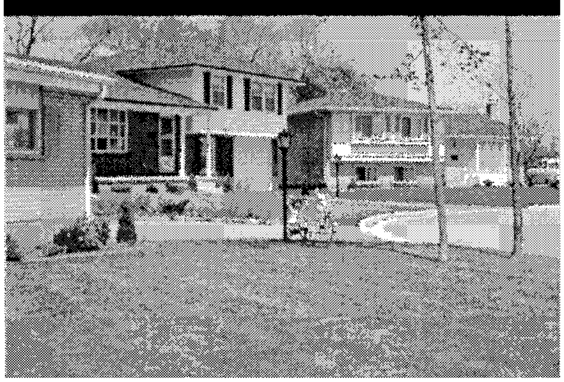
Seven different residential landscape types are analyzed and compared in this report. Three are considered traditional horticultural types: conventional lawn, ornamental flowerbeds, and ornamental trees and shrubs. The other four, including low-maintenance lawn, naturalized meadow, naturalized woodland and xeriscape, qualify as alternatives[1]. In this chapter, brief descriptions of each of these seven landscape types are provided as a precursor to the comparative analysis of maintenance inputs and environmental impacts conducted in Chapters 3 and 4[2].

Though nowhere near as common as their traditional counterparts, the alternative landscape types are gaining in popularity in many Canadian communities. Their appeal, for many people, lies in their reduced maintenance requirements and their environmental "friendliness". However, they must also satisfy other criteria. In general, they should be easy to install and maintain; they should accommodate a variety of outdoor household activities or practical needs; and, they should satisfy the homeowners' desire for some form of landscape beauty and interest around the home.

With respect to these criteria, each of the seven landscape types offer both advantages and disadvantages, as outlined in the descriptions below. Thus, it is more likely that a homeowner will adopt a variety of different landscape types for different portions of the property, depending on how the yard is used. For instance, the homeowner may, for public viewing, install conventional lawn and formal ornamental plantings in the front yard, while perhaps opting for low-maintenance lawn and naturalized meadow in the privacy of the backyard (by way of example, refer to Chapter 5 and the seven different landscape design options for a hypothetical home). To determine an appropriate combination of landscape types for your home, it is best to first develop property management objectives and a design program that reflects the family's functional and aesthetic needs.

2.1 Conventional Lawn

Figure 1:
Conventional Lawn



The conventional lawn is by far the most common and widespread residential landscape type. Far from its origins in the cool, damp climates of England (see Appendix 1), the lawn is now firmly entrenched throughout Canada and North America. It is the landscape of choice in even the most extreme of locations, from communities in the desert regions of the American southwest, to Canada's far north, from Labrador City to Whitehorse. Though originally ill suited to many of our varied, often harsh climates, the lawn thrives because we've learned to alter the site to fit the lawn, through the on-going development and refinement of a wide range of maintenance practices, products and equipment.

The conventional lawn typically consists of either a low-diversity mix or monoculture of exotic grass species such as Kentucky bluegrass, tall fescue, and their cultivars. These species have been specifically selected to meet certain horticultural, aesthetic and functional criteria.

Turfgrass species are also uniquely adapted to intensive mowing (or grazing). They can continue to produce vigorous new growth and rhizomes as leaf blades are mown, grazed, or damaged. These biological features, by extension, also enable these species to withstand trampling and foot-traffic, thereby making lawn an ideal groundcover for a wide range of human activities and uses. Turfgrass species used in lawns are typically of the cool-season variety to ensure as long a growing season as possible. Cool-season species are at their greenest, most vigorous during the cool, damp spring and fall months[3]. Keeping the lawn green, lush, and blemish-free through the heart of summer, however, is the maintenance challenge.

The "ideal" conventional lawn - as promoted by the landscape industry and aspired to by so many homeowners - is a deep rich green, exhibits vigorous growth, and is neatly mown to a height of six to eight centimetres through much of the year, whilst being free of the weeds, pests, disease and other blemishes that can spoil its carpet-like appearance. This aesthetic is possible only through an intensive maintenance regimen, one to which homeowners adhere to varying degrees. The conventional lawn is generally:

- mown and trimmed at least once or twice a week during peak growing seasons;
- treated, as required, with herbicides, insecticides and fungicides to keep weeds, insects, and disease at bay[4];
- regularly watered during dry periods to prevent dieback and browning;
- neatly edged at least once a year along walkways and flowerbeds;
- de-thatched, aerated, top-dressed, and over-seeded every two or three years to alleviate compaction, and to repair unsightly brown spots.

Organic Lawn: A Non-chemical Approach to Conventional Lawn Maintenance

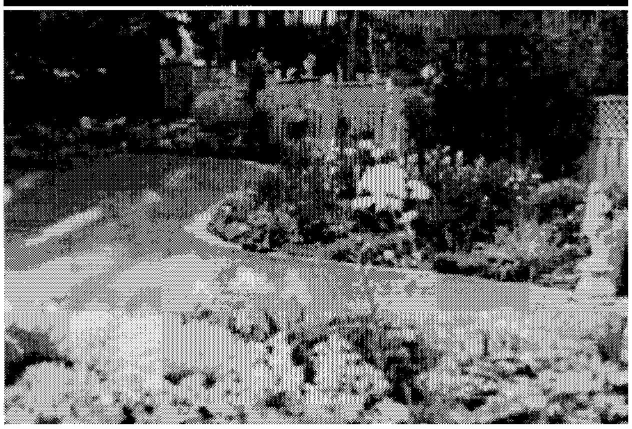
In recent years, the *organic lawn* has gained some prominence as a viable alternative to the conventional lawn. Though not analyzed in this study, it is worth mentioning here. An organic lawn offers all the aesthetic and functional benefits of a conventional lawn, without the synthetic chemical inputs. In this respect, organic lawns are hard to distinguish from conventional lawns, in that they are generally composed of the same turfgrass species as conventional lawns, and tend to be just as green, uniform, and weed-, pest- and disease-free.

However, there are some important differences between organic and conventional lawns. Whereas conventional lawns may be seeded or sodded with a single all-purpose seed mix, an organic lawn may consist of several different seed mixes selectively applied to suite variable site-specific conditions, such as soil moisture and shade. Organic lawns also tend to be watered less often than conventional lawns, primarily out of a concern for the environment. As well, cultural practices such as de-thatching, top-dressing, and aerating are typically applied with more frequency; maintaining lawn health through these management practices is considered an effective preventative measure to minimize disease and pest problems. For this reason, organic lawn maintenance is generally perceived to be more labour intensive than conventional lawn. Unlike conventional lawns, which are typically fertilized with synthetic, fast-release fertilizers, organic lawns are usually fertilized with organic slow-release alternatives (derived from both natural and synthetic sources. Finally, organic lawncare involves the use of a wide range of selective, carefully timed cultural, organic, and biological controls to deal with pests, rather than relying on chemical pesticides. Control strategies are largely based on an understanding of the pests' life cycles, growth requirements, and natural predators[5].

In most respects, organic lawn care is similar to *integrated pest management* (IPM), in that both emphasize the need to maintain lawn health though proper management practices. The key difference between the two approaches, however, centres on the fact that in an IPM lawn care strategy, chemical pesticides may still be used if non-chemical pest control techniques fail to produce desired results.

2.2. Ornamental Flowerbeds

Figure 2: Ornamental Flowerbeds
Photo Credit: Marion Warburton



Whereas the dominant feature of the Canadian yard is typically the lawn, ornamental flowerbeds are still a common and much cherished feature of the residential garden. For the purposes of this report, "flowerbeds" refers to massed plantings of both perennial and annual flowers designed and maintained to embellish the residential garden[6]. Usually, they are grown in full sunlight, though skillful gardeners may also nurture flowerbeds even in shaded conditions. A well-designed flowerbed, rich in colour and texture, can be a striking accent to the lawn through all seasons, and can be a source of great pleasure for both the gardener and bystander. Flowerbeds may be either tended as linear border plantings along house foundations, walls, fences, and walkways, as a foreground to trees and shrubs, as a rock garden on slopes too steep to mow, or as a stand-alone feature of the yard. They may be very large or very small, depending on the homeowner's gardening philosophy and available leisure time. Those with a green thumb, horticultural knowledge and an insatiable love of plants may be inspired to cultivate spectacular, multi-season floral displays encompassing large portions of both the front and backyards. On rare occasions, flowerbeds may even overtake the lawn as the dominant landscape type, particularly on smaller urban lots. However, most homeowners do not have the time and resources needed to maintain such creations, and are typically more reserved. Their flowerbeds may still be vibrant and skillfully arranged, but on a much lesser scale.

The perennials and annuals used in flowerbeds are, for the most part, exotic ornamental species and their cultivars selected for their aesthetic qualities, including bloom colour, size and period, and foliage texture, colour, and pattern. These species, numbering in the thousands, herald from all corners of the planet, and in some cases, have been cultivated as ornamentals for many centuries. More recently, there has also been a growing interest in native species, both for their ornamental qualities and their appeal to birds and butterflies.

Several key maintenance activities are essential to the successful cultivation of ornamental flowerbeds, including:

- periodic soil amendments with peat moss, compost and/or fertilizer to condition soil and maintain optimal soil fertility;
- regular watering;

- regular weeding to control unwanted colonizing plants that compete for nutrients, water and sunlight, and which can detract from the carefully crafted floral arrangements (bearing in mind that some gardeners are more tolerant of weeds than others);
- spring and fall clean-ups (primarily to remove plant litter)
- plant division, thinning, pinching and dead-heading
- periodic modifications/additions to the mix of perennial species as a means to refresh the garden (non-essential task at the discretion of the individual gardener)
- annual species plantings (quantities depend on the extent to which the gardener incorporates annuals into the garden)

In terms of pest and disease control, philosophies differ from one gardener to the next. Some use pesticides as and when required to eliminate the occasional insects or fungi infestation that may blemish or otherwise diminish the floral display. However, more and more gardeners, including most of those involved in the maintenance monitoring survey, prefer not to use chemical pesticides; they instead choose to live with the imperfections, or resort to organic, biological, and/or cultural controls.

2.3. Ornamental Trees and Shrubs

Figure 3:
Ornamental Trees and Shrubs

Ornamental trees and shrubs are a staple of the conventional Canadian residential landscape, for a variety of reasons. From an aesthetic standpoint, they add vertical interest to the monotonous horizontality of the lawn; they frame and adorn our homes; and, they can often unveil a dazzling array of leaf, flower, and fruit colours through the seasons. Ornamental trees and shrubs also serve a variety of other functions. Trees, in particular, can shade and cool the house and yard, and provide shelter from wind. Planted in massed hedges or groupings, trees and shrubs can shape and enclose spaces, delineate property lines, block unfavourable views, and provide privacy.

As with perennials and annuals, commercially available ornamental trees and shrubs are primarily introduced species from other parts of the world, and have been specifically selected for their aesthetic qualities. However, the palate of commercially available native woody ornamentals has increased substantially in recent years, in tandem with a growing awareness of the benefits of native species. Invariably, the individual plant's winter hardiness rating is the determining factor when selecting suitable ornamental trees and shrubs. For this reason, homeowners in the warmer climatic zones of coastal British Colombia, southern Ontario, and Nova Scotia have at their disposal a much wider diversity of woody ornamentals than those living in the north and across the Prairies. However, nurseries and researchers are constantly trying to develop hardier cultivars that can tolerate these regions' harsh winter climates.

As with flowerbeds, tree and shrub planting arrangements can vary widely in scope and scale from one homeowner to the next, and can range from the very elaborate to the very simple. Further, some dedicated gardeners may opt for specialized types of shrub plantings, such as rose or rhododendron and azalea gardens. These usually require very specific types of site alterations and, in most cases, intensive on-going maintenance interventions.

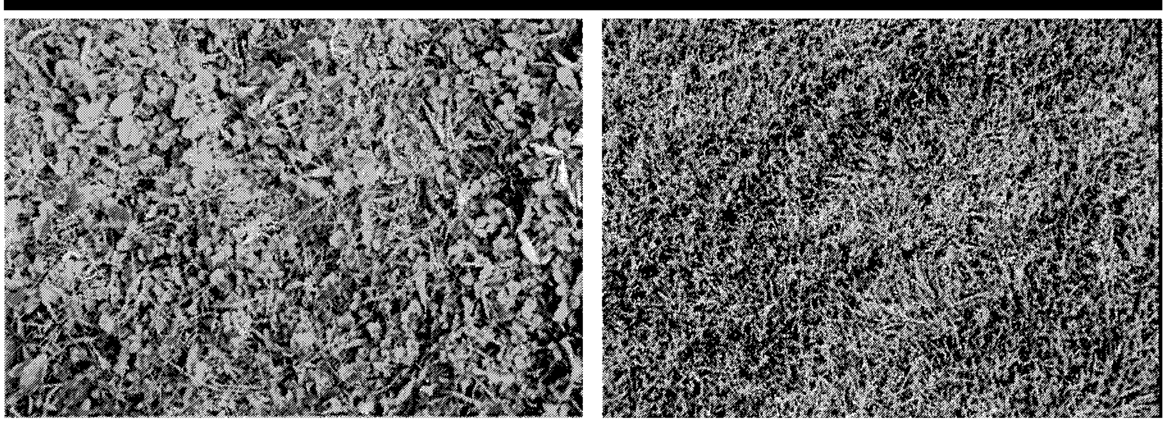
Depending on whether they are planted as bare root or container grown stock, it typically takes one to two years to establish newly planted trees and shrubs, during which time regular watering is usually necessary. Once established, the plants' watering demands will vary depending on their site suitability and adaptation to local precipitation rates. Many established tree and shrub species require supplemental water only during periods of drought. Watering requirements can be greatly reduced by creating shrub masses, which shade the ground and thus help reduce evaporation rates. Similarly, mulching can significantly reduce evaporation loss.

Once established, it is generally assumed that trees and shrubs are a relatively low-maintenance option. However, the monitoring survey results (see Chapter 3) suggest that this is not always the case. Actual maintenance inputs depend on both the types of species used, and as in the case of other landscape types, the individual homeowner's preferences. On-going maintenance tasks commonly associated with ornamental trees and shrubs include:

- occasional corrective pruning and trimming to contain the plant's growth and maintain desired form (hedges, for instance, may require a regular monthly trimming to retain a smooth wall-like appearance);
- watering as required during periods of drought
- hand-weeding (mulching and dense plant massing can help suppress weed growth;
- periodic pesticide applications to deal with disease and insects (frequency generally depends on the species used; as with conventional lawns and flowerbeds, both organic pest controls and integrated pest management strategies are increasingly being used as viable alternatives to chemical pesticides);
- other routine tasks such as occasional plant replacements and additions, pinching and deadheading (of spent blooms), and fertilizing.

2.4 Low Maintenance Lawn

Figure 4:
Close-up of low maintenance lawn (left) and conventional lawn (right)
Photo credit: Ecological Outlook



Many homeowners have adopted low maintenance lawns because they deliver all the functional advantages of conventional lawns - space to play and gather, open vistas, etc. - without many of the labour-intensive maintenance practices, inputs, and environmental impacts. By the same token, homeowners who opt for a low-maintenance lawns are decidedly less concerned about the lawn's visual quality, and are generally willing to forgo the all-season, weed-free, green carpet look. In this respect, low-maintenance lawns tend to be significantly less uniform in colour and appearance than conventional lawns. Blemishes, brown spots, weeds and other imperfections are accepted into the fabric. For this reason, low-maintenance lawns are sometimes relegated to locations out of public view and scrutiny, in backyards, low-use areas and other out of the way places. On larger properties, they may be combined with conventional lawns - or other landscape types - to create differentiated maintenance zones.

Low-maintenance lawns are characterized by much wider species diversity than conventional lawn monocultures, and may be established in one of two ways. They can be created from scratch with one of the many commercial low-maintenance seed mixes that have become widely available in recent years. These typically consist of a broad selection of several hardy, drought-tolerant grasses in combination with clover, yarrow, and other broadleaf species that tolerate periodic mowing and foot traffic. Some mixes are designed to minimize mowing by including only low-growing grass and broadleaf species.

The second way to establish a low-maintenance lawn is to convert existing turfgrass areas. Ideally, the existing turf could be stripped-off before seeding with the low-maintenance seed mix. Alternatively, the lawn area could be topdressed and overseeded, which would work best if the existing lawn had bare soil patches. Finally, by ceasing many lawn care practices, other grass and broadleaf species may colonize the turf area[7]. Over time, the species composition will reflect a natural adaptation to the site. Those species that persist and thrive are ones naturally suited to the sites' soil type, fertility levels, moisture levels, and sunlight intensity, and which are able to withstand regular mowing and trampling. For these reasons, a low-maintenance lawn may not be uniform in appearance, but it can remain surprisingly green through all seasons.

Unlike conventional monocultural lawns, the species diversity of a low-maintenance lawn allows it to better withstand the effects of disease, drought and other environmental factors, since only a small portion of the community is likely to be affected at any given time and the species are highly adapted. As a general rule, low maintenance lawn is:

- never treated with herbicides or pesticides;
- rarely, if ever, fertilized, relying instead on a combination of species tolerant of infertile soils and on clover and other legume species to fix nitrogen in the soil;
- never watered once established (during periods of drought, the grass species fall dormant and become brown until the rains return, though some of the drought tolerant broadleafs, as noted earlier, may remain green);
- never aerated, top-dressed, or over-seeded.

Lawn growth rates are usually reduced in the absence of these inputs, resulting in less frequent mowing. By mowing the low-maintenance lawn to a height of about 10 cm (compared to 6-8 cm for conventional turf), its susceptibility to drought and certain fungal diseases is further reduced.

2.5. Xeriscape

Figure 5: Xeriscape
Photo Credit: Cathy Dueck

Xeriscapes are water-efficient landscapes composed of hardy, drought tolerant species. As a landscape management practice, xeriscaping was first conceived in the dry desert regions of the American southwest, in response to dwindling water supplies and the unsustainable irrigation practices required to maintain conventional lawn and other ornamental landscapes. In these regions, xeriscaping is now widely accepted and practiced, sparking an interest in the use of native, drought tolerant species such as cacti and other desert plants as an alternative to conventional introduced ornamentals.

In recent years, the xeriscape movement has spread northwards into Canada. Despite seemingly abundant water supplies, the ever-increasing demand for water in many fast-growing urban and suburban areas has stretched municipal water systems to the limit. Consequently, summertime lawn watering bans and restrictions during periods of drought have become a fact of life in many Canadian communities. Recognizing that the conventional care of lawns and other ornamental landscapes only exacerbate the problem, many landscape designers and homeowners have turned to the xeriscape alternative as a means to reduce water consumption.

SIDEBAR

The Benefits of Native Plants

Having evolved in tandem with local environmental conditions over long periods of time, native plant species are genetically well adapted to local soils, climate and other environmental factors[8]. In a typical garden setting, native species are less likely to be stressed – and are therefore more disease and pest resistant – than exotic ornamentals, which typically require more intensive water, fertilizer, and pesticide inputs to compensate for less than favourable growing conditions (Hightshoe, 1988). Since native species have evolved in tandem with local birds, insects, and butterflies and other fauna, naturalized landscapes can also function as wildlife habitat. Contrary to the popular misconception that they are wild and scraggly-looking, many native plants are strikingly beautiful and can make exceptional additions to the garden.

Although ours is, for the most part, not a nation of deserts and cacti, Canadian applications of the concept hinges on the use of plants that are well adapted to local precipitation rates. Plant selections may include a wide selection of both native and exotic horticultural trees, shrubs, vines, woody and herbaceous groundcovers, grasses and perennials, with drought tolerance being the common denominator. Xeriscapes may include flowerbeds, massed tree and shrub plantings, rock gardens, low-maintenance turfgrass and even naturalized meadows and woodlands if composed of drought tolerant species. A variation of this approach known as *scree gardening* involves the installation of a sand or gravel planting bed to create excessively drained, droughty conditions. Plant selections are restricted primarily to highly drought-tolerant ornamental perennials – including a very limited selection of native species – that can thrive in such a difficult growing medium. Scree gardens are essentially weed-free, since most weeds simply cannot survive these difficult conditions.

The following features of xeriscapes help to reduce water use and other maintenance inputs:

- the use of plant species carefully selected to match local annual precipitation helps minimize the need for supplemental water inputs;
- soil amendments, such as compost or topsoil may be incorporated during the plant installation to help retain moisture, particularly during the establishment phase;
- stone and mulches such as woodchips, which are integral to xeriscapes, help to reduce evaporation and contain weed growth;
- trees, shrubs, groundcovers, and other plantings are typically massed together in mulched beds, rather than planted as individual specimens, in order to further reduce evaporation rates and weed competition;
- efficient irrigation systems, if used, can also help to reduce water use.

Once established, xeriscapes are generally considered a low-maintenance alternative to ornamental landscapes (though actual maintenance inputs depend on the individual gardener's preferences and gardening philosophy). Typical maintenance activities include occasional plant additions or replacements, weeding, periodic mulching and composting, and some thinning and dividing as plants mature.

2.6 Naturalized Woodland Shade Garden

SIDEBAR: Naturalization and Ecological Restoration

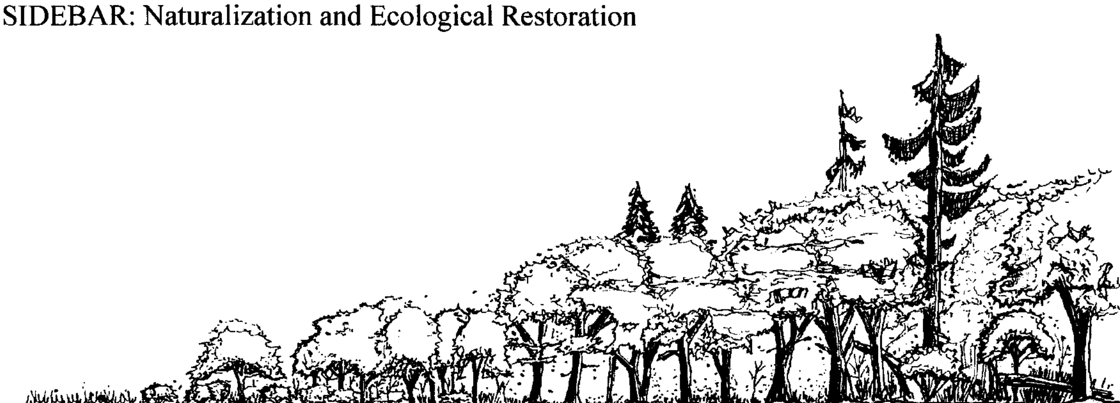


Figure 6: Natural forest succession over time: from oldfield meadow to forest
Credit: Ecological Outlook

In response to mounting ecological and human health concerns, the environmental movement of the 1980's and 90's has spawned the concept of naturalization, which first gained prominence as an urban parkland management strategy. Many municipal parks departments also adopted naturalization as a means to cut labour costs in light of shrinking maintenance budgets. Originally, it referred to the simple cessation of lawn mowing and maintenance activities, thereby allowing the grass to grow "wild". Over time, as the thinking went, the site would become a meadow and eventually revert back to a natural community such as a forest, as shown in Figure 7.

By allowing natural processes to take over, managed parklands would thus evolve to more natural – and naturally evolving – landscapes requiring minimal human intervention. More importantly, maintenance (especially labour) costs were significantly reduced, while eliminating the need for chemical inputs. Inspired by these local park initiatives, a small but vocal and determined contingent of environmentally concerned homeowners and gardeners across the country adopted naturalization on their own properties, often to the dismay of neighbours, local newspaper editorialists, and by-law officers[9].

Since those early years, *naturalization* has been greatly influenced by the principles and practice of ecological restoration[10], becoming distinctly more proactive and "hands-on". Though the underlying goal is still to develop a naturalistic, naturally-evolving landscape, naturalization – also now sometimes referred to as natural landscaping – now tends to focus on re-creating or restoring entire native plant communities modeled on those indigenous to the local area or bioregion. To this end, naturalization projects now often involve substantial native tree, shrub, grass, and wildflower plantings.

Figure 7: Forest ecosystem
Credit: Ecological Outlook

Figure 8: Prairie ecosystem
Credit: Kim Delaney

Naturalized woodland shade garden refers to diverse plantings of native trees, shrubs, vines, grasses and wildflowers in attractive arrangements designed to mimic the structure, composition, and natural cycles of a natural forest community. Structurally, the key component of a naturalized woodland garden is the tree canopy, which shades the ground and generates the microclimatic conditions needed to grow a wide assortment of shade tolerant woodland understorey shrubs and groundflora. Ideally, species selections are modeled on locally or bioregionally appropriate forest communities. For this reason, native woodland gardens are generally best suited to locales within Canada's forest regions. Having co-evolved with native wildlife, the native plants used in woodland gardens can provide habitat for many desirable wildlife species, such as songbirds and butterflies.

From a functional standpoint, woodland gardens, like all non-turf landscape types, restrict the range of yard activities typically associated with lawns. However, they do provide a cool, shaded

Figure 9: Woodland Shade Garden
Credit: Don Scallen

setting near the home, and can be interspersed with seating nooks, decks, and open lawn areas to permit a range of passive uses. In terms of aesthetics, woodland gardens are distinctly more natural, informal, and subtle in appearance than conventional, ornamental landscape types. The beauty of a woodland garden is in its intimate, yet often striking detail - the brief but sometimes dazzling show of spring ephemerals; the textural contrast of ferns against bark; dappled sunlight dancing on the forest floor; the early morning melodies of songbirds nesting in the shrub thicket. Woodland gardens may also be embellished with other natural elements such as rocks, logs, and water to provide additional visual interest as well as to enhance the planting's value as wildlife habitat.

As with any of the non-turf landscape types, woodland gardens do require some horticultural knowledge during the establishment phase, especially with respect to the growth requirements and habits of native plants. Fortunately, there now exist many excellent publications to assist novice gardeners (refer to the resource list in Appendix 2). Unlike most ornamentals, many native species are relatively well adapted to infertile soils. As a result, woodland gardens can often be established in existing site soils without the need for imported topsoil. The establishment phase for naturalized woodland can vary widely depending on, among other factors, the type, quantity, and size of plant material, and the presence or absence of an existing canopy. Where existing mature trees already form a canopy, a naturalized shrub and groundflora understorey may be established with plantings in as little as one or two years. However, it should be noted that some non-native tree species such as Norway maple be inadequate as a canopy species due to their heavy shade and shallow root systems, which can impede the development of an understorey plant community. Where no canopy exists, it may take at least three or more years to create a reasonably shaded woodland garden from scratch. Typically, the process begins with an initial planting of fast-growing pioneer trees (e.g. poplar) and shrubs (e.g. chokecherry) usually in combination with locally-appropriate old-growth species such as sugar maple and white ash. In subsequent years, shade-dependent understorey groundflora plantings are introduced once the canopy has closed and suitable micro-climatic conditions have formed.

Glossary of Natural Succession Terms

Natural succession: The process by which a natural plant community renews itself after it has been disturbed, usually through a progression of more or less distinct and predictable community stages. In the case of a disturbed forest, the succession of stages typically includes, among others, oldfield meadow, shrubland, pioneer woodland and old-growth woodland.

Oldfield Meadow: The earliest developmental stage in the natural succession of a forest, consisting of a mix of grasses and wildflowers that are gradually replaced by colonizing pioneer shrubs and trees over prolonged periods of time.

Pioneer Species: Hardy, fast-growing, short-lived native tree and shrub species that colonize oldfield meadows and gradually displace shade intolerant meadow grasses and wildflowers. Pioneer species help create microclimatic conditions favourable to the growth of longer-lived old growth species.

Old growth: The oldest stage in the natural succession of a forest. Old growth communities may persist for very long periods of time until a new disturbance once again triggers the process of natural succession.

Canopy closure: The canopy is the uppermost layer of a forest community, composed of the interwoven branches and foliage of the tallest trees. Canopy closure signals the point in the development of a forest community when sunlight levels in the understorey drop dramatically, thereby enhancing the growing conditions for shade dependent understorey species.

Plant selections are carefully matched to site soils and local precipitation, among other factors, thereby minimizing the need for supplemental water other than during the establishment phase. In this respect, woodland gardens, once established, may also qualify as a form of xeriscape. Leaf litter and other dead plant matter are left on the ground to be naturally recycled into the soil, thereby eliminating the need for fertilizer. The broad species diversity allows the planting to better withstand pest and disease problems. For the most part, the shaded conditions in woodland gardens prevent the growth of most common weeds, though the gardener does have to be wary of shade tolerant invasive exotic species such as Norway maple, European buckthorn, and garlic mustard, which may spread onto the site from adjoining properties. Most people who grow woodland gardens do so for the environmental benefits, and are thus inclined to avoid chemical pesticides.

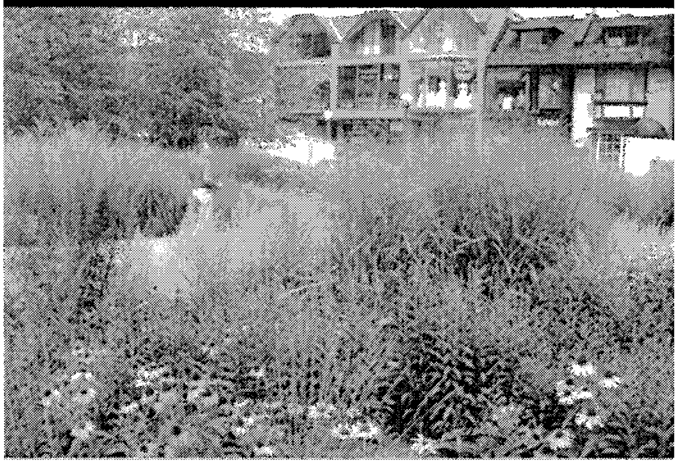
As a general rule, naturalized woodland gardens typically require minimal maintenance compared to the conventional landscape types, relying instead on the processes of natural succession. However, as with most of the other landscape types, actual time spent in the garden is largely dependent on each individual gardener's preferences and values. Some people may opt for a woodland garden primarily to minimize their yard work, and take great satisfaction in achieving the woodland look with as little effort as possible, while others may enjoy the opportunity to periodically modify the garden. Maintenance activities associated with woodland shade gardens include periodic:

- plant replacements and/or additions;
- hand weeding; mulching and composting;
- edging;
- corrective pruning and thinning;
- and dividing and transplanting within.

Cultural methods (i.e., digging, cutting, etc.) and organic pesticides, rather than chemical pesticides, are generally preferred if weed or pest problems occur, though some woodland gardeners may on occasion use chemical pesticides to deal with persistent weeds or pests.

2.7. Naturalized Wildflower Meadow

Figure 10: Naturalized Wildflower Meadow
Credit: Ecological Outlook



For the purposes of this report, the definition of naturalized meadow is restricted to landscapes composed of native grass and wildflower plantings modeled on locally- or bioregionally-appropriate grassland communities, including both meadows and prairies. It does not refer to unmown lawn gone wild. Although the latter is sometimes a viable first step towards creating a naturalized meadow, it is not always acceptable to others in residential settings. Unmown lawn typically consists of tall turfgrass species mingling with many common lawn weeds, and may appear neglected rather than naturalized. Consequently, this approach may, in some jurisdictions, be considered an infringement of local property maintenance bylaws and provincial noxious weed acts. Nor does it refer to landscapes created with generic, mass-produced "meadows-in-a-can". Invariably composed of exotic annuals and short-lived perennials, these meadows may result in an abundant floral show within as little as six weeks of seeding, only to rapidly fade out within a year or two as the annuals are replaced by a limited selection of tough, weedy species.

The distinction between a meadow and a prairie garden is largely geographical. Meadows, in ecological terms, are a temporary community occurring in the very early stages of forest succession; meadow gardens are thus more commonly associated with the forest regions of the country. Although meadows are, in nature, a short-lived successional community, meadow gardeners obviously favour them for their floral qualities, and thus, over the long term, must arrest their development and evolution towards woodland.

A prairie, on the other hand, is considered a permanent old-growth community in and of itself. In Canada, prairies occur in regions where limited rainfall and other factors prevent the growth of forest communities. Prairie gardens are thus more likely to be associated with the tall, short, and mixed prairie regions of Canada, as well as parts of British Colombia and in Ontario (where scattered tall grass prairie remnants tell of a prairie heritage that is only now being fully recognized). Although meadow and prairie gardeners try to work primarily with locally indigenous species, most are not purist and may opt to enrich their plantings with species native to Canada, but not necessarily to their particular bioregion.

As with other non-turf landscape types, naturalized meadow is ill suited to foot traffic. Consequently, it should be integrated with lawn, decks, and/or patio structures to provide gathering and play areas. From an aesthetic standpoint, naturalized meadow and prairie gardens typically look natural and untended. By selecting shorter species, meadows can permit the same open vistas as lawn. They provide a bountiful, if sometimes subtle, display of colourful grasses and wildflowers, without the intensive maintenance inputs associated with ornamental flowerbeds. As with woodland gardens, the meadow or prairie garden's beauty is more often experienced in the small details, in the contrast of foliage types and textures, in the discrete but eye-catching flowers or seed clusters seen only by those who search them out, in the butterflies and bees darting about across the flower tops, and in the subtle shift to earth tones as fall arrives and the grasses ripen.

As with other non-turf landscape types, some horticultural knowledge may be required to successfully establish and maintain a naturalized meadow (or prairie). Useful resources are listed in Appendix 2. Meadow and prairie communities can be seeded, planted, or both. Unless money is no object, plantings are usually restricted to smaller sites under 100 m^2, due to the proportionately higher costs of plant stock. Seed is generally considered more cost-effective on larger sites. Depending on whether it was seeded or planted, a meadow/prairie can take from two to three or more years to become well established. Over time, the native – and invariably, some colonizing exotic – grasses and wildflowers infill to form a dense, richly textured groundcover. Many native grass and wildflower species are well adapted to infertile soils, and thus usually do not require the rich topsoils or fertilizers that generally favour the growth of exotic weeds. With proper plant selections tailored to soil type, available moisture, and microclimate, meadow and prairie gardens can be highly drought tolerant, thereby qualifying them as a form of xeriscaping.

Unlike perennial and annual flowerbeds, which typically require regular weeding, watering, and attention, established meadow/prairies are relatively stable, self-sustaining plant communities requiring minimal maintenance. However, individual gardeners may espouse different maintenance philosophies. Some may aspire to a decidedly hands-off approach, while others may chose to invest more time editing and fine-tuning the garden.

At a bare minimum, the meadow or prairie should be mown once a year and, ideally, burned every second or third year to effectively suppress the successional growth of woody plants and exotic weeds. However, burns are generally not permitted in urban or suburban areas; consequently, some limited hand-weeding may be occasionally required to remove noxious or otherwise disruptive exotic weeds that persist despite the annual mowing.

In addition to annual mowing or burning, other maintenance activities associated with a residential meadow and prairie gardens include:

- annual plant replacements or additions;
- pinching and deadheading;
- weeding and litter clean-up;
- edging;
- and, thinning and dividing.

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[1] Other alternatives not considered at length in this report include organic lawn and garden maintenance and integrated pest management (IPM). Both of these approaches are ideally tailored to those homeowners who aspire to the aesthetic standards associated with a conventional lawn and ornamental garden, without the chemical pesticide and fertilizer inputs. In organic maintenance, a wide range of cultural practices, organic fertilizers, and natural or biological pest controls are used as a substitute for chemical fertilizers and pesticides. IPM, on the other hand, involves a range of preventative management practices to control weeds and other pests. Chemical pesticides, however, are still used, albeit in reduced quantities as a means of last resort.

[2] The following descriptions are intended merely as a general introduction to the various landscape types discussed in this report, and do not include practical "how-to" installation and maintenance information. For this purpose, a selection of useful publications, Internet web sites, and other resources are listed in Appendix 2

[3] On the other hand, warm-season species – including many of the native grass species found in Canada's native prairies and grasslands – restrict their growth period to the warm summer months, and are thus ill adapted to the conventional lawn (though they may be better suited to the low-maintenance lawn)

[4] A 1990 survey of lawn care companies by the University of Guelph Turfgrass Institute revealed that the average Ontario household annually received 2 4 chemical herbicide applications, one insecticide application, and 7 fungicide applications (Struger et. al , 1994).

[5] For instance, crab grass may be controlled by a springtime application of gluten meal to suppress seed germination, and by over-seeding bare spots where crab grass seed may germinate. Insects such cinchbugs may be controlled with beneficial insects such as nematodes, and/or by not watering the lawn during the peak summer months, whereas white grubs can be controlled by thoroughly spike-aerating the lawn. Damage caused by various fungal diseases such as brown patch and dollar spot can be reversed and controlled through carefully timed watering and fertilizing practices.

[6] Some gardeners do prefer to create beds composed exclusively of either annuals or perennials, rather than mixing the two However, all the participants in the maintenance monitoring survey combined both types in their flowerbeds

[7] Non-turf species colonize the lawn as a result of several factors, including the elimination of pesticides, which allows non-turf ("weed") species to become established In the absence of chemical fertilizer applications, the turfgrass growth becomes less vigorous, thereby enabling other species adapted to less fertile soils to become established As well, colonizing species may also set roots where bare patches occur as a result of trampling, compaction, disease, or insects.

[8] However, it should be noted that native species may not be well suited to a given site if native soils have been altered or disturbed (i.e., stripped, compacted, or replaced). In urban areas, air pollution and harsh microclimates can also hamper the growth of native (and non-native) species For information on the specific tolerances and vulnerabilities of native tree and shrub species, see Hightshoe (1988).

[9] In many localities, homeowners interested in naturalization must contend with noxious weed and property maintenance by-laws. In recent years, a few determined Canadian homeowners have undertaken court challenges contesting these by-laws, including the City of Toronto vs Sandra Bell case (Rappaport, 1997)

[10] *Ecological restoration* is a relatively recent - and hopeful - science and field of practice dedicated to the repair of degraded ecosystems and ecological communities Restoration projects aim to restore or recreate native plant communities that are representative of the local area or bioregion's flora. To this end, restoration usually involves plantings based on plant community models derived from natural areas that currently exist, or historically occurred, in the local area or bioregion By restoring these native plant communities, habitat for the myriad wildlife species with which they have evolved is also restored Ecological restoration, however, is more than just plantings. It also involves the restoration of those natural processes that sustain these plant communities, such as fire in relation to prairies and dry woodlands, or flooding in wetlands and riparian zones It involves eliminating the sources of degradation that have led to the need for restoration in the first place, and requires a commitment to the protection and careful management of those healthy natural ecosystems that do remain Restoration projects can be conceived on any scale, from an entire watershed or regional landscape, to a single, tiny backyard At the core of all restoration efforts, regardless of the scale and complexity, is a desire to heal past injuries, and engage in a more caring, constructive, and ecologically responsible relationship to the land

3.1 Background

Four of the seven landscape types reviewed in this study - naturalized woodland, naturalized meadow/prairie, low-maintenance lawn, and xeriscape - are commonly described as resource-efficient, low-maintenance alternatives to conventional lawns and ornamental landscapes. While studies from other countries such as the U.S. have collected field data of various landscape types to compare maintenance inputs, very little, if any, empirical research has been conducted for Canadian residential landscapes. Many publications and enthused gardeners may expound on the low-maintenance virtues of their alternative landscape relative to their neighbour's lawn, but have no real basis for comparison unless they actually monitor the time and other inputs spent doing yard work over a sample of different gardens. Despite the widespread interest in the landscape alternatives, there have been few attempts to actually quantify and compare their maintenance inputs with those of conventional lawn and ornamental landscapes[1].

The goal of this research study was to begin the process of filling this information gap. To this end, a landscape maintenance monitoring survey involving 24 participants was designed and conducted over the summers of 1998 and 1999. Several of the participants monitored more than one landscape type. The raw field data collected through this survey was subsequently compiled, analyzed and converted to *mean annual values* (MAV) for key inputs associated with the seven landscape types considered in this report. Given the small sample group and short survey period, the data generated through the survey cannot be construed as being statistically precise. It does, however, provide useful "ballpark" figures adequate for the comparative purposes of this report. A more rigorous study would have required a larger sample group over a longer monitoring period. This, however, was beyond the scope of the study. Also alternative landscapes such as xeriscapes and naturalized woodland gardens are not yet common within the study region, thereby making it difficult to find willing survey participants. Hopefully, this initial survey may serve as a springboard for a more rigorous study in the future.

In this study, MAVs serve two key purposes. First, they are required for the comparative life cycle analysis of the seven hypothetical landscape design options depicted in Chapter 5. Secondly, as an end in themselves, they provide the quantitative basis for comparing the various maintenance cost, material, and time inputs associated with each of the seven landscape types. Charts and tables included in this chapter provide at-a-glance summaries of the time, money, and material required on a per m^2 basis to maintain each type[2]. When deciding on an appropriate landscape type for their own properties, homeowners can use the MAVs to predict potential maintenance costs and time commitments for each landscape type, by multiplying them by the size of the site. However, as noted in the conclusions at the end of this chapter, actual inputs may vary for some landscape types, depending on the homeowner's goals and interests.

3.2 Maintenance Monitoring Survey Methodology

Phase 1 - 1998

The initial monitoring phase was conducted during the 1998 growing season, and involved at least two monitoring participants per landscape type. For this phase, a total of 11 participants - four of which were responsible for tracking inputs for more than one landscape type - were selected primarily through personal and professional contacts. Of these, only 5 were residential homeowners. The others included the Town of

Caledon, the University of Guelph Arboretum, the Peterborough Ecology Garden and a commercial nursery, the latter three of which maintained residential landscape demonstration gardens suitable for this survey. Though the participants are widely distributed across southern Ontario, all are geographically located within the Great Lakes - St. Lawrence Life Zone[3] and the northern fringe of the Carolinian Life Zone. To the extent possible, at least one institutional and one residential participant were assigned to each landscape type[4].

Participants were provided with monitoring instructions and survey forms designed to help them track and record time, material, energy and cost inputs. The instruction package included a brief questionnaire on maintenance philosophies and standards (see Appendix 3 for sample monitoring form). The costs of purchasing and servicing maintenance equipment and tools were not considered in the MAV cost calculations.

Monitoring was carried out over a five-month period from mid-May to October 3, 1998[5]. Upon reviewing and compiling the results of the 1998 survey, it became apparent that some significant data gaps had resulted from the limited participant sampling. The survey was therefore extended for a second year, with a larger number of participants.

Phase Two - 1999

For Phase Two, the number of participants per landscape type was doubled from two to at least four, with a total of 23 participants involved in the survey. Again, several participants assumed responsibility for more than one landscape type. Maintenance monitoring was conducted between April 15 and October 3, 1999. All but one of the Phase One participants continued through the second monitoring year. The additional participants were all residential homeowners, and were recruited in three ways: personal and professional contacts; an advertisement in a local paper; and by seeking the involvement of local gardening clubs.

3.3 Data Analysis and Mean Annual Value (MAV) Calculations

The field data supplied by the study participants has been tabulated in a series of seven tables, one for each landscape type. Each table includes the site-specific per m^2 values for each activity, as well as overall MAVs/m^2 for each activity.

In the process of compiling and analyzing the survey data, a number of variables were considered. Variables applicable to two or more landscape types are outlined below, along with descriptions of any resulting data adjustments as a result of discrepancies in the data. Variables specific to individual landscape types are outlined in subsequent sections.

Essential vs. non-essential maintenance tasks: Some survey participants reported inputs not considered essential to the maintenance of a particular landscape type in question, such as the installation of bird houses or repaving walkways. These activities were deleted from the calculations. As well, tasks involving the enlargement of gardens were deleted, since the goal here is to report on the maintenance of established, rather than new, plantings.

Site conditions: Site-specific variables, such as soil texture and porosity, topography, microclimate and hydrology, can all influence input quantities. For instance, a lawn growing on sandy, infertile, drought-prone soil is likely to require more water and fertilizer than one on fertile loam. Or, the mowing time for a sloped site may be substantially more than for a flat site of equivalent size. The scope of this survey did not allow for any control over such site factors; no adjustments were made for these and other site variables.

Climatic variation: Climatic differences from one year to the next can have a direct bearing on the amounts of water, fertilizer, pesticide, and time required to maintain any given landscape. For example, both 1998 and 1999 were considered dry years in southern Ontario (where all of the monitoring site were located). Consequently, even normally drought tolerant landscape types required water inputs, sometimes in surprising quantities. However, this is a particularly difficult variable to quantify and account for in a short-term survey; no attempt was made to adjust the data.

Maintenance standards and interests: As a result of personal preference and level of interest, maintenance practices and standards for any given landscape type can vary widely from one person to the next. In this respect, some people are hobby gardeners, while others view yard work as a chore and thus aim to minimize their time maintaining the lawn and garden. Variations amongst participants were noted for most landscape types. Consequently, the MAVs generated through the survey represent a reasonable medium.

Professional vs. homeowner maintenance: In two instances, homeowners hired contractors to do some limited lawn maintenance work. As well, paid staff were responsible for maintaining the various public or private demonstration gardens included in the 1998 survey. Although it can be assumed that there is likely to be some difference in the work habits and efficiency of homeowners and paid professionals, no time adjustments were carried out. Instead, it was simply assumed that efficiency rates vary from one homeowner to the next, and that the paid professionals were equivalent to highly efficient homeowners.

Pesticides: Due to the vast array of pesticide products available to homeowners, no attempt was made to differentiate between the various types of both chemical and organic pesticides used, be they herbicides, insecticides, or fungicides. Instead, these were all aggregated together as a single input class to establish application rate[6], time and cost MAVs. The purpose here is simply to demonstrate which of the landscape types are more likely to be treated with pesticides. Individual homeowners have the option of using either chemical or organic products, depending on their preference and degree of concern for the environment. Potential ecological and human health impacts associated with chemical pesticides are discussed at length in Chapter 4. Interestingly, while it was easy to enlist homeowners who use lawn pesticides, only four of the ten participants reporting on the maintenance of ornamental flowerbeds and ornamental trees and shrubs used chemical pesticides (several did use organic alternatives). This is somewhat surprising, considering the number of pesticide products lining garden centre shelves. However, this may reflect shifting attitudes towards chemical pesticides. Indeed, many of the participants indicated they avoided using pesticides for environmental and health reasons.

Fertilizers: The survey participants reported using a wide array of fertilizers on conventional lawns, and to a lesser extent, on ornamental plantings. Both liquid and granular formulations were used, in a wide range of nutrient concentrations and proportions, depending on the purpose and season. Most participants used fast release synthetic fertilizers, though a few did use organic, slow-release, urea-based formulations. For the purpose of the monitoring survey, no attempt has been made to differentiate between the various types of fertilizers used. Fertilizers are reported simply by weight and cost. The environmental implications of synthetic fertilizers are discussed in Chapter 4.

Mowers and trimmers: All of the lawn maintenance participants used a standard 21- or 22-inch gas-powered push mower. To simplify fuel consumption calculations, it was assumed that the mowers used .8L of gasoline per hour[7]. Fuel consumption was calculated by multiplying the length of mowing operations by .8L. Although both electric and gas-powered trimmers were used, the energy consumption calculations were simplified by assuming that all participants used a mid-range 2.5 hp, 3.5 amp electric device. Fuel consumption data for gas-powered trimmers was converted to kilowatt consumption, based on the length of time the trimmer was operated.

Watering calculations: To calculate water consumption rates, survey participants did a simple calibration test to determine the amount of water that flowed from their hoses over a one-minute period. Based on these results, they could then calculate the amount of water used, by multiplying the rate of flow by the duration of the watering event. If watering was done with a hand-held nozzle, the entire watering period was recorded as a maintenance activity. However, if a sprinkler was used, the time input was limited to 15 minutes for setting up and dismantling the hoses during each watering. In the case of one homeowner with an irrigation system, no time inputs were reported.

Material and energy: The reported costs of certain material inputs varied significantly from one participant to the next. For instance, the cost of woodchip mulch ranged from a high of $50/m^3 to a low of "free-of-charge". As well, some participants purchased materials at wholesale value, while others paid retail costs, resulting in significantly different mean cost values. To simplify the MAV calculations, standardized costs were established for the following material and energy inputs, based in part on average costs reported by participants:

- **woodchip mulch**: $25/m^3
- **topsoil**: $30/m^3
- **water**[8]: $.68/m^3
- **gasoline**: $.50/L (1998); $.60/L (1999)
- **electricity**[9]: $.10/kwh

3.4 Survey Results and MAV Calculations

3.4.1 Conventional Lawn

Figure 11: Conventional lawn, McManamna residence
Credit: Jacquie McManamna

Participant	*Location*	*Size*
Seniuk Residence:	Mississauga, ON	195 m^2
Childs Residence:	Gananoque, ON	185 m^2
Warburton Residence:	Newmarket, ON	557 m^2
Antle Residence:	Schomberg, ON	993 m^2
McManamna Residence:	Sutton, ON	1037 m^2

Maintenance Standards/Philosophies: Two of the participants indicated that they maintain their lawns to high horticultural standards (i.e., neatly mown, vigorous growth, and weed-, pest- and disease-free), and use water, fertilizers and pesticides as required to adhere to this standard. The three other participants espouse a more relaxed maintenance approach and accept some imperfections. Two of them indicated they use pesticides very selectively, only when absolutely necessary; the third does not use chemical pesticides whatsoever, relying instead on various organic maintenance practices. All of the participants used fertilizers, and four of the five water their lawns as required to maintain green growth through the summer. Averages derived from these various approaches paint a reasonably accurate picture of a typical conventional lawn maintenance regime.

Survey Results and Discussion[10]

Lawn maintenance data supplied by the survey participants, with resulting MAVs, are outlined in Table 1.

Table 1: Maintenance MAV's for Conventional Lawn

	Site 1 195m²	Site 2 185m²	Site 3 557 m²	Site 4 993 m²	Site 5 1037 m²	MAV / m²
Maintenance Activities	Min. per m²	Min. per m²	Min. per m²	Min. per m²	Min. per m²	Minutes
1. Mowing and trimming	4.02	2.66	1.88	3.98	1.62	2.83
2. Raking (grass clippings/fall leaves)	.03	0	.97	.30	.09	.28
3. Pesticide application	.56	.02	0	.09	.19	.17
4. Watering	.47	0	.28	.29	0	.21
5. Edging (along pavements)	.46	0	.22	.16	.17	.2
6. Hand weeding	.04	0	.52	.18	0	.15
7. De-thatching	.62	0	0	.15	0	.15
8. Fertilizer application	.08	.06	0	.14	.06	.07
9. Spot-repairs / over-seeding	.16	.01	.32	0	0	.1
10. Aerating	.16	.05	0	.06	0	.05
11. Top-dressing	.04	0	.08	.06	0	.03
TOTALS, TIME	6.64	2.8	4.27	5.41	2.13	4.24

	per m²		per m²		per m²		per m²		per m²		MAV / m²	
Material / Energy Inputs	qty	$	qty	$	qty	$	qty	$	qty	$	qty.	$
1. Fertilizer (all formulations)	44 6 gm	25	146 gm	26	19 8 gm	37	222 gm	17	17 4 gm	06	89.96 gm	.22
2. Herbicide	4 7 gm	15	54 gm	06	4 gm	14	7 04 gm	12	1 93 gm	03	3.53 gm	.10
3. Insecticide	3 5 gm	18	n/a**	11	3 4 gm	06	0	0	0	0	1.71 gm	.07
4. Seed	n/d	02	10 gm	07	n/d	01	0	0	0	0	3.33 gm	.02
5. Topsoil for top-dressing	n/d	10	0	0	22 ml	04	01 ml	04	0	0	.06 ml	.03
6. Water	94 5 L	07	0	0	10 L	01	81 6 L	06	0	0	37.2 L	.03
7. Fuel	40 ml	02	33 ml	01*	25 7 ml	02	44 ml	03	22 ml	01	32.94 ml	.02
8. Electricity (trimmer)	005 kwh	01*	002	01*	0	0	006 kwh	03	0	0	.003 kwh	.01
TOTAL COSTS, MATERIALS	---	0.79	---	0.50	---	.65	---	.45	---	.10	---	.50

* Cost and material values under 01 rounded upwards to .01
** Participant used live nematodes, no weight reported
n/d - No data; participant did not supply quantity data; n/d's not factored into MAV calculations

The total **time MAV** was calculated at **4.24 min./m²**, with site-specific values ranging from a high of 7 to a low of 2.13 min./m². By far, lawn mowing and trimming, at 2.83 min./m², was the most time consuming activity. Watering, edging, and pesticide application were next at .21, .20, and .17 min./m² respectively. Other maintenance activities reported in the survey included hand-weeding, de-thatching, fertilizer application, spot repairs, aeration, and top-dressing, with a combined total of 0.75 min./m².

The total **cost MAV** was calculated at **$0.50/m²**. Fertilizers had the highest cost of all the material inputs, at $0.22/m². All participants applied fertilizers at least once, with two participants using them 4 times during the growing seasons. Total amounts ranged from a low of 17.4 to a high of 222 gm/m², with a

MAV of 90 grams of fertilizer per m^2. Interestingly, this represents only slightly more than half of the total fertilizer inputs recommended by the landscape and lawn care industry.[11]

Herbicides, by cost, were the next most significant material input, at 3.53 gm/m^2 and $0.10/sq.m.[12]. Four of the five participants used chemical herbicides such as 2,4-D, Killex and mecoprop at least twice over the course of the growing season; the fifth used corn gluten meal once as organic alternative to control the spread of crab grass. Although the latter was included in the cost MAV, it was excluded from the weight MAV due to its disproportionately high application rate (54gm/m^2) relative to other herbicides.

Only two of the five participants reported the use of chemical insecticides, primarily diazinon, with MAVs of 1.71 g/m^2 and $.07/$m^2$. One participant relied on nematodes as an organic alternative; only the cost was factored into the MAVs. There were no reports of fungicide use, contrary to the Struger et al. (1994) findings that fungicides are applied on residential lawns by maintenance contractors at least twice every three years (.7 applications/yr.)[13].

Only three of the five participants watered their lawns, with a resulting MAV of 37.2 liters/m^2. Assuming an average monitoring site area of 593 m^2, this translates into a consumption rate of approximately 22,000 liters (22 m^3) per lawn. This low rate may be due to several factors, including watering restrictions imposed by local municipalities, as well as the limited survey sampling. On the other hand, it may actually signal a trend towards reduced water use on lawns as Canadians become increasingly aware of local water conservation concerns.

3.4.2. Ornamental Flowerbeds

Figure 12:
Ornamental Flowerbed, Slingerland residence
Credit: Mary Slingerland

Participant	*Location*	*Size*
Warnock Residence	Sutton, ON	65 m^2
Reid Residence	Markham, ON	108 m^2
St. Albans Parish Manse	Georgetown, ON	103 m^2
Slingerland Residence	Mount Albert, ON	275 m^2
Town of Caledon	Caledon, ON	84 m^2

Maintenance Standards/Philosophies: A team of volunteers maintained the St. Albans parish manse flowerbeds. Both the Town of Caledon and the parish volunteers aspired to maintaining the flowerbeds to high aesthetic standards, this being a result of the flowerbeds' high public profile. The other participants all indicated a preference for a more relaxed approach and could accept some imperfection. Three of the five participants never use pesticides. The three residential participants, as well as the parish manse volunteers, identified themselves as hobby gardeners who enjoyed working in and editing their flowerbeds, though two did indicate a preference to minimize their maintenance time (as evidenced in their time MAVs)[14].

Survey Results and Discussion[15]

Ornamental flowerbed maintenance data supplied by the survey participants, as well as the resulting MAVs, are outlined in Table 2.

Table 2: Maintenance MAV's for Ornamental Flowerbeds

	Site 1 103 m	Site 2 84 m²	Site 3 275 m²	Site 4 65 m²	Site 5 108 m²	MAV
Maintenance Activities	Min./m²	Min./m²	Min./m²	Min./m²	Min./m²	Min./m²
1. Weeding	26.2	23.93	2.95	2.15	2.31	11.51
2. Spring/fall clean-ups*	9.45	7.14	.71	1.69	3.29	4.46
3. Edging	6.22	4.28	.44	0	3.75	2.94
4. Plant replacements / additions	7.65	1.43	1.31	0	3.98	2.87
5. Pruning / pinching / deadheading	4.07	5	1.22	1.15	2.69	2.83
6. Watering	4.38	3.21	2.62	0	0**	2.04
7. Plant thinning and dividing	2.06	4.28	0	0	1.57	1.58
8. Fertilizing	0	.71	.69	0	1.85	.65
9. Pesticide application	0	0	.21	0	.74	.19
10. Mulching	0	0	0	0	.74	.15
TOTALS, TIME	60.03	49.98	11.03	4.99	20.92	29.22

	per m²		per m²		per m²		per m²		per m²		MAV/m²	
Material / Energy Inputs	qty	$	qty	$	qty	$	qty	$	qty	$	qty.	$
1. Plants / seed	n/a	2 02	n /a	3 53	n/a	43	n/a	1 60	n/a	52	n/a	1.62
2. Pesticide	0	0	0	0	3 63 gm	03	0	0	11 6 gm	13	3.04 gm	03
3. Fertilizer	0	0	23 8 gm	19	69 gm	18	0	0	41 7 gm	30	26.9 gm	.13
4. Water	246 5 L	17	40 2 L	03	26 L	02	0	0	592 L	40	180.9 L	.12
5. Mulch	0	0	0	0	0	0	0	0	18 5 L	46	3.7 L	.09
TOTAL COSTS, MATERIALS	---	2.21	---	3.8	---	.66	---	1.6	---	1.85	---	1.99

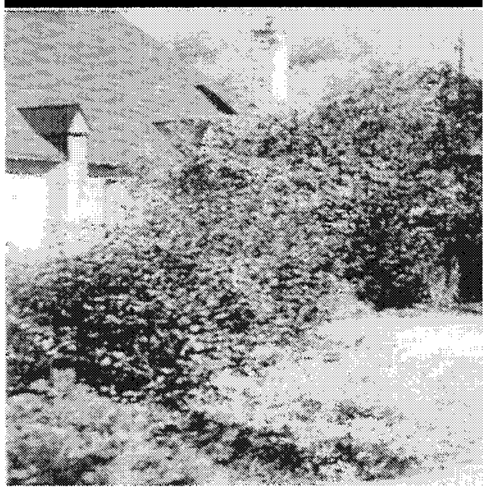
* Clean-ups refer primarily to removal of dead plant litter and raking
** Participant used an underground irrigation system
n/a – Not applicable; no standard unit of measure available

The total **time MAV** for flowerbed maintenance was calculated at **29.22 min./m²**, with site-specific values ranging from a high of 60.02 to a low of 4.99 min./m². This wide discrepancy reflects the fact that individual homeowners do have widely varying philosophies and standards when it comes to maintaining flowerbeds, and that it is possible to adopt a low-maintenance approach. By far, weeding, at 11.51 min./m², was the single most time-consuming activity. Spring and fall clean-ups were next, at 4.46 min./m², followed by edging (2.94 min./m²), plant replacements/additions (2.87 min./m²), pruning (2.83 min/m²), and watering (2.04 min./m²). Other minor tasks included fertilizing, pesticide application, and mulching.

The total **cost MAV** was determined to be **$1.99/m²**. Plant additions (including annuals) and replacements represented the largest investment, at $1.64/m². Three of the five respondents reported the use of chemical fertilizers, resulting in MAVs of 26.9 gm/m² and $0.13/m2. Two participants applied pesticides, in the form of organic insecticidal soaps. Four of the five participants reported significant water inputs, while a fifth did not water her flowerbeds.

3.4.3 Ornamental Trees and Shrubs

Figure 13: Ornamental Trees & Shrubs, St. Albans Parish Mance
Credit: Rebecca Caverly



Participant	*Location*	*Size*
Ryan Residence	Pottageville, ON	35 m^2
Antle Residence	Schomberg, ON	160 m^2
St. Albans Parish Manse	Georgetown, ON	202 m^2
Reid Residence	Markham, ON	269 m^2
Town of Caledon	Caledon, ON	680 m^2

Maintenance Standards/Philosophies: Four of the five participants described themselves as hobby gardeners and indicated a preference for maintaining their tree and shrub plantings to a high aesthetic and horticultural standard. Only two use pesticides as and when required, while the others never do.

Survey Results and Discussion[16]

Ornamental tree and shrub maintenance data supplied by the survey participants, as well as the resulting MAVs, are outlined in Table 3.

Table 3: Maintenance MAV's for Ornamental Trees and Shrubs

	Site 1 202 m^2	Site 2 680 m^2	Site 3 160m^2	Site 4 35 m^2	Site 5 269 m^2	MAV /m^2
Maintenance Activities	Min./m^2	Min./m^2	Min./m^2	Min./m^2	Min./m^2	Minutes
1. Weeding/planting bed maintenance	3.86	4.1	1.13	10.57	.95	4.12
2. Spring/fall clean-ups	.45	0	0	13.71	2.04	3.24
3. Edging	.15	.09	.66	12	.07	2.59
4. Fertilizing	0	0	0	11.71	.37	2.41
5. Plant replacements / additions	.37	0	.38	10.29	.19	2.25
6. Watering	1.34	.13	1.31	6.43	0'	1.84
7. Pruning / pinching / deadheading	1.84	.61	3.17	2.42	1.12	1.83
8. Plant thinning and dividing	.3	0	0	5.14	0	1.09
9. Pesticide application	0	0	.76	4.29	.07	1.02
10. Mulching	0	.88	0	0	.19	.21
TOTALS, TIME	8.31	5.81	7.41	76.56	5.0	20.6

	per m^2		per m^2		per m^2		per m^2		per m^2		MAV/m^2	
Material / Energy Inputs	qty	$	qty	$	qty	$	qty	$	qty	$	qty.	$
1. Fertilizer	0	0	0	0	0	0	834 gm	2 06	1 86	02	167.2 gm	.42
2. Pesticide	0	0	0	0	6 25 gm	16	23 7 gm	1 71	5 gm	01	6.09 gm	.38
3. Plants / seed	n/a	03	0	0	n/a	30	n/a	1	n/a	18	n/a	.31
4. Mulch	0	0	2 61 L	07	0	0	0	0	14 9	37	3.5 L	.09
5. Water	23 4 L	02	47 1 L	04	184 L	13	67 4 L	05	68 L	05	77.98 L	.06

6. Electricity (hedge trimmers, 300 wt)	01 kwh	01**	0	0	02 kwh	01**	009 kwh	01**	0	0	.01 kwh	.01
TOTAL COSTS, MATERIALS	---	.07	---	.09	---	.62	---	4.83	---	0.64	---	1.28

* Participant used underground irrigation system
**Cost and material MAVs under 01 were rounded up to 01
n/a – Not applicable; no standard unit of measure available.

The total **time MAV** for tree and shrub maintenance was calculated at **20.06 min./m^2**, with site-specific values ranging from as low as 5.81 to a high of 76.56 min./m^2. This latter value was recorded at the smallest of all the monitoring sites, which included a number of labour and resource-intensive shrub species such as roses. This is the widest of all time discrepancies noted for any of the landscape types. Again, it reflects the fact that individual homeowners may have widely varying philosophies and standards when it comes to maintaining even ornamental landscapes.

Weeding was the most time-consuming activity, at 4.12 min/m^2. Interestingly, only one of the participants used mulch to suppress weeds, which could drastically reduce weeding time. Spring/fall clean-ups and edging were next, at 3.24 and 2.59 min./m^2 respectively. Fertilizing, plant replacements and additions, watering, and pruning each required 2.41, 2.25, 1.84 and 1.83 min./m^2 respectively, while mulching, pesticide application, and plant thinning rounded off the slate of activities.

The total **cost MAV** was **\$1.28/m^2**. Fertilizer was determined to be the most expensive input, at 167.2 gm/m^2 and \$0.47/m^2, even though only one of the five participants reported using fertilizer (in large quantities). Pesticides were the second most expensive, at 6.09 gm/m^2 and \$0.38/m^2. Again, these figures are based entirely on rather heavy pesticide use by a single participant, who applied large quantities of diazinon to rose bushes and other flowering shrubs. These quantities seem very high compared to those reported by the Institute for Maintenance Research (1983), and may not be an accurate reflection of the average amounts of pesticides used by Canadian homeowners (due to the small participant sampling)[17].

All of the participants watered their trees and shrubs, resulting in a MAV of 77.98 L/m^2, the largest quantity reported for any of the landscape types. Again, it must be noted that this consumption rate is due at least in part to the drought conditions that prevailed over the two-year survey period. Participants were likely aware of the need to water many woody plant species when rainfall is low to ensure long term vigor.

3.4.4 Low Maintenance Lawn

Figure 14:
Low maintenance lawn, Pickering residence
Credit: Jim Pickering

Participant	***Location***	***Size***
Pickering Residence	Sharon, ON	1305 m^2
Agosta Residence	Bolton, ON	402 m^2
Peterborough Ecology Gdn.	Peterborough, ON	36 m^2
Guelph Arboretum	Guelph, ON	246 m^2

Maintenance Standards/Philosophies: Two of the four participants considered themselves hobby gardeners, but all preferred a more relaxed approach when it comes to maintaining their lawns. None used pesticides during the survey period, with two indicating they never use pesticides as a rule. One participant did note that pesticides might be used selectively, when absolutely necessary.

Survey Results and Discussion[18]

Low maintenance lawn data supplied by the survey participants, as well as the resulting MAVs, are outlined in Table 4.

Table 4: Maintenance MAV's for Low Maintenance Lawn

	Site 1 246 m^2		Site 2 36m^2		Site 3 1305 m^2		Site 4 402 m^2		MAV/m^2	
Maintenance Activities	Min./m^2		Min./m^2		Min./m^2		Min./m^2		Minutes	
1. Mowing and trimming	.98		2.43		1.62		.64		1.42	
2. Hand weeding	0		0		0		1.49		.37	
3. Edging (along pavements)	.12		.65		0		0		.19	
4. Fertilizer application	0		.35		.05		0		.1	
5. Raking	0		0		.06		0		.02	
TOTALS, TIME	1.1		3.43		1.73		2.13		2.1	
Material / Energy Inputs	per m^2		per m^2		per m^2		per m^2		MAV/m^2	
	qty	$	qty	$	qty	$	qty	$	qty.	$
1. Fertilizer	0	0	18 gm	09	37 gm	10	0	0	13.8 gm	.05
2. Fuel	12 ml	01*	28 ml	02	22 5 ml	01	7 ml	01	17.4 ml	.01
3. Electricity (trimmer, 430 watts)	01* kwh	01*	01* kwh	01*	01* kwh	01*	0	0	.01	.01
TOTAL COSTS, MATERIALS	---	.02	---	.12	---	.12	---	.01	---	.07

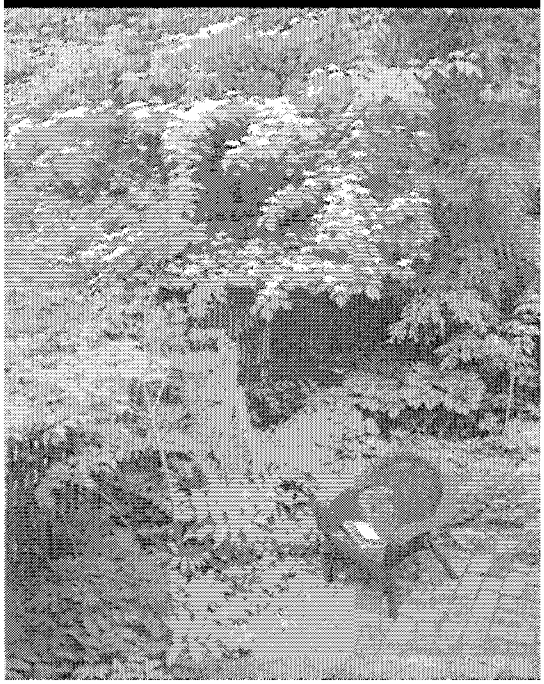
* Cost and material MAVs under 01 were rounded upwards to 01.

The total **time MAV** for low-maintenance lawn was calculated at **2.1 min./m^2**, or half the time spent on conventional lawns. Site-specific values ranged from a high of 3.43 to a low of 1.1 min./m^2, a rather narrow discrepancy compared to ones observed for other landscape types. By far, lawn mowing and trimming, at 1.42 min./m^2, was the most time consuming activity. This is approximately half of the conventional lawn MAV, reflecting the fact that low-maintenance lawns are not mowed as frequently. An additional .68 min./m^2 was devoted for hand-weeding, edging, raking and fertilizer applications.

The total **cost MAV** was \$0.07/m^2. In terms of materials, two of the four participants recorded single fertilizer applications, resulting in a MAV of 13.8 gm/m^2 and \$0.05/m2, which is substantially less than the 90 gm/m^2 reported for conventional lawns. None of the participants applied any water or pesticides.

3.4.5 Naturalized Woodland Shade Garden

Figure 15: Naturalized woodland shade garden, Hodgins residence
Credit: Jim Hodgins



Participant	***Location***	***Size***
Kock Residence	Guelph, ON	170 m^2
Scanlon Residence	Georgetown, ON	50 m^2
Guelph Arboretum	Guelph, ON	300 m^2
Hodgins Residence	Toronto, ON	39 m^2

Maintenance Standards/Philosophies: Three of the four participants (Guelph Arboretum excluded) identified themselves as hobby gardeners who enjoy working in and editing the woodland garden. All expressed a preference for a more relaxed maintenance approach; three of the four indicated they never use pesticides.

Survey Results and Discussion[19]

Woodland maintenance data supplied by the survey participants, as well as the resulting MAVs, are outlined in Table 5.

Table 5: Maintenance MAV's for Naturalized Woodland Shade Garden

	Site 1 300m²		Site 2 170 m²		Site 3 39 m²		Site 4 50 m²		MAV	
Maintenance Activities	Min./m²		Min./m²		Min./m²		Min./m²		Min./m²	
1. Thinning / dividing / transplanting	0		.71		6.15		0		1.72	
2. Weeding	.03		.89		3.07		.9		1.22	
3. Mulching	0		1.06		2.69		.45		1.05	
4. Pruning / pinching / deadheading	.13		1.15		1.54		0		.71	
5. Plant replacements / additions	0		.62		.77		0		.35	
6. Watering	0		1.23		0		.14		.34	
7. Edging	0		.49		0		0		.12	
8. Spring/fall clean-up	0		.05		0		0		.01	
9. Pesticide application	0		.05		0		0		.01	
TOTALS, TIME	.16		6.25		14.22		1.49		5.53	
	per m²		per m²		per m²		per m²		MAV(per m²)	
Material / Energy Inputs	qty	$	qty	$	qty	$	qty	$	qty.	$
1. Plants / seed	0	0	n/a	07	n/a	64	0	0	n/a	.18
2. Mulch	0	0	8 85 L	25	0	0	0	0	2.21 L	.06
3. Pesticide	0	0	02	01	0	0	0	0	.01* gm	.01*
4. Water	0	0	10 9 L	01	0	0	109 L	07	29.97 L	.02
TOTAL COSTS, MATERIALS	---	0	---	.14	---	.64	---	0.7	---	.27

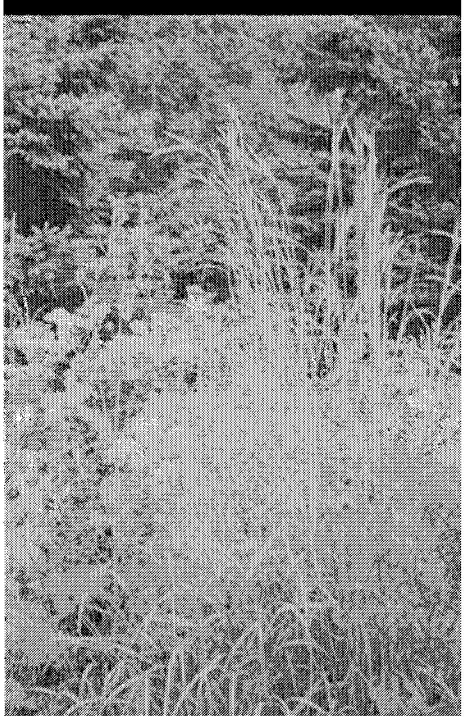
* Cost and material MAVs under 01 were rounded upwards to .01.
n/a – Not applicable; no standard unit of measure available.

The total **time MAV** was determined to be **5.53 min./m^2**. However, there were some wide discrepancies in the site-specific values, which ranged from as low as .15 min./m^2, to as high as 14.22 min./m^2. This wide time discrepancy clearly reflects contrasting woodland garden maintenance philosophies. On one hand, it is possible to maintain a woodland garden with a minimum of intervention, as is the case with the Guelph Arboretum demonstration garden (no maintenance inputs in 1999). However, two of the other participants were much more engaged with their garden, and devoted significant amounts of time to editing and weeding. Both approaches are viable and can produce successful results. Plant thinning and dividing, weeding and planting bed maintenance, and mulching were the three most time-consuming activities, at 1.72, 1.22, and 1.0 min./m^2 respectively. Pruning accounted for another .71 min/m^2, with the balance of time spent on a variety of other minor activities such as watering, edging, and spring/fall clean-ups.

The **cost MAV** was determined to be **\$0.27/m^2**, with annual plant additions and replacements being the single most expensive material input at \$0.18/m^2. Mulch was the only other significant expenditure, at \$0.06/m^2. Although woodlands are generally considered to be water-efficient landscapes, a surprising amount of water (29.97 L/m^2) was used in 1999 as a result of the severe drought conditions[20]. It should also be noted that approximately one third of the water used in the woodland gardens was to help establish new plantings that were struggling due to the drought conditions. Consequently, the MAV of water use appears rather high (relative to lawn), and may not be an accurate reflection of water used averaged out over a 4 year period. Over the two year survey period, only one 7 gm pesticide application was reported, which has been factored into the MAV calculations.

3.4.6 Naturalized Meadow/Prairie

Figure 16: Naturalized meadow, McGaw residence
Credit: Paul McGaw



Participant	Location	Size
Guelph Arboretum	Guelph, ON	110 m^2
Johnson Residence	Guelph, ON	25 m^2
Hilts Residence	Puslinch, ON	200 m^2
McGaw Residence	Toronto, ON	65 m^2

Maintenance Standards/Philosophies: All of the participants indicated a preference for a more relaxed maintenance approach, and chose to keep maintenance to a minimum. Two of the four participants consider themselves hobby gardeners; all stated a preference not to use pesticides.

Survey Results and Discussion[21]

Prairie and meadow maintenance data supplied by the survey participants, as well as the resulting MAVs, are outlined in Table 6.

Table 6: Maintenance MAV's for Naturalized Meadow and Prairie

	Site 1 110 m^2	Site 2 25 m^2	Site 3 200 m^2	Site 4 65 m^2	MAV/M^2
Maintenance Activities	**Min./m^2**	**Min./m^2**	**Min./m^2**	**Min./m^2**	**Min./m^2**
1. Weeding	.28	2.36	0	4.15	1.69
2. Annual mowing / periodic burn	3.27	0	0	.92	1.04
3. Spring/fall clean-up	0	2.3	0	0	.57
4. Plant replacements / additions	0	.24	0	1.8	.51
5. Pruning / pinching / deadheading	0	.9	0	.92	.45
6. Plant thinning and dividing	0	0	0	.92	.23
7. Watering	0	0	0	.46	.11
8. Mulching	0	0	0	.46	.11
9. Pesticide application	0	.30	0	0	.08
10. Edging	.27	0	0	0	.07
11. Raking (mowing clippings)	.07	0	0	0	.02
TOTALS, TIME	3.89	6.1	0	9.63	4.88

	per m^2		per m^2		per m^2		per m^2		MAV/m^2	
Material / Energy Inputs	qty	$	qty	$	qty	$	qty	$	qty.	$
1. Plants / seed	0	0	n/a	20	0	0	0	0	n/a	.05
2. Fuel (for mower)	3 01 ml	01*	0	0	0	0	2 64 ml	01	1.41 ml	.01*
3. Pesticide	0	0	84 gm	01*	0	0	0	0	.21 gm	.01*
4. Water	0	0	0	0	0	0	49 L	03	12.25 L	.01
TOTAL COSTS, MATERIALS	---	.01*	---	.01	---	0	---	.11	---	.08

* Cost and material MAVs under 01 were rounded upwards to 01

n/a – Not applicable; no standard unit of measure available

The **time MAV** for naturalized prairie / meadows was **4.88 min./m^2**. Site-specific values ranged from a low of 0 min./m^2 to a high of 9.63 min./m2. This discrepancy reflects somewhat different maintenance approaches to meadow and prairie gardens. While opting for a naturalized landscape, some people - usually the hobby gardeners - still enjoy the opportunity to periodically edit, weed, and generally tidy-up the garden. Others, however, prefer a hands-off approach with minimal intervention, and place their faith in natural process to shape and evolve the garden. Both approaches are viable and can produce successful results. Weeding, at 1.69 min/m^2, was the most time consuming activity. Most of the weeding was undertaken by two of the four participants. Annual mowing and/or periodic burns was the next most time-consuming activity, at 1.04 min./m^2. Spring and fall clean-ups, plant replacements, and pinching and dead-heading followed at .57, .51, and .45 min/m^2 respectively. The remaining time inputs are more or less evenly distributed amongst tasks such as watering, pesticide applications, mulching, and annual mowing.

The total **cost MAV** was **\$0.08/m^2**, with the most expensive item being plant additions and replacements, at \$0.05/m^2. In terms of material inputs, only one of the four participants applied water over the two year period. One participant noted the use of an organic insecticidal soap and water formula three times over the 1999 survey period.

3.4.7 Xeriscape

Figure 17:
Xeriscape, Chinell residence
Credit: Patricia Chinell

Participant	Location	Size
Country Squires Garden	Campbellville, ON	19 m^2
Peterborough Ecology Gdn.	Guelph, ON	33 m^2
Mason Hogue Residence	Uxbridge, ON	101 m^2
Chinell Residence	Aurora, ON	52 m^2

Maintenance Standards/Philosophies: Three of the participants noted a preference to minimize garden maintenance. All four espouse a more relaxed maintenance philosophy, and can live with some imperfection in the garden. Two participants indicated they never use pesticides, while the other two use them selectively, when absolutely necessary (a single application of BTh, an organic pesticide, was recorded, in 1998).

Survey Results and Discussion

Xeriscape maintenance data supplied by the survey participants, as well as the resulting MAVs, are outlined in Table 7.

Table 7: Maintenance MAV's for Xeriscape

	Site 1 19 m^2		Site 2 33m^2		Site 3 52 m^2		Site 4 101 m^2		MAV/m^2	
Maintenance Activities	Min./m^2		Min./m^2		Min./m^2		Min./m^2		Min./m^2	
1. Weeding	.92		4.25		5.19		17.23		**6.90**	
2. Pruning / pinching / deadheading	2.37		.98		16.73		0		**5.02**	
3. Spring/fall clean-up	2.37		.91		1.2		3.56		**2.01**	
4. Plant replacements / additions	1.9		3.64		0		1.03		**1.64**	
5. Mulching	0		1.13		1.2		1.19		**.88**	
6. Watering	0		1.75		1.2		.10		**.77**	
7. Plant thinning and dividing	.84		.46		1.35		0		**.66**	
8. Edging	0		1.29		0		0		**.32**	
9. Fertilizer application	0		.27		.4		.30		**.24**	
10. Pesticide application	0		.11		0		0		**.03**	
TOTALS, TIME	8.4		14.79		27.27		23.41		18.47	
	per m^2		per m^2		per m^2		per m^2		MAV/m^2	
Material / Energy Inputs	qty	$	qty	$	qty	$	qty	$	qty.	$
1. Plants / seed	n/a	20	n/a	1 26	0	0	n/a	99	**n/a**	**.61**
2. Mulch	0	0	24 L	58	0	0	4 95 L	15	**7.24 L**	**.18**
3. Fertilizer	0	0	21 gm	12	58 gm	01	49 5 gm	10	**17 gm**	**.01**
4. Water	0	0	9 L	01	9 17	01	11 L	01	**7.29 L**	**.01**

5. Pesticide	0	0	3 03	01	0	0	0	0	.75 gm	.01*
TOTAL COSTS, MATERIALS	---	0	---	2.94	---	.02	---	1.57	---	.82

* Cost and material MAVs under 01 were rounded upwards to.01
n/a – Not applicable; no standard unit of measure available.

The xeriscape **time MAV** was **18.47 min./m^2**. Site-specific time values ranged from a low of 8.4 min./m^2 (for a scree garden[22]) to a high of 24.41 min./m^2 (a rock garden). Again, as with the other landscape types, this discrepancy mirrors the different maintenance practices and philosophies espoused by the participants; as well, scree gardens are inherently less demanding than rock gardens, due to their reduced weeding and mulching requirements. By a wide margin, weeding, at 6.90 min./m^2, constituted the single most time-consuming activity. An additional 5.02 min./m^2 was devoted to pinching and dead-heading. Other key activities included spring and fall cleanups, at 2.01 min./m^2, and plant replacements/additions, at 1.64 min./m^2. A number of other minor maintenance tasks, such as fertilizer application, plant thinning and watering round off the time inputs.

The total cost MAV was \$0.82/m^2. In terms of material inputs, new plantings constituted the single most expensive item, at \$0.61/m^2. Mulches are a key water-conserving feature of xeriscapes, and were the next most significant input, at 7.24 L/m^2 and \$0.18/m2. As with other landscapes, drought conditions did result in some water use, at 7.29 L/m^2, though all of the water applied to the gardens was for new rather than established plantings.

In calculating these MAVs, it should be noted that two of the gardens underwent major renovations involving significant numbers of new plants well beyond what would be considered routine annual maintenance. Assuming this type of major maintenance activity might occur every 4 years (based on participants' observations), new planting quantities were reduced by a factor of four. By extension, the water used to nurture these new plantings was similarly reduced, as was watering time.

3.5 Summary of Results

The various MAVs associated with each of the seven landscape types are summarized below in Table 8 and Charts 1 though 6.

Table 8: Summary Chart, Maintenance MAV's

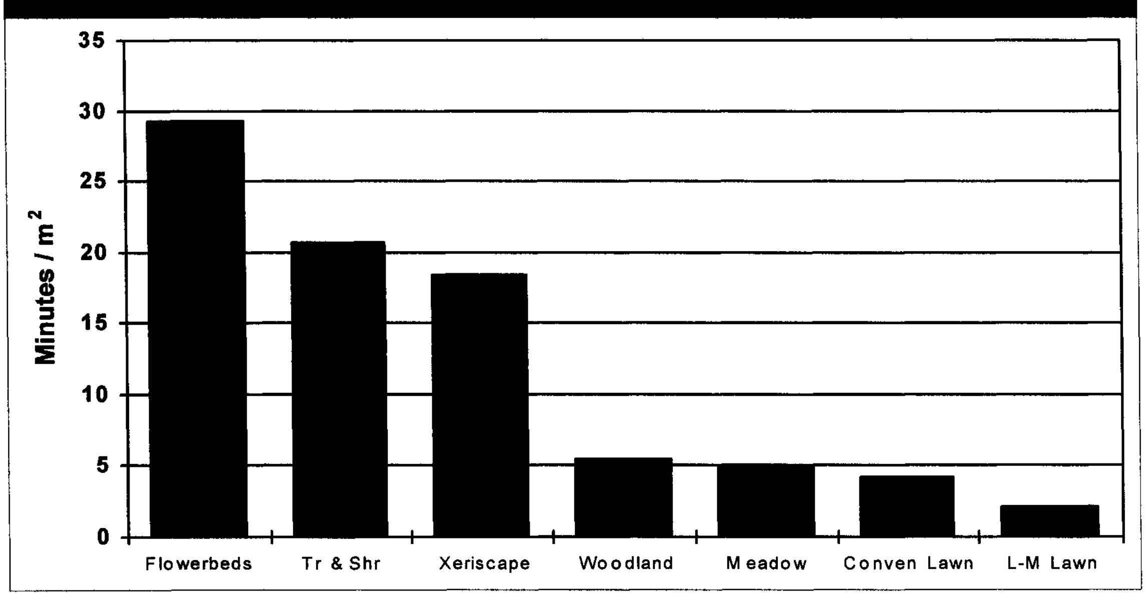
	LANDSCAPE TYPE/ Labour Time in minutes / m^2						
MAINTENANCE TASK	**Conven. Lawn**	**Low-Main. Lawn**	**Trees and Shrubs**	**Flowerbed**	**Woodland**	**Meadow**	**Xeriscape**
Mowing and Trimming	2 83	1.42	0	0	0	0	0
Raking	.28	.02	0	0	0	02	0
De-thatching, aerating, top-dressing	.23	0	0	0	0	0	0
Pesticide application	.17	.1	1.02	.19	.01	.08	.03
Watering	.21	0	1.84	2.04	.34	.11	.77
Edging	20	.19	2.59	2 94	12	.07	.32
Hand weeding	.15	.37	4.12	11.51	1.22	1.69	6 90
Fertilizer application	07	0	2.41	.65	0	0	25
Reseeding /plant replacements & additions	.10	0	2.25	2.87	.35	51	1 64
Spring/fall cleanup	0	0	3.24	4.46	01	.57	2 01

Mulching	0	0	.21	15	1 05	.11	88
Plant thinning / division / transplanting within	0	0	1.09	1.58	1 72	.23	.66
Annual Mowing / Periodic Burn	0	0	0	0	0	1 04	0
Pruning / pinching / deadheading	0	0	1 83	2.83	.71	45	5 02
Total Time MAV (min. / m²)	**4.24**	**2.10**	**20.60**	**29.22**	**5.53**	**4.88**	**18.47**

MATERIAL & ENERGY INPUTS	**Conven. Lawn**		**Low-Main. Lawn**		**Orn. Trees & Shrubs**		**Orn. Flowerbed**		**Woodland**		**Meadow**		**Xeriscape**	
	LANDSCAPE TYPE/ Material and Energy MAV's / m²													
MATERIAL	Q	$	Q	$	Q	$	Q	$	Q	$	Q	$	Q	$
Fertilizer (chemical & organic)	89 96 gm	.22	13.8 gm	05	167 2 gm	.42	26 9 gm	.13	0	0	0	0	17 gm	01
Pesticides (chemical & organic, all types)	5 24 gm	17	0	0	6 09 gm	38	3.04 gm	01	01 gm	01	.21 gm	01	75 gm	01
Plants/seeds (annuals, spot repairs, new plantings)	5 75 gm	.02	0	0	n/a	32	n/a	1.64	n/a	18	n/a	05	n/a	61
Topsoil for topdressing	06 ml	.03	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline	32 94 ml	02	17.4 ml	.01	0	0	0	0	0	0	1.41 ml	01	0	0
Electricity	003 kwh	01	.001 kwh	01	01 kwh	01	0	0	0	0	0	0	0	0
Water	37 2 L	03	0	0	77 98 L	06	180 9 L	12	30 L	02	12 3 L	01	7 29 L	01
Mulch	0	0	0	0	3 5 L	.09	3 7 L	.09	2 21 L	.06	0	0	7 24 L	18
Total Mat. & Energy Costs MAV ($ / M²)	**.50**		**.07**		**1.28**		**1.99**		**.27**		**.08**		**.82**	

Based on the results of the monitoring survey, low-maintenance lawn is the most time-, material-, and cost-efficient of the seven types, whereas ornamental flowerbeds are the most consumptive.

Figure 18: Annual Time Inputs / m²

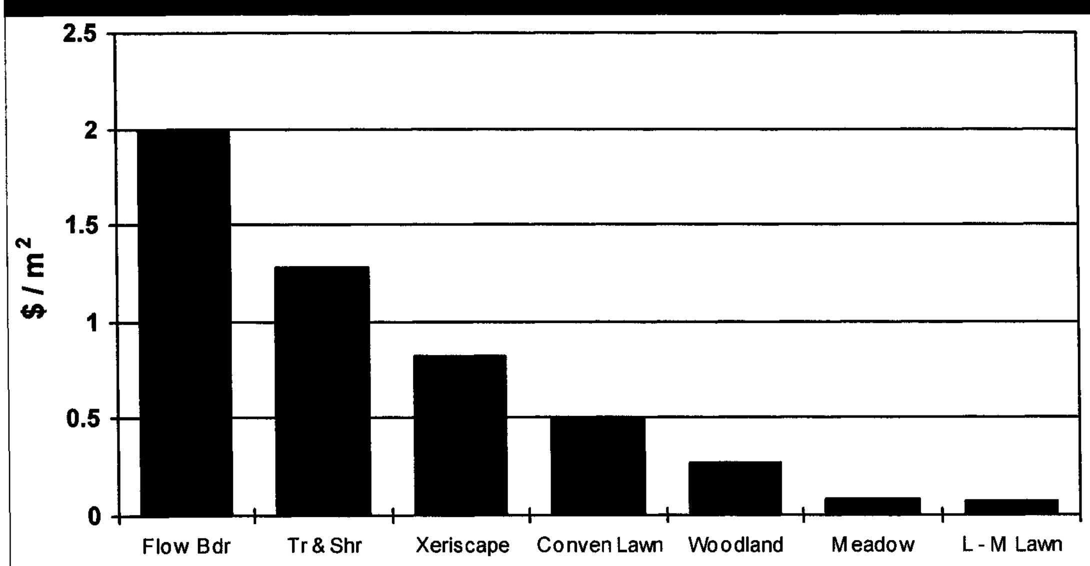


In terms of time inputs (see Figure 19), **ornamental flowerbeds were the most time-consuming, at 29.22 min./ m^2**, followed by ornamental trees and shrubs, at 20.60 min./m^2. Xeriscapes, considered by many as a resource-efficient alternative to conventional flowerbeds, indeed required considerably less time (18.47 min./m^2). **The least time consuming was low-maintenance lawn, at 2.1 min. / m^2**, or half the time needed to maintain conventional lawn.

Some readers may be surprised by the fact that slightly less maintenance time (4.24 min./m^2) was devoted to conventional lawn, at least in the context of this study, than either naturalized meadow (4.88 min./m^2) or naturalized woodland (5.53 min./m^2). On the face of it, this seems to contradict popular conceptions of lawn as a high maintenance option. The fact is that mowers, trimmers, fertilizer spreaders, sprinkler and irrigation systems, and other equipment make lawn maintenance a fast and efficient process. *However, whereas conventional lawns necessarily demand consistent, regularly scheduled maintenance, the maintenance requirements for the naturalized alternatives (and other non-turf landscape types) is ultimately up to the discretion of the individual gardener.* Thus, for instance, individual site records for the woodland gardens ranged from a high of 14 min./m^2, to a low of .16 min./m^2, while those for naturalized meadows ranged from over nine min./m^2, to 0 min./m^2 (i.e., no maintenance inputs). Conversely, the range was much narrower for lawns (from a low of 2.13 to a high of 6.65); obviously, none of the participants reported zero inputs. Another factor that likely played into these surprising results is that whereas most homeowners probably view lawn maintenance as a chore to be completed as expediently as possible, those who maintain a naturalized landscape (or ornamental garden) likely derive some pleasure and fulfillment from the activity and thus are not as time-conscious. Finally, new plantings and periodic garden modifications for the non-turf options, most notably the xeriscapes, resulted in significant time inputs.

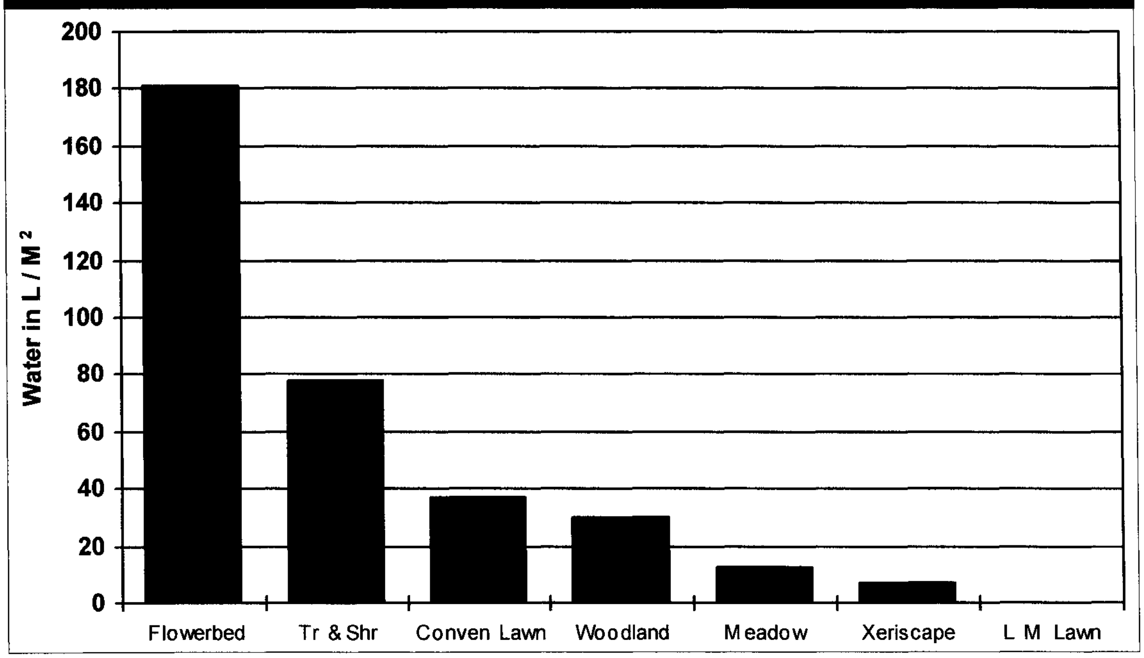
In terms of costs (see Figure 20), **ornamental flowerbeds were the most expensive to maintain, at \$1.99/m^2**, with \$1.64 of that amount devoted to seasonal plant purchases (including annuals). Ornamental trees and shrubs were the second most expensive, at \$1.28, with over 60% of that amount devoted to fertilizers and pesticides. Xeriscapes, at \$0.82, were next, with \$0.61 devoted to the purchase of plant material. Again, this value may be inordinately high due to the fact that two of the gardens underwent major modifications during the survey period (despite data adjustments). **Low-maintenance lawn was the least expensive at \$.07/m^2**, followed by naturalized meadow (\$.08) and naturalized woodland (\$.27).

Figure 19: Annual Maintenance Costs / m^2

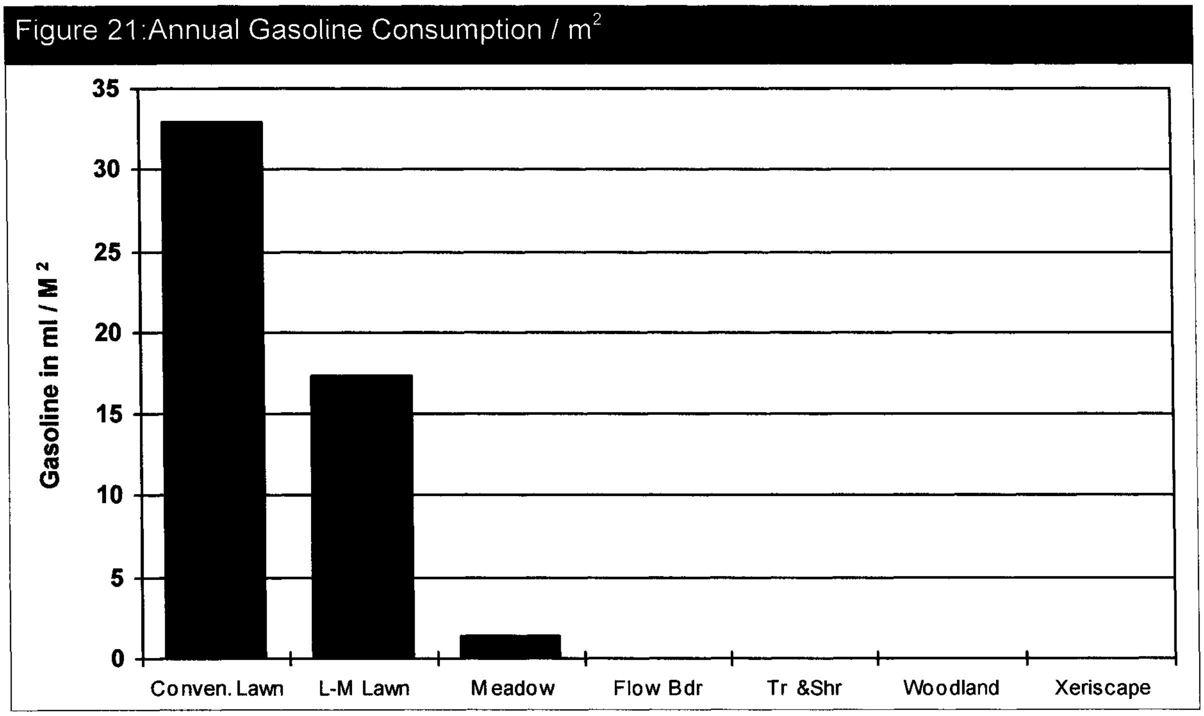


Low-maintenance lawn was the most water-efficient of the seven types, with no recorded water inputs over the duration of the survey (see Figure 21). By a wide margin, ornamental flowerbeds consumed the most water, at 180.9 L/m^2. Ornamental trees and shrubs received just under half that amount, at 77.98 L/m^2, while conventional lawns received 37.2 L/m^2. Surprisingly, woodland gardens required 30 L/m^2, an unexpectedly large amount considering that these are generally assumed to be water-efficient landscapes relative to lawn. The prevailing drought, as noted earlier, likely dictated these higher-than-expected inputs, of which approximately one third was devoted to new plantings stressed by the dry conditions. Meadows received 12.3 L, while xeriscapes consumed 7.29 L. It must be noted that all of the water used in the xeriscapes was directed to new plantings, which required supplemental water to become established amidst the drought conditions, and thus is an unusually high amount.

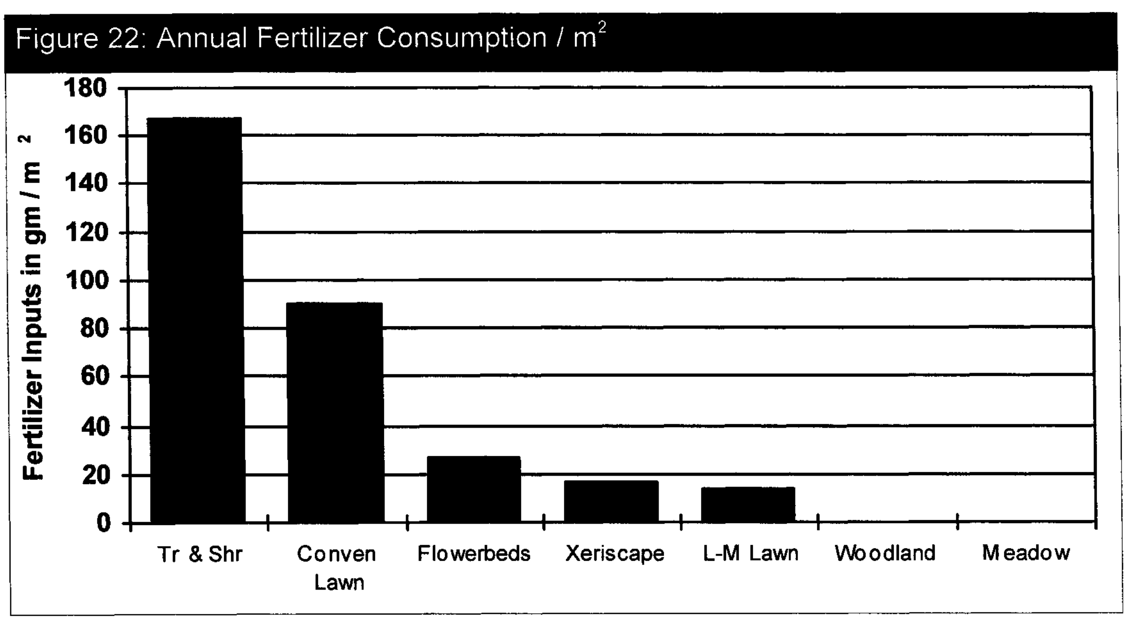
Figure 20: Annual Water Consumption / m^2



As expected, **the highest energy requirements, at 33 ml/m^2 of gasoline, were associated with conventional lawn** (see Figure 22). Half that amount -- 17.4 ml/m^2 – is needed for low-maintenance lawn, reflecting the reduced mowing requirements. Meadows required 1.41 ml/m^2 for a single annual mowing. Gasoline was not used in the maintenance of any of the other landscape types. The survey results indicate that electricity consumption was not an important factor in any of the landscape types.

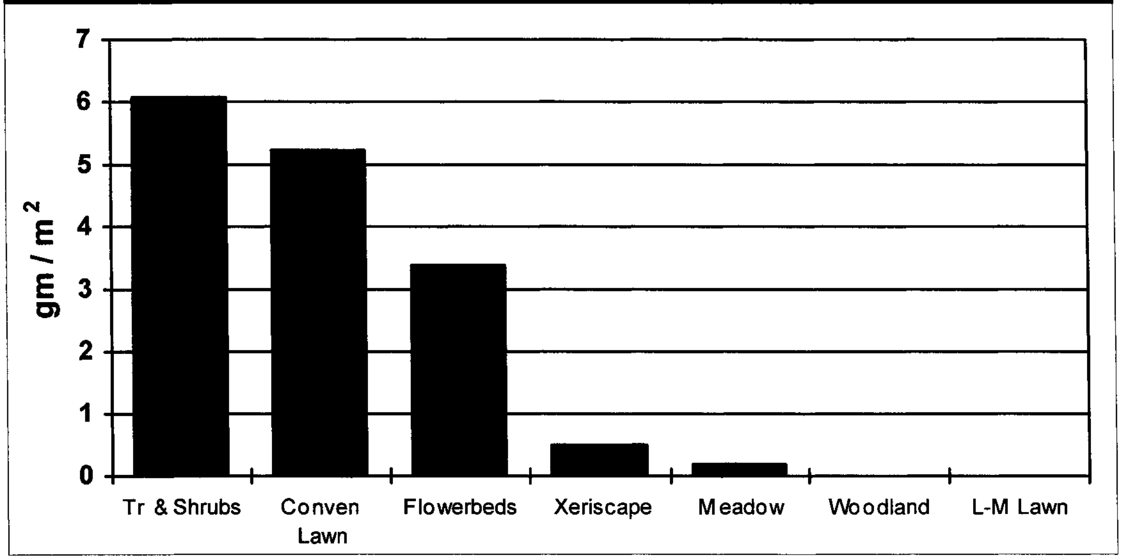


By a wide margin, **ornamental trees and shrubs received the highest fertilizer inputs, at 167.2 gm/m^2** (see Figure 23). Conventional lawns received slightly under half that amount, or 89.96 gm/m^2, followed by 26.9 gm/m^2 for ornamental flowerbeds. A total of 17 gm/m^2 was applied to xeriscapes, while 13.8 gm/m^2 was applied to low-maintenance lawn. No fertilizer inputs were recorded for either naturalized woodland or meadow.



Finally, in terms of pesticides (herbicides and insecticides, organic and chemical combined), **ornamental trees and shrubs received the greatest amounts, at 6.09 gm/m^2**, followed closely conventional lawn at 5.24 gm/m^2 (see Figure 24). Ornamental flowerbeds were treated with 3.4 gm/m^2. Beyond these three landscape types, pesticide use drops significantly to 0.75 gm/m^2 for xeriscapes and 0.21 gm/m^2 for meadows. Trace amounts were applied to woodlands (0.01 gm/m^2), the latter being the result of a single chemical pesticide application over the two-year survey period. **No pesticide inputs were recorded for low-maintenance lawn.**

Figure 23: Annual Pesticide Consumption / m^2



The time, cost, and material inputs depicted in this chapter represent only one dimension in the analysis of the seven landscape types discussed in this report. To many homeowners, environmental considerations are equally – and for some, even more – important. The next chapter examines the various environmental costs and benefits associated with the seven types.

Endnotes

[1] At the time of publication, an extensive literature and Internet search had failed to turn up any reports quantifying and comparing maintenance requirements specifically for Canadian residential landscapes. Fisher (1994) generated some mean annual values for residential landscapes, as interpolated from the National Capital Commission park and greenspace management database. Nelson (1987), McPherson et al. (1989), McPherson (1990), Diekelmann and Bruner (1988) provide some comparative values for alternative landscapes in the U.S.

[2] While each of the monitoring sites encompassed a number of landscape types, only maintenance data for the specific landscape option of interest was collected.

[3] In Canada, life zones are often alternately referred to as forest regions or biomes.

[4] All participants were paid a modest honorarium for their involvement in the survey.

[5] All participants were requested to estimate material, energy, time, and cost inputs that had taken place earlier in the season, prior to the commencement of the monitoring survey, as well as any additional inputs expected prior to the onset of winters.

[6] Rate MAV's are in grams; quantities reported by volume were roughly converted to an equivalent weight, using the weight volume equivalents for water (1ml = 1gm). No attempt was made to adjust weight figures to account for the fact that different pesticides come in different concentrations, resulting in sometimes highly variable application rates.

[7] Based on average fuel consumption rates reported by survey participants

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8 Figure derived from 1996 Municipal Water Use Database (MUD), via a personal communication with Dave Lacelle of the Environmental Economics Branch, Economic and Regulatory Affairs Directorate, Environment Canada

9 Derived from a national survey of residential electrical rates conducted by Manitoba Hydro, based on consumption of 375 kwh/month (for more info, refer to website address http //www hydro.mb ca/dollars_cents/utility_rate_comparisons html

10 In calculating the MAVs, two variables were considered, resulting in several minor data adjustments. **1) Maintenance by contractors vs. homeowners**: Two participants employed the services of a lawn maintenance contractor to apply fertilizers and pesticides. Since the participants themselves did not do the work, no time data was recorded. Quantities of fertilizers and pesticides used are rough approximations based on sparse information supplied by contractors Costs of pesticides and fertilizers reported in the data tables reflect the total amount paid by the homeowner, including labour costs. The values thus represent the average cost of these materials based on the assumption that 2 out of 5 homeowners use lawn care companies to apply pesticides and fertilizers **2) Pesticides**: Participants reported using a number of different pesticides on their lawns. As with chemical fertilizers, no attempt has been made to differentiate between the various types of pesticides used, though they were categorized as either herbicides or insecticides (no fungicides reported). Pesticide quantity MAVs based on the total weight of all herbicides or insecticides used The weight of herbicides in "weed and feed" fertilizers were based on their concentrations as noted on product packages.

11 A lawn care pamphlet produced by White Rose Nursery, for instance, recommends four applications per year for a total of 160 gm/m^2.

12 This value is substantially higher than reported in Struger et al. (1994), which found that a total of 198 gm/ha (198 gm/m^2) of lawn herbicides are annually applied on properties within the study area (several subdivisions in the City of Guelph, Ontario) The discrepancy may be due to the fact that the Struger findings are based on a survey of lawn maintenance contractors, who may use herbicides in more highly concentrated commercial formulations than the domestic equivalents available to homeowners

13 According the U.S. Environmental Protection Agency, as reported in Bormann et al. (1993), a typical maintenance regime for conventional lawn includes four or more applications of a high nitrogen fertilizer, along with up to *ten or more* pesticide treatments.

14 A number of survey participants indicated that they considered themselves hobby gardeners, but also preferred a more relaxed maintenance approach and preferred to minimize their maintenance time. In other words, they enjoy maintaining the garden, but for whatever reason, prefer to limit the actual amount of time devoted to yard work.

15 In calculating the MAVs, three variables were considered. **1) Flowerbed expansion:** The manse flowerbeds were expanded in 1998 from 38 to 103 m2. The maintenance data supplied in 1998 included time inputs required to enlarge the garden. This time was deleted from the data records, since it did not pertain to the maintenance of an established flowerbed However, for the 1999 portion of the survey, the size of the monitoring site was increased from 38 to 103 m2, with 1999 MAV calculations factored accordingly. **2) Volunteer Maintenance**: Volunteers working in pairs or larger groups maintained the manse flowerbeds Time data records thus reflect total person hours, and may have slightly inflated time MAVs relative to data submitted by other participants, due to factors such as socializing. However, most data records were tabulated as recorded, except for one. A total of 12 hours was reported to plant four flats of annuals and 21 perennials. This is an inordinately long time for such a small number of plants, and upon consultation with the participant, was reduced by half to six hours. **3) Leaf Mulch:** Two of the participants reported applying leaf mulches to their flowerbeds. However, since the leaves were simply collected off the lawn and street, no quantity estimates were provided. Thus, while mulching is included in the time reports, quantities have not been noted in the material input charts.

16 In calculating the MAVs, the following variable was considered. **Weeding**: Town of Caledon staff recorded 93 hours for weeding. Upon further discussion, it was determined that the intensive weeding requirements were in part due to the fact that the shrub plantings, as two year plantings, were only marginally established and had not yet formed a solid canopy (shade would reduce weed growth). In future years, the staff estimates that weeding requirements will consequently be reduced by at least 50%. For this reason, the weeding time has been reduced by half to more accurately reflect actual weeding requirements.

17 The Institute for Maintenance Research (1983) estimates that 34.6 ml of pesticides (converts to 34.6 gm using the 1:1 weight to volume equivalents for water) and 4.9 g of fertilizer are applied annually per m^2 of shrub bed area.

18 In calculating the MAVs, the following adjustment was carried out. **Fertilizer**: Two participants reported using fertilizers In both cases, organic rather than synthetic fertilizers were used One of these respondents indicated that a specially-formulated urea-based fertilizer had actually been applied in November of 1998. Since it appears that some low-maintenance lawn owners do occasionally fertilize their lawns, this data was included in the 1999 survey. Since the participant was unable to provide an estimate

of the fertilizer quantity and cost, an estimate was generated by using the MAVs for conventional lawn, divided by three to reflect a single application (conventional lawn MAVs based on 3-4 applications per year).

19 In calculating the MAVs, one variable was considered, with no adjustments. **Leaf Mulches**: Two participants recorded leaf mulch applications. Since the leaves were collected from the yard and street, no dollar value or quantities were provided. Thus, time inputs have been recorded, but not material inputs.

20 Unlike turfgrass, trees do not go dormant under drought conditions, and can consequently sustain stress injury and possibly permanent damage. Participants were obviously aware of this fact and thus chose to water their woodland gardens.

21 In calculating the MAVs, several variables were considered. **Meadow Burns and Annual Mowing**: Although periodic every two or three years) burns are considered an integral aspect of maintaining and rejuvenating a prairie or meadow, a single annual mowing is generally considered a viable alternative. Burns generally are not feasible for most urban and suburban dwellers, due to local by-laws and the potential risks involved (but may be more feasible for rural meadow owners). Only the Arboretum reported conducting a spring burn (involving 6 people over a 2 hour period, for a total of 12 person hours), while two participants reported an annual mowing. The burn and mowing data has been grouped together as a single input. **Zero Maintenance**: One of the 1999 survey participants reported no maintenance activities whatsoever. These results have been factored into the mean values without adjustment. Interestingly, the participant acknowledges that, in the absence of on-going maintenance, the meadow's plant diversity and aesthetic quality had diminished somewhat, and she was considering the possibility of undertaking a major restoration planting and weeding in 2000. However, no attempt was made to factor in the time and costs of such an endeavour over a three or four-year period, since no baseline data is available to determine the actual costs, time requirements, and material inputs that would be required.

22 As discussed in Chapter 2, a scree garden is a highly drought tolerant form of xeriscape wherein perennials are planted in a bed of rapidly drained gravel or limestone screenings.

Chapter 4. Environmental Impacts and Benefits

The most pressing environmental problems of our times - air, soil and water pollution, ozone depletion, global warming, and the loss of biodiversity - are attributed to prominent and obvious sources, such as industrial production, the automobile, rampant urban and suburban growth, clear-cut logging and industrial agriculture. Although by comparison, home landscaping may seem relatively benign, certain landscape maintenance practices can impact directly, indirectly and cumulatively on human and ecosystem health.

The purpose of this chapter is to draw attention to some of the potential environmental impacts associated with five common landscaping practices:

- the use of chemical pesticides;
- the use of synthetic fertilizers;
- unnecessary watering;
- the operation of gas-powered equipment;
- and, the use of invasive exotic species in conventional ornamental landscapes.

Several secondary impacts are also reviewed, as are some of the environmental benefits associated with the various landscape types. The intention of this chapter is to provide information so that homeowners can make informed landscape management decisions. Ultimately, individual homeowners must ascertain for themselves whether the use, for cosmetic reasons, of pesticides, fertilizers, fossil fuels, water and known invasive species warrants the potential impacts. The landscape industry in recent years has acknowledged these concerns and is actively engaged in the research and development of environmentally friendly products and practices.

No attempt has been made to quantify the environmental impacts or benefits as direct, measurable outcomes of residential lawn and garden maintenance inputs. The maintenance survey discussed in Chapter 3 generated useful data on the quantities of pesticides, fertilizers, water and fuel used. However, the figures reveal little about resulting impacts, since input quantities are but one of many variables to consider. For instance, while survey participants on average annually applied 13.8 grams of pesticide per m^2 on their lawns, the resulting impacts, if any, will depend on factors such as:

- the specific type of product used and its concentration;
- the extent to which it was applied in accordance with label instructions;
- the type of protective clothing worn;
- climatic conditions;
- the site's proximity to water;
- natural areas and vulnerable habitats;
- soil types;
- and, duration of exposure.

A meaningful quantification of potential impacts would require an intensive site-specific analysis that considered these variables, and which could project, for example, the potential number of vulnerable species that might be harmed by a given pesticide application or the degree to which it may compromise a homeowner's health. This was beyond the scope of the study.

The Residential Yard as an Ecosystem

Picture the individual residential yard as an ecosystem. The yard, in turn, is nested within increasingly larger ecosystems - a local sub-watershed, a regional watershed, a bioregion, a life zone, and ultimately, the biosphere. When conceived this way, it becomes possible to see and appreciate the myriad connections that link the residential yard, and our actions within it, to the surrounding landscape. Rain that falls in the yard is typically conveyed off-site, via overland or sub-surface stormwater drainage systems, to low-lying areas nearby, while small amounts may filter through the soil to replenish groundwater. Similarly, the air we breath moves with the wind and thus transcends artificial boundaries, as do songbirds, butterflies, and bees darting from one garden to the next to nearby natural areas in search of food and shelter. These and a multitude of other ecological relationships are powerful reminders of the interconnectedness of all things and of the need to be responsible stewards in our interactions with the land.

4.1 Primary Potential Impacts

4.1.1 Chemical Pesticides[1]

Since the onset of the environmental movement in the 1960's, the potential environmental impacts of pesticides in general have been a contentious and hotly debated subject. Consequently, there still remains a significant lack of consensus on the human and ecosystem health risks associated with the use of pesticides. The following discussion aims to shed some light on the key concerns that have been raised relative to the domestic use of horticultural pesticides. Table 9 provides a brief overview of some of the potential impacts related specifically to 10 common domestic horticultural pesticides[2].

In Canada (and elsewhere around the world), the heaviest pesticide use occurs in the agricultural sector. However, pesticide loading from lawns and gardens in urban areas can be substantial. A recent Environment Canada survey found that 66% of homeowners in two Guelph (Ontario) subdivisions used lawn and garden pesticides, and that residential lawn pesticide use in urban areas in the Canadian portion of the Lake Ontario watershed, estimated at approximately 290,000 kg, may be as high as 25% of the agricultural total (Struger et al. 1994). It is also notable that application rates for some phenoxy herbicides such as 2, 4D and mecoprop can be up to 5 times higher on lawns than for agricultural uses (Short et al., 1999).

Fortunately, the landscape industry has in recent years begun addressing these concerns through the development of low-toxicity chemical pesticides, non-toxic organic pesticides, disease and pest resistant plant stock, user education, and the introduction of practices such as integrated pest management, which aims to reduce reliance on chemical pesticides. However, some concerns remain.

One concern is that some pesticides currently registered for use in Canada may not necessarily meet new safety standards. In order for a new pesticide product to be registered, pesticide manufacturers must undertake a battery of human and environmental toxicological tests for assessment by the Pest Management Regulatory Agency (PMRA)[3]. However, some pesticides currently in use were registered prior to the enactment of recent laws mandating more stringent testing. A number of these pesticides, including all 27 organophosphate pesticides[4] currently registered in Canada, are slated for re-evaluation by the year 2006 (PMRA, 1999); in the interim, their use continues.

Another key concern surrounding the domestic use of horticultural pesticides is that some homeowners may not always follow necessary precautions when applying them. It is estimated that 50% of homeowners do not read warnings on the container labels (Bormann et al., 1993). Further, according to Templeton et al (1998), a "significant minority" of homeowners does not follow label directions and recommended precautions, and apply more than the recommended dosages; a majority does not wear protective clothing.

An environmental concern surrounding the widespread use of pesticides is the fact that they can and do escape into the environment. According to Short (1998), pesticides are regularly detected at continuous low-level concentrations in both the atmosphere and much of the surface water, groundwater, and treated drinking water throughout the U.S. According to U.S. Geological Survey studies conducted between 1987 and 1995 in King County, Washington, a total of 23 pesticides, many of which are commonly used in both agriculture and residential lawns and gardens, were detected in water from urban streams during rainstorms; concentrations of 5 of these pesticides, including diazinon, carbaryl, malathion, and chlorpyrifos, exceeded U.S. and Canadian water quality guidelines (WQG) for the Protection of Aquatic Life (USGS, 1999). Likewise, a 1998 Environment Canada study involving surface water sampling from a number of creeks and ponds in Toronto, Hamilton, and Guelph repeatedly detected nine common lawn and garden pesticides, among other pollutants, following rainfall events. Furthermore, levels of diazinon and chlorpyrifos detected in water samples exceeded Canadian and/or Ontario WQGs for the Protection of Aquatic Life, though they did not exceed those for Drinking Water (Struger et al., 1998). Clearly, these and other studies demonstrate that some pesticides used on lawns and gardens (as well as on farms) can and do migrate into the environment. The effect of chronic long term, low-level exposure to these and other water- and air-borne pesticides on long-term human, wildlife, and aquatic health is generally not known (Short, 1999).

Spillage may be the most common means by which pesticides find their way into water supplies. In this respect, it is estimated that one gram of diazinon spilled and carried into a suburban storm water catchment pond by a 12.5 mm (1/2 inch) rainfall would result in surface water concentrations 19 times higher than the Ontario WQG for the Protection of Aquatic Life (Struger, no date). Considering the proximity of most residential homes to storm sewer systems and roadside catch basins, factors such as spillage can be of serious concern. Other factors that may contribute to the presence of domestic pesticides in urban waters may include higher than recommended application rates and improper disposal of unused products and their containers (Short, 1999).

Human health concerns

A great deal of debate and controversy surrounds the issue of human health impacts. However, even the PMRA acknowledges that "pesticides may pose a hazard to human health" (PMRA, no date).

It is impossible in a study of limited scope such as this to prepare a comprehensive analysis of all the research conducted on both sides of the debate for horticultural pesticides. Ultimately, individual homeowners must draw their own conclusions as to the safety of pesticides, and should always exercise great care if and when they choose to use them.

Aside from residues on food, unintended human exposure to pesticides in residential areas can result from swallowing, breathing, or direct skin contact with, wind drift spray or recently treated lawns or gardens. As discussed earlier, it may also result from long-term low-level exposure to pesticides in surface and drinking waters, as well as atmospheric residues contained in rain, fog, and snow (Short, 1999). Potential human health impacts resulting from undue exposure to ten common horticultural pesticides are outlined in Table 9 below.

Some studies indicate that children may be particularly vulnerable to the adverse health effects of pesticides (Zahm et al., 1998)[5]. Prior to the passing of the US Food Quality Protection Act (FQPA) [6] in 1996, all toxicological data submitted to the EPA by pesticide manufacturers were based on adults, "who respond to chemicals very differently from the unborn, infants, and children whose tissues are still developing" (Short, 1999). While pesticide manufacturers must now test specifically for health effects on children and fetuses, some pesticides currently in use were not subjected to those tests.

Ecosystem health concerns

Although human health concerns are usually at the fore in the pesticide debate, some studies also link their use to a wide variety of potential ecosystem impacts. Due to growing public concerns about the environmental impacts of persistent pesticides[7], most pesticides now in use are non-persistent and do not bioaccumulate, but may still be toxic when they come in immediate contact with non-target terrestrial or aquatic organisms (Struger et al., 1994).

Most chemical pesticides are non-specific and can thus harm both the intended target species, as well as harmless or beneficial organisms. For instance, diazinon and carbaryl are two insecticides toxic to non-target butterflies and bees (see Table 9), the latter being an important pollinator of many agricultural, ornamental, and wild plants. For this reason, the Ontario Bees Act makes it an offence to spray insecticides on fruits, vegetables, and ornamentals while in bloom.

By extension, birds are also known to be at a particularly high risk from pesticide poisoning due to their environmental behavior. They may eat contaminated insects, seed and/or fruit, and may even eat pesticide granules as dietary grit; during their frequent preening, they may ingest pesticides deposited on their feathers; their nests - and eggs or nestlings - may be inadvertently sprayed with insecticides (Hammond, 1995). Diazinon, in particular, is known to be especially harmful to waterfowl and other insect-eating songbird species (Extension Toxicology Network, 1996).

Since insecticides are indiscriminate, they can, in addition to killing off undesirable pest species, also destroy other beneficial insect and arthropod populations. They can also impact on important and essential soil decomposers such as earthworms, fly maggots, bacteria, and symbiotic fungi Hammond (1995). In turn, small mammals such as moles and shrews can be killed or injured via secondary poisoning when they eat contaminated earthworms and insects (Mineau, 1993). Even domestic pets can be affected by pesticides, as noted in a 1991 study, which found a link between the use of 2,4-D and canine malignant lymphoma (Hayes, 1991). Many pesticides that migrate to open waters are known to be harmful to fish and aquatic invertebrates (see Table 9); as well, there is growing concern that some pesticides may be harmful to frogs (Short, 1999).

Pesticide resistance is an additional concern. Pests that are repeatedly exposed to a particular pesticide often tend to become resistant. It is estimated that since the 1950's, when pesticides were first widely adopted throughout North America, the number of pesticide resistant insect species has grown from 10 to over 450(Environment Canada, no date); likewise, the number of herbicide resistant weeds has grown to over 140 (Short, 1999). This sets up an unfortunate pesticide "treadmill", wherein heavier application rates are required to overcome the resistance, or, alternatively, new pesticides have to be designed to replace the ineffective ones. Either way, our society's reliance on pesticides grows proportionately to the pests' ability to resist them.

Table 9: Potential Impacts Associated with Exposure to Common Lawn and Garden Pesticides

	Pesticide (uses)	Human Health: Acute Toxicity	Human Health: Chronic Toxicity	Human Health: Other Health Effects	Environment: Toxicity to Birds	Environment: Toxicity to Aquatic Life	Environment: Toxicity to Insects/ Mammals	Environment: Persistence (half-life)	Environment: Comments
erbicides	**Dicamba** (lawns)	**dermal**: medium **eyes**: high **inhalation**: low **oral**: low	low	highly corrosive to eyes; may burn skin	low	low	non-toxic to bees	**soil**: 1 - 4 weeks highly soluble in water	
	MCPA (lawns)	**dermal**: low **eyes**: med - high **inhalation**: **oral**: low	medium	can cause severe eye irritation	medium	low	non-toxic to bees	**soil**: 14 days - 1 month **water**: 2-5 weeks	
	Mecoprop (lawns)	**dermal**: low **eyes**: low **inhalation**: low **oral**: low	n/a	may be mutagenic in high doses; may be carcinogenic	low	low	non-toxic to bees	**soil and groundwater**: 2 months	may leach into groundwater
	2,4-D (lawns)	**dermal**: low **eyes**: high **inhalation**: med **oral**: low	low	can cause severe eye irritation; may cause adverse reproductive effects and birth defects in high doses; carcinogenic status unclear	low to medium	**fish**: low to high, depending on formulation. **invertebr.**: n/a	toxic to bees	**soil**: 7 days **water**: several weeks	low concentrations have been detected in surface waters throughout the U.S., also found in groundwater
Insecticides	**Bacillus thuringiensis** (ornam./ lawns)	**dermal**: low **eyes**: low - med **inhal.**: low **oral**: low	non-toxic		non-toxic	**fish**: very low **invertebr.**: may affect shrimp and mussels	may affect some non-target insects, including some butterflies	**soil**: approx. 4 months **water**: 48 hours	
	Carbaryl (ornamentals/ lawns)	**derm.**: med-high **eyes**: med - high **inhal.**: med-high **oral**: med - high	n/a	may pose a slight mutagenic risk over prolonged exposure; possible adverse endocrine and nerve effects	low	**fish**: med **invertebr**: n/a	lethal to many non-target species, including bees and beneficial insects	**soil**: 7 - 28 days, depending on soil type **water**: 10 days (varies with pH)	may bioaccumulate in fish in acidic aquatic environments
	Chlorpyrifos (ornam./ lawns)	**dermal**: medium **eyes**: medium **inhal.**: very low **oral**: very low	n/a	over-exposure can result in cholinesterase inhibition (disruption of central nervous system functions)	medium	high	serious hazard to many faunal species and bees	**soil**: variable (45 hrs - over 1 year) **water**: 35 – 78 days	
	Diazinon (ornamentals/ lawns)	**dermal**: medium **eyes**: medium **inhal.**: medium **oral**: medium	medium	over-exposure can result in cholinesterase inhibition; inconclusive evidence of birth defects and mutations	high	**fish**: high **invertebr.**: n/a	highly toxic to bees	**soil**: 2 - 4 weeks **water**: variable (12 hrs. - 6 months)	may contaminate groundwater; has been found in tap water
	Malathion (ornamentals)	**dermal**: low **eyes**: medium **inhal.**: medium **oral**: low	non-toxic	may affect immune system response; over-exposure can result in cholinesterase inhibition; may be mutagenic; carcinogenic status unclear	medium	**fish**: low to very high, depending on species **invertebr.**: high	highly toxic to bees	**soil**: 1 - 29 days **water**: 1 week or less	may pose a risk to ground or surface waters
Fungic.	**Benomyl** (ornamentals/ lawns)	**dermal**: medium **eyes**: n/a **inhal.**: low **oral**: low	low	mutagenic and carcinogenic effects inconclusive	medium (redwing blackbirds)	**fish**: very high **invertebr.**: n/a	single lawn application can substantially reduce soil-dwelling species; lethal to earthworms	**soil**: 3 - 12 months **water**: 2 months	
	Captan (ornamentals)	**dermal**: low **eyes**: medium **inhal.**: n/a **oral**: low	low to medium	may be carcinogenic	low	**fish**: very high **invertebr.**: med		**soil**: 1 - 10 days **water**: variable 1 - 54 hours	
	Chlorothalonil (lawns)	**dermal**: high **eyes**: high **inhal.**: n/a **oral**: medium	low to medium	may cause severe eye and skin irritation; may be carcinogenic	low	**fish**: very high **invertebr.**: n/a		**soil**: 1 - 3 months **water**: 10 weeks	

The data was derived entirely from Pesticide Information Profiles (PIP) prepared by the Extension Toxicology Network (EXTOXNET)[8] and does not represent a comprehensive overview of the literature on the subject. It does not examine the toxicity of pesticide "cocktails" (pesticide mixtures), or that of inert carrier substances. Note: n/a = data not available.

4.1.2Chemical Fertilizers

Natural plant communities do not require artificial nutrient inputs, for two reasons. First of all, they consist of plant species ideally adapted to the site's biophysical and chemical properties, including natural soil fertility levels. Secondly, they are highly effective at recycling essential nutrients such as nitrogen through the accumulation and decomposition of organic matter. In contrast, plant species used in conventional lawn and ornamental gardens are often ill adapted to existing soils and other site conditions. As well, for cosmetic reasons, organic matter such as fallen leaves, twigs and other debris is often removed from lawns and planting beds, resulting in a net annual nutrient loss (though in recent years, most homeowners have recognized the importance of leaving lawn clippings on the ground as a way to recycle plant nutrients, as well as to reduce the stream of compostable garden waste into landfills). Consequently, conventional lawns and ornamental gardens require periodic fertilizer inputs to replenish three essential nutrients: nitrogen, phosphorous, and potassium.

Although fertilizers are generally non-toxic, their extensive use in both horticulture and agriculture has been linked to several potential environmental impacts, primarily with respect to water quality and nutrient loading in aquatic ecosystems.

The concerns centre on the possibility that the nutrients – most notably nitrogen – may migrate from the application site to groundwater and surface water supplies. This is particularly true of "fast-release", water soluble fertilizers; for this reason, homeowners are encouraged to use "slow-release", water insoluble fertilizers on their lawns as a means to reduce the possibility of nutrients migrating off the site.

Organic and Inorganic Fertilizers

Nitrogen is the principal component of most lawn and garden fertilizers. It is widely used to promote the vigorous growth and bright green colour desired in conventional turfgrass. Nitrogen may be derived from a number of different sources, including both organic and inorganic fertilizers.

Organic fertilizers contain carbon in chemical structure, and may be derived from either natural or synthetic sources. Natural organic sources include materials such as compost, manure, processed sewage sludge, seaweed extracts and other natural products. These are all considered slow release fertilizers, in that the nitrogen is gradually made available to the plants over time as the fertilizer decomposes through microbial and chemical action. Temperature, moisture and soil ph are therefore key factors regulating the release rate. Climatic conditions that are too hot, cold, dry or wet can hamper decomposition, as can acidic soils.

Synthetic organic fertilizers typically consist of urea, and may be purchased in either granular or liquid form. Although urea is water-soluble and is thus considered a fast-release nitrogen source, it also has a very high leaf burn potential and is very volatile (i.e., nitrogen escapes into the atmosphere). Consequently, it is usually combined with other materials such as a sulfur to slow the nitrogen release. As such, urea-based fertilizers typically behave like a natural organic fertilizer in that microbial action is required to decompose the fertilizer and make the nitrogen available to plants.

Inorganic nitrogen fertilizers include synthetic chemical compounds such as ammonium nitrate, calcium nitrate and potassium nitrate, which may be purchased in either granular or liquid form. For most homeowners, these are the fertilizer of choice because they are cheap, easy to apply, and produce immediate results. Being water soluble, fast-release fertilizers, the nitrogen becomes available as soon as turf or plants are watered. The results are immediate but short-lived. The lawn responds with an immediate green-up that quickly fades as the nitrogen is used up by plants or escapes the site.

Most of the environmental problems associated with fertilizers arise from the use of fast-release, ammonia- or nitrate-based formulations, which are the most common among homeowners. When applied to a lawn or garden, only a portion of the nitrogen contained in these fertilizers may actually be taken up by the plant or tied up in the soil for later consumption by plants. Factors such as temperature, moisture, soil pH, soil texture, topography, application rates and watering practices generally dictate the amount of nitrogen that may leave the site before being absorbed by the plants.

It has been estimated that as much as 36 to 45% of the nitrogen in nitrogen based fertilizers may be volatized and released to the atmosphere in the form of nitrous oxide (Gallant, 1999). Nitrous oxide is a component of urban smog (OMEE, 1996), as well as a serious "greenhouse" gas linked to global warming (Bormann et al., 1993). Although nitrous oxide occurs naturally in the atmosphere through the process of de-nitrification[9], a dramatic increase in the amount of nitrous oxide in the atmosphere has been observed in recent decades. While it was long believed that combustion of fossil fuels, wood, and other biomass was a primary source, many scientists now believe that fertilizers – both agricultural and horticultural - may actually be a more critical source of nitrous oxide (National Safety Council, 1995).

Leaching is a second environmental concern. Agricultural fertilizers are generally considered the primary source of groundwater contamination. Other primary sources include septic systems and atmospheric deposition. However, according to Gold et al. (1990), lawn and garden fertilizers can in some circumstances exacerbate the problem. Leaching is more likely to occur when fast-release fertilizers are applied on sandy soils followed by heavy irrigation or rainfall, or when the fertilizer is applied at a time when turf is not actively growing. To this effect, a 1984 study conducted in Long Island found that up to 60% of nitrogen applied on permeable sandy soils over shallow aquifers ended up in local groundwater supplies (Flipse et al., 1984). When dissolved in water, nitrogen is not bound to soil particles and can thus move freely through the soil. Under these conditions, the nitrogen in water may be transported past rootzone to groundwater, potentially contaminating groundwater drinking water supplies with nitrates. Exposure to high concentrations of this common well contaminant has been linked to the "blue-baby" syndrome, as well as to birth defects, cancer, nervous system impairments, and other health problems (Bormann, 1993).

The third environmental concern pertaining to the use of chemical fertilizers is the possibility that the dissolved nitrogen (as well as phosphorous) may be carried by both surface runoff and groundwater into lakes, streams and coastal waters. Current research indicates that surface run-off from residential lawns and gardens is relatively minor, at least in terms of its contribution to nitrate contamination of drinking water supplies (Mugaas et al., 1997). However, in coastal or near-water areas, surface run-off from fertilized lawns and gardens may contribute to the deterioration of aquatic habitats (Morton et al., 1988; USGS, 1997). Nitrogen and phosphorous are essential to aquatic plants and animals. However, an overabundance of nutrients can have a detrimental effect on aquatic ecosystems[10].

As with leaching, site conditions are a key factor in determining whether surface run-off is likely to be a problem. Sites that are steeply sloped, or that consist of heavy clays and/or compacted soil are more likely to promote runoff than flat sites on absorbent, well-drained soils. The problem may be exacerbated if the site is located near vulnerable open waters, or adjacent to catch basins that drain directly into local creeks or lakes. Turf density is also a factor: dense, healthy swaths of turfgrass are less significantly prone to runoff than sparse, patchy lawns.

Fertilizer mismanagement can also contribute to excessive nutrient losses via surface runoff. Fertilizers that are spilled or carelessly applied on hard surfaces such as walkways and paved areas can be quickly dissolved and washed away to open waters via storm sewers by rain or irrigation, as can fertilizer that is applied in grassed swales or ditches. Heavy rainfalls or excessive irrigation immediately following a fertilizer application can wash away significant amounts of nitrogen before plants can take it up. Finally, the presence of natural vegetation strips along the edges of open waters can mitigate the impacts of surface runoff from adjacent properties by taking up nutrients.

Through proper management, problems such as leaching and surface runoff can be significantly reduced or eliminated. However, some homeowners may not be aware of the potential impacts associated with fertilizers, and thus do not necessarily apply sufficient care when applying them.

4.1.3 Fossil Fuel Combustion

The use of gas-powered lawn mowers and other lawn and garden maintenance equipment can contribute to air quality and atmospheric problems that can impact on both human and ecosystem health[11]. The burning of fossil fuels is directly linked to the release of various pollutants that contribute to the formation of urban smog. Environment Canada estimates that thousands of Canadians suffer respiratory ailments or die prematurely each year from the effects of smog and air pollutants (Environment Canada, 1998b).

In addition to impacting on human health, by-products of fuel combustion, such as ground level ozone, can also have a direct impact on the health of many plant species and plant communities, particularly in urban or near-urban areas affected by smog (Hightshoe, 1988). Furthermore, many of these pollutants are also implicated in several broader, more far-reaching problems such as global warming, acid rain, and the depletion of the upper-atmospheric ozone layer.

With respect to landscape maintenance, the operation of gas-powered equipment is the most obvious and direct source of harmful atmospheric emissions[12]. Obviously, this is but one of many more significant sources of air pollution, which also includes industry, coal burning electrical plants, the automobile, and home furnaces, to name a few. However, the impact of lawn and garden maintenance equipment must not be underestimated. Small garden equipment, such as gas-powered leaf blowers, trimmers, and edgers, use lightweight 2 cycle engines, while lawn mowers are typically powered by 4 stroke engines. Unlike vehicles, neither of these types of engines is subject to emission controls. Consequently, it is estimated that 2 and 4 stroke engines respectively produce 11.5 and 35 times the emissions of a car (Honey et al., 1998; USEPA, 1998). Research by the Air Resources Board of California indicates that operating a typical lawn mower 4 stroke engine for one-hour results in pollution emissions equivalent to driving a car 350 miles (Bormann, 1993). For this reason, gas powered lawn and garden maintenance equipment are typically identified as a key contributor to urban smog; the City of Toronto recently adopted a policy restricting the use of lawn mowers and other parks maintenance equipment whenever smog alerts are issued (Honey et al., 1998). Harmful emissions are not just the result of burning fossil fuels. In the US, the EPA estimates that minor spillages while refueling lawn and garden equipment annually add up to over 17,000,000 gallons, which subsequently evaporates and pollutes the air in the form of VOC's (USEPA, 1998).

4.1.4 Water consumption

Over the years, surface and ground water pollution in and around communities has greatly reduced the available supply of potable, readily available water. Seventeen percent of all Canadian municipalities with water systems reported water availability problems in 1994 due to factors such as drought, insufficient storage capacity, pollution, and inadequate or aging distribution systems (Environment Canada, 1998c).

Excessive water consumption in the maintenance of residential lawns and gardens is problematic for both environmental and economic reasons, particularly when it is drawn from groundwater sources. From an ecological standpoint, it can lower water tables, which in turn can reduce stream flows. Consequently, downstream aquatic and wetland habitats are impacted as water levels drop. Terrestrial habitats such as forests are also vulnerable, particularly if they are adapted to shallow water tables that gradually drop below the rootzone.

From an economic standpoint, excessive water use can strain reservoirs and distribution systems, resulting in the need for system improvements or expansions, thereby increasing the economic costs of supplying water. To deal with the growing demand for water, massive public works projects are required to tap into more remote, less accessible supplies, at a great cost to the taxpayer. Although many communities have access to an ample water supply, they may not have the financial resources required to maintain and upgrade the infrastructure needed to meet growing demand, and to replace aging systems. Furthermore, the more water is used, the more energy (and money) is required to pump potable water and wastewater (and the greater the volume of waste water that has to be treated).

Recognizing the economic impacts of escalating infrastructure development costs and the need for new water supplies, a concerted effort has been undertaken by government and conservation organizations to reduce Canadians' excessive thirst. The residential sector has been a major focus of these efforts. Of all the surface and groundwater withdrawn in Canada, 11% is for municipal use[13]; of that amount, 49% of the demand comes from the residential sector (Environment Canada, 1992). Many Canadian municipalities have initiated ambitious water conservation campaigns. Homeowners are being actively encouraged to reconsider how they use water. To this end, a growing number of municipalities have switched from flat to metered water rates, meaning that many homeowners now pay more for the water they use. Many are now actively conducting public education campaigns geared towards the reduction in the amount of water used in the home, including residential landscape maintenance.

During the growing season, water use in the residential sector can jump by as much as 50%, primarily as a result of lawn and garden watering (Pleasance, 1999; Environment Canada, 1992). Many homeowners also choose to water their landscapes even during relatively moist periods, simply to heighten the productivity of turfgrass and ornamental plants. Either way, this represents an entirely cosmetic, non-essential use of water that is becoming increasingly difficult to justify in light of shrinking water supplies and escalating delivery costs. Due to improper watering practices, substantial portions of this water may be wasted due to over watering, which can result in excessive surface runoff. Carelessly placed sprinklers may divert water to driveways, sidewalks, and streets. Large amounts of water may be lost to evaporation before reaching plant roots, particularly if the watering is done during the midday heat, or if inefficient irrigation equipment is used; upwards of 50% of water dispersed by oscillating sprinklers can be lost to evaporation (Environment Canada, 1992). On average, a lawn needs no more than an inch of water per week to stay healthy and green, even during dry periods.

To counter the excessive water demand for landscape purposes, periodic watering bans and restrictions have become a fact of life in many Canadian municipalities, making it increasingly difficult for homeowners to sustain the manicured landscape aesthetic[14]. As part of their water conservation efforts, many of these municipalities are now promoting practices such as the use of rainbarrels as a natural source of water for outdoor use and the installation of more efficient irrigation systems. More importantly, they are also actively endorsing new approaches to residential landscaping as an alternative to the conventional lawn and ornamental garden. Homeowners are now being encouraged to adopt low-maintenance, water-efficient landscapes promoted in this report, including xeriscapes and naturalized meadows and woodlands.

4.1.5 Spread of invasive species

Although the spread of invasive plant species into natural ecosystems is not a direct consequence of maintenance practices per se, it is a significant ecological impact that has arisen in part from the use of horticultural ornamental plants. In Ontario alone, it is estimated that upwards of 700 species, representing 27% of the province's total flora, have escaped into the wild (White, et al., 1993). Of course, not all of these are garden escapees, nor are they all invasive. However, familiar, widely planted woody ornamentals, such as Norway maple, European birch, European highbush cranberry, common buckthorn, Russian olive, Japanese honeysuckle, and multiflora rose, are notorious for their ability to spread into natural areas from widely-dispersed seed originating in managed horticultural landscapes. Invasive ornamental perennials include periwinkle, lily-of-the-valley and purple loosestrife. Once established, these and other invasive plants can rapidly spread through the ecosystem. In the process, they can displace native plant species – and in severe cases, entire plant communities – often with dire consequences to wildlife habitat and biodiversity.

The use of potentially invasive horticultural species is most problematic when they are planted in the vicinity of a vulnerable natural area, such as a woodlot, vegetated streambank, or wetland. However, proximity is only one factor to consider, since some species can disperse their seed widely over long distances by wind (Norway maple), water (purple loosetrife) and birds (common buckthorn), among other means of transport.

4.2 Secondary / Indirect Impacts

In addition to the primary impacts described above, several other potential environmental impacts and side effects have been attributed either to maintenance practices, or to the landscape types themselves. These are briefly discussed below.

4.2.1 Yard Waste

Up until the early 1990's, most residential yard "waste" was collected as garbage and sent to local landfills. According to a U.S. Congress Report, it is estimated that in 1989, two-thirds of the waste stream entering American landfills consisted of yard wastes, 3/4 of which was lawn clippings (Bormann et al., 1993). Once in the landfills, the decomposition of organic matter contributes to the concentrated point-source production of methane, a major greenhouse gas. As well, pesticide and fertilizer residues in discarded containers and plant matter can become hazardous leachates contributing to groundwater contamination (Bormann et al., 1993).

In recent years, there has been a marked reduction in the volume of yard wastes sent to landfills. The search for new landfill sites has proven difficult due to the lack of suitable land and intense public opposition. Concurrently, homeowners have become increasingly conscious of the need to reuse, reduce, and recycle products that otherwise would have ended up in the waste stream. Many Canadian municipalities now operate municipal composting programs to divert grass clippings, leaves, and other organic matter from the waste stream. Some municipalities no longer even collect grass clippings and other yard wastes; homeowners are instead encouraged to do their own composting, or to leave clippings on the lawn, where they will decompose and act as a natural fertilizer. In naturalized landscapes such as woodland gardens, organic debris becomes an integral aesthetic and ecological component of the plant community.

4.2.2 Noise Pollution

Gas-powered landscape maintenance equipment such as lawnmowers and leaf blowers can be very loud. The sound of a typical older model lawnmower engine can, for instance, reach up to 70 or 80 or more decibels. From a human health standpoint, prolonged unprotected exposure to such loud noise can result in hearing loss, and is believed to contribute to a variety of other physiological and emotional problems, including sleep disturbances, cardiovascular disease, fetal health, and endocrine responses (Environmental Health Perspectives, 1998) From a purely subjective aesthetic standpoint, some people consider the sound of maintenance equipment as a form of noise pollution that disrupts natural or otherwise quiet soundscapes. Noise from residential lawn maintenance operations has in recent years become a growing source of community dissatisfaction, and in some communities (for instance, Westmount, P.Q), has resulted in the implementation of by-laws restricting or banning equipment such as leaf blowers. Fortunately, the landscape industry is responding to these concerns through a concerted effort to development of quieter equipment and to educate maintenance contractors on their proper use (Pereira-Bron, 1999).

4.2.3 Loss of habitat and natural biodiversity

The global biodiversity crisis is not confined to distant tropical rainforests; it is happening in Canada as well, in our communities and backyards. The construction of new residential (or other) developments often entails the fragmentation or wholesale destruction of forests, woodlots, oldfield meadows, prairies, wetlands or other natural areas. Biologically diverse, species-rich ecological communities are bulldozed to make way for roads, houses, commercial developments, and parks. Then, acres and acres of lawn are laid down, carpeting the landscape with simplified, biologically impoverished grass monocultures, accented with a scattering of ornamental, usually exotic trees, shrubs, and flowerbeds. The process can also happen on a much smaller scale, when a homeowner chooses to convert a natural shoreline thicket, meadow patch, or woodlot understory to conventional lawn. The end result in either case is a net loss of local or site-specific wildlife habitat and biodiversity, and a further deterioration of natural ecosystems. In choosing manicured, ornamental gardens and lawns over more naturally diverse and complex landscape alternatives, opportunities are lost to restore and protect at least a vestige of the original ecosystems that once occupied the small parcels of land we call home.

4.2.4 Wild-digging and seed collection

Perhaps somewhat ironically, the current trend towards the use of native plants in residential landscaping creates a risk that more people will collect plants and seed from local natural areas. None of the participants in the maintenance monitoring survey reported wild-digging plant material for their gardens; however, some gardeners and nurseries may on occasion seek out plants from the wild as an inexpensive way to diversify their plant selections. While some native plant species with large populations are fairly resilient to this type of impact, populations of rare species that are valued by collectors and native plant gardeners may be more susceptible to the effects of wild-digging. In addition to contributing to the loss of these species in the wild, wild-digging also damages the ecosystems from which they have been collected. Over-collecting seed may impede some species' ability to reproduce, and may deplete valuable wildlife food sources. Buying the plants from a nursery is no guarantee that they are not wild stock. To this end, the Canadian Wildflower Society, which actively discourages wild-digging amongst its members unless it is to rescue plants from sites awaiting development. The organization regularly publishes advisories against the purchase of certain rare or endangered species unless the nursery can verify that the plants were nursery propagated.

4.3 Environmental Benefits

The following are some of the key environmental benefits associated with some of the landscapes types (or their maintenance practices) considered in this study.

Improved hydrological cycles

Intricately structured natural plant communities such as forests are highly effective at capturing rainfall and slowing its movement across the land and through watersheds. In these environments, rainwater is absorbed, retained and gradually released to groundwater, wetlands, streams, and lakes. As forested land is paved with an array of impervious roads, pavements, and buildings, the natural water cycle of the complex, multi-layered forest community is disrupted. Rainwater that falls on urban areas instead rapidly drains across hard surfaces into storm sewer systems, and ultimately, open streams and drainage channels. In the process, only a fraction of the rainfall actually infiltrates the ground to replenish groundwater and aquifers. While any healthy vegetation, including turfgrass, helps to slow surface run-off and promote the soil infiltration of rainwater, some of the landscape types considered in this study are more effective than others. Generally, a landscape's effectiveness in improving hydrological cycles is directly proportional to the amount of leaf cover and plant biomass. Thus, the dense, vertically layered vegetation of naturalized woodland, for instance, is most effective at absorbing and dissipating rainfall energy, with understory vegetation and absorbent topsoils slowing the surface movement of water so that it can infiltrate the ground and replenish water tables. As a rule of thumb, complex, multi-layered landscapes perform better in this regard than simple single-layered ones, such as turfgrass, ornamental flowerbeds, or meadow.

Restoring and protecting biodiversity and wildlife habitat

On a global to local scale, countless plant and animal species extinctions and declines have been attributed to land development activities. The use of native tree, shrub, and groundflora species in residential gardens and backyards thus represents a positive, if small, contribution towards restoring and protecting local and regional biodiversity. Though the benefits are most tangible in naturalized, ecologically diverse landscape alternatives such as woodland or meadow-prairie gardens, there is also some benefit, however small, to using native species in conventional ornamental plantings. The selection of native plants grown from locally sourced seed stock, in particular, can help maintain individual species' genetic diversity and local gene pools, a key factor in biodiversity protection and restoration. Native plant gardens, in turn, can become habitat for a diverse array of wildlife species, providing food and shelter for songbirds, insects and butterflies, and small mammals.

Improved Air Quality

Residential landscapes in general can help improve urban air quality by: 1) producing oxygen; and 2) absorbing carbon dioxide, nitrogen oxide, airborne particulates and a host of other pollutants resulting from the combustion of carbon-based fuels. All landscape types considered in this report, including turfgrass, can contribute to improved air quality. However, naturalized landscapes typically create more biomass and leaf surface area per m^2, and are thus superior in this function.

Temperature Moderation: Residential landscapes can help moderate local and site specific temperatures via the process of evapo-transpiration (the natural cooling effect that occurs when water evaporates and transpires through the leaves), helping to reduce extreme summer heat. For instance, it is estimated that up to 50% of the sunlight heat striking turf is eliminated through transpiration. Consequently, on a hot sunny day, temperatures over lawns can be 10-14 degrees (F) cooler than over concrete or asphalt; a block of eight average-sized residential lots can have the cooling effect of 70 tons of air conditioning, (compared to the 3 or 4 ton capacity of a typical central home air conditioner). Again, all plants – and plant communities – share this ability to moderate climates through transpiration. As with other benefits noted above, the extent to which a landscape can moderate temperatures is related to the extent of its biomass and leaf cover. Given that naturalized landscapes create more biomass per m^2, they are superior in this function. Further, naturalized woodland (as well as ornamental trees and shrubs), can also regulate microclimatic with their shade.

4.4 Summary of Potential Impacts and Benefits

Table 10 summarizes both the environmental impacts and benefits associated with the seven landscape types and their related maintenance practices.

Table 10: Potential Environmental Impacts and Benefits

		Landscape type						
Potential Environmental Impacts		Convent. Lawn	Low-Main. Lawn	Ornam. Trees & Shrubs	Ornam. Flower Borders	Woodland	Meadow Prairie	Xeriscape
Primary	Pesticides	XXX		XXX	XX			X
	Fertilizers	XXX	X	XXXX	XX			X
	Fossil Fuel Combustion	XXXX	XXX				X	
	Water Consumption*	XXX		XXX	XXXX	XX	X	X
	Invasive Exotics			X	X			
Secon.	Yard Waste	XX		XX	X			
	Noise	XXXX	XXX					
	Wild-digging/Seed Collection					X	X	X
	Loss of Habitat and Native Biodiversity	XXXX	XXXX	XX**	XX**			XX**
Environmental Benefits								
Improved Hydrological Cycles		✓	✓	✓✓✓	✓	✓✓✓✓	✓✓	✓
Restoration of Biodiversity and Habitat				✓***	✓***	✓✓✓✓	✓✓✓✓	✓***
Improved Air Quality		✓	✓	✓✓✓	✓	✓✓✓✓	✓✓	✓
Temperature Moderation		✓	✓	✓✓✓	✓	✓✓✓✓	✓✓	✓

* Water consumption ratings reflect water use during a prolonged drought period, and may vary from one year to the next. **Impact is reduced if native plants are used

*** Benefits are increased if native plants are used.

Wherever a potentially detrimental maintenance input applies to a given landscape type, up to four **X**s are placed in the appropriate column, relative to other landscape types considered in this report. Up to four ✓s placed wherever a particular benefit applies to a given landscape type. The ratings for potentially harmful inputs (primary impacts) are derived from the input quantities reported in the monitoring survey results. Ratings for the secondary impacts and environmental benefits are largely subjective, since no quantitative data is was collected through the monitoring survey.

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[1] The main types of pesticides used in residential landscaping and gardening are herbicides (to kill weeds), insecticides (to kill insects), and fungicides (to kill disease-causing funguses). Of these, herbicides are the most widely used, primarily to control lawn weeds. Most lawn and garden pesticides used by Canadian homeowners are synthetic chemical products. However, in recent years, a number of organic, non-toxic or low-toxicity alternatives such as insecticidal soaps and beneficial insects have become commercially available.

[2] Interested readers who want more detailed information with which to draw their own conclusions can refer to the publications referenced in this chapter, as well as other resources listed in Appendix 2

[3] The PMRA is a branch of Health Canada responsible for administering the Pest Control Products Act for the federal Minister of Health.

[4] Organophosphates include several common lawn and garden pesticides such as chlorpyrifos, diazinon, malathion, and bensulide.

[5] Aside from lower body weights, children may also be more susceptible to pesticides in part because of their behavior: they tend to roll around in the grass, and put their fingers, toys, and other potentially contaminated objects in their mouths. As well, some children are known to ingest substantial amounts of soil, leading to the possibility that acute pesticide intoxication might occur if the soil has been treated with a pesticide (Calabrese et al., 1997).

[6] On August 3, 1996, the U.S. Food Quality Protection Act (FQPA) was signed into law, setting stringent safety standards and tolerances for pesticide residues in all foods. The U.S. Environmental Protection Agency (EPA) was summarily obliged to reassess exposure tolerances based on these and other factors. The PMRA has developed its own reassessment program that utilizes the new EPA data as it becomes available.

[7] Some older agricultural pesticides, such as the now banned DDT and other restricted organochlorines, tend to persist and retain their toxicity in the environment for a long time, where they move up terrestrial and aquatic food chains to bioaccumulate to toxic levels in the tissues of fish, aquatic invertebrates, waterfowl, and other species.

[8] EXTOXNET is a joint Pesticide Information Project of the Cooperative Extension Offices of Cornell University, Oregon State University, the University of Idaho, and the University of California at Davis and the Institute for Environmental Toxicology, Michigan State University. EXTOXNET receives major support and funding from the U.S. Department of Agriculture/Extension Service/National Agricultural Pesticide Impact Assessment Program. EXTOXNET Pesticide Information Profiles may be downloaded from the Internet (http://ace.ace.orst.edu/info/extoxnet/ghindex.html).

[9] De-nitrification is the natural process wherein certain soil microorganisms take nitrogen out if it's fixed form in the soil and return it to the atmosphere.

[10] Excessive nutrient loading can lead to an overgrowth of algae. Algal blooms can harm aquatic plants by increasing turbidity, thereby decreasing the amount of sunlight available to them. As the algae dies and

decomposes, dissolved oxygen concentrations may drop dramatically to levels harmful to fish and other aquatic life. Nutrient loading, in this manner, is directly linked to the process of eutrophication.

[11] Two factors that can help at least reduce these impacts is to keep the mower engine well-tuned, and to avoid spillage.

[12] Although homeowners may opt for electrically powered equipment, this simply transfers rather than resolves the problem, since the electricity may be generated at fuel or coal-burning plants, which in many cases are a primary source of pollution emissions. Significant pollution emissions and other environmental problems are also generated indirectly through the manufacture and transportation of fertilizers, pesticides, and maintenance equipment. For instance, a bag of fertilizer purchased in a local garden centre is the result of several production processes, each of which involves the consumption of fossil fuels. They are required in the mining, and refinement of potassium and potash, and in the shipping of these raw materials to fertilizer plants Fossil fuels are also integral to the fertilizer's manufacturing process, and are required to ship the final product to retailers. The production of pesticides and maintenance equipment follows the same basic route.

[13] Other uses include, in order of priority: 63% for thermal power generation (conventional and nuclear); 16% for manufacturing; 9% for agriculture; and 1% for mining

[14] It should, however, be noted that these bans apply to established landscapes; watering newly installed landscapes, which are typically sensitive to drought, is generally permitted.

Chapter 5. Life Cycle Analysis for Seven Residential Landscape Design Options

5.1 Methodology

When selecting one or more landscape types for their property, homeowners should give some thought to several factors. Installation and long-term financial costs, maintenance time requirements, environmental impacts and benefits, aesthetics, and functionality are all important considerations. Homeowners selecting from the various alternatives should strive to make an informed choice, one that weighs these different factors and which ultimately reflects their specific set of priorities.

In this study, a *life cycle analysis* was conducted to facilitate this decision-making process[1]. The analysis considers expenditures related to both the initial installation of the landscape options as well as to their on-going maintenance.[2] In addition to comparing the long term costs, the life cycle analysis compares long term time commitments and environmental impacts or benefits associated with the landscape types discussed in this report[3].

To this end, a series of seven different landscape design options for a hypothetical single-family home have been prepared. Each design is based predominantly on one of the seven landscape types. Life cycle cost, time commitment and environmental impact values have been prepared for each design option, with the mean annual maintenance values (MAV) outlined in Chapter 3 as the quantitative basis for this component of the analysis. The results of this exercise are in and of themselves revealing and insightful in that they make obvious some of the tradeoffs associated with the various alternatives.

Designing the Seven Landscape Options: Site Characteristics and Design Criteria

Seven different landscape design options have been prepared for a hypothetical, two-storey single-family house. For plant selection purposes, it is assumed that the property is located in a southern Ontario suburb, and bears the following characteristics:

- lot dimensions (including the easement): 20 x 34.35 m = 687m^2;
- house footprint (including garage and rear deck): 134.5 m^2;
- driveway = 30.38 m^2;
- concrete slab walkways = 15.84 m^2;
- total area available for landscaping = 506.28 m^2.

It is assumed that the site consists of exposed soils ready for landscaping. Other site features include:

- a 2 m tall privacy fence enclosing the entire back yard;
- three street trees situated within the street easement (cost and maintenance requirements not included in the analysis);
- southernmost portion of the property is shaded by a row of mature trees located in a natural area on the adjacent property;
- soils are assumed to be a clay loam topped by a 7.5 to 10 cm layer of topsoil;

- front yard gently slopes towards the street, while the back yard drains towards the natural area.

Each design option:

- predominantly features one of the seven landscape types, in combination with two other landscape types[4];
- is conceptual in nature (while plant lists are provided, no attempt has been made to pinpoint the exact location of each plant);
- is designed to be aesthetically attractive, and attempts to realize the potential inherent in the different combinations of landscape types;
- attempts to integrate with the existing streetscape by maintaining the easement as lawn[5];
- addresses aesthetic design issues such as spatial form and sequence, line, and plant layering;
- includes at least a modest area patch of lawn (conventional or low-maintenance) to provide space for child's play or outdoor gathering;
- includes a bench (not factored in cost calculations).

Although several of the designs included, by necessity, a path or walkway through heavily planted areas, installation costs were not considered since in reality a homeowner could chose from a wide range of building materials and price ranges (e.g., woodchips, limestone screenings, brick, or flagstone). None of the designs include garden sheds or storage space for items such as firewood.

Each design is rendered to show plantings as they might appear in five to eight years after installation. All native plant selections are based on plant community models native to southern Ontario; many of these plants may not be appropriate to other parts of Canada. Plants marked with "spp." indicate that various varieties or species of the genus are included in the design.

5.1.1. Life Cycle Cost Calculations

Life cycle cost calculations have been prepared for each design option. Typically, life cycle calculations are based on the projected lifespan of a given item from initial purchase to eventual disposal. Residential landscapes, in this respect, are somewhat different in that once established, they can be maintained indefinitely. Hence, it was necessary to establish an arbitrary time frame as a benchmark for the life cycle calculations. A projected lifespan of ten years was thus used, based on the length of time a homeowner might be expected to reside in the same home and reap the benefits (and expenses) of the landscape they installed[6].

The life cycle calculations were performed in three steps, as described below: 1) determine capital installation costs; 2) determine maintenance costs over 10 yr period; 3) merge ten year maintenance costs with capital costs.

i. Capital Costs

Capital installation cost estimates are provided with each design option. These estimates are based on plantings only, and do not include the installation costs for hard landscape elements such as the fence, deck, bench, and footpaths. The capital costs also do not include the cost of any equipment purchases, such as irrigation and mowing equipment.

To calculate the capital installation costs, a slate of unit prices (price/m^2) was prepared for the various types of plantings that recur throughout the seven design options. These unit prices are listed in Table 11 below.[7]

Table 11: Unit prices used in capital cost calculations

Item	Description	Type	Unit price, installed
Conventional Lawn (sod)	Standard Kentucky Bluegrass and Fescue species mix, site preparation includes addition of a 4" layer of topsoil, fine grading, etc.		$6 50/m^2
Low-maintenance lawn (seed)	Mix of short fescues, clovers, and annual cover crop, installation includes 2" layer of topsoil, fine grading		$4 90/m^2
Trees (deciduous)	Installation includes bone meal, staking, mulch, and tree guards	a 45mm caliper (wire basket) b 250 cm c. Seedling (50-100 cm)	$240/tree $85 00/tree $15 00/tree
Trees (evergreen)	150 cm, ball and burlap stock, installation includes bone meal, mulch		$225 00/tree
Shrubs (deciduous)	Bare root stock, installation includes bone meal, mulch	a 100 cm b 50 cm c. seedling	$35 00/shrub $17 50/shrub $7.50/shrub
Shrubs (evergreen)	Potted, 50-70 cm stock, installation includes bone meal, mulch		$55 00/shrub
Woody groundcover	Mix of both seedling and 50 cm potted stock of suitable groundcover species, spacing and quantity varies according to plant size, installation includes bone meal and mulch		$19 75/m^2
Herbaceous groundcover	Seedlings, planted on 30 cm centres (11 plants/m^2)		$27 50/m^2
Ornamental perennials	2 year-old plants on 30 cm centres, installation includes addition of 15 cm layer of topsoil and compost to planting bed, cultivated and fine graded, with straw mulch		$60 00/m^3
Native Prairie/meadow (wildflowers & grasses)	Installation includes loosening top 6 inches of soil, addition of 2 inch layer of compost, fine grading, and a straw mulch	a. 50 50 mix of 2 year-old plants and 6 week plugs, 20 to 30 cm centres b. Seed	$51 56 / m^2 $6.15 / m^2
Native Woodland (wildflowers & grasses)	Installation includes addition of 15 cm layer of topsoil and compost to planting bed, cultivated and fine graded, and a straw mulch	a. 50 50 mix of 2 year-old plants and 6 week plugs, 20 to 30 cm centres b. Seed	$54 56 / m^2 $6.15 / m^2

ii. Ten Year Maintenance Costs

To calculate the total ten-year maintenance costs for each design option, the first step is to calculate the maintenance requirements for each individual landscape type encompassed in the design, using the formula:

$MC10yr = a Cmav10$

where:

$MC10yr$ = 10 yr maintenance costs

a = the total area of a given landscape type (m^2)

Cmav = the cost MAV/m^2 for the given landscape type (as outlined in Chapter 3)

10 = number of years

Once the ten-year maintenance costs for individual landscape types have been calculated, a total long-term maintenance value is determined by adding the costs of all three landscape types represented in each design option[8].

iii. Total Life Cycle Costs

To determine the total life cycle costs for each option, long-term maintenance expenditures are then merged with the capital installation costs, using the formula:

Life cycle costs = MC10yr + Ccost

where:

MC10yr = 10 year maintenance costs

Ccost = capital cost

5.1.2. Environmental Impact Analysis

As discussed in Chapter 4, it is not possible within the scope of this study to quantify specific environmental impacts or benefits associated with the various landscape types and their maintenance inputs. However, as part of this analysis, it is possible to at least draw correlations between the quantities of potentially harmful materials into the environment over the ten-year maintenance period and the potential for resulting impacts to occur. In other words, the more pesticides, fertilizers, gasoline, and water are used to maintain a given landscape type, the greater the likelihood that these inputs will contribute in some way to environmental degradation (in the form of air and water pollution, as well as the depletion of drinking water supplies).

The environmental impact analysis for each landscape option is therefore limited to simple calculations of the total amounts of pesticides, fertilizer, gasoline, and water used to maintain each landscape option over a 10-year period. Unlike a conventional life cycle analysis, no attempt has been made to quantify the secondary or indirect environmental impacts (energy consumption, air and water emissions, waste production) associated with the manufacture, transportation and sale of the various products used goods such as pesticides, fertilizers, plant materials, and other products.

As discussed in Chapter 4, it must be reiterated that site conditions such as soil type, slope, microclimate, and proximity to vulnerable open waters and natural generally dictate the extent to which any of the chemical inputs will result in some form of ecological or human health impact. The product type is also a major factor. As well, these impacts may be further mitigated or exacerbated depending on whether the homeowner has followed all the proper application instructions and safeguards. As stated, this study does not account for these factors.

5.1.3. Time Requirements

Time inputs required to maintain each of the seven landscape options over the 10-year period are the third component of the analysis. Total time requirements include:

- time inputs required during the initial landscape establishment phase;
- and, the annual inputs during the post-establishment period[9].

To calculate the total ten-year maintenance costs for each design option, the first step is to calculate the maintenance time requirements for each individual landscape type encompassed in the design, using the formula:

MT10yr = *a*Tmav10

where:

MT10yr = 10 yr maintenance time requirements

a = the total area of a given landscape type (m^2)

Tmav = the time MAV/m^2 for the given landscape type (as outlined in Chapter 3)

10 = number of years

Once the ten-year maintenance time requirements for individual landscape types have been calculated, a total long-term maintenance value is determined by adding the costs of all three landscape types represented in each design option.

The final life cycle values were calculated by adding estimates of the additional time requirements during the planting establishment phase. The establishment phase refers to the period of time following installation during which short-term aftercare maintenance is required to properly establish the plantings, primarily through additional watering and weeding. Maintenance time requirements during this period are generally more intensive than maintenance requirements for an established landscape. The length of the establishment phase varies depending on the landscape type, and was assumed as follows[10]:

Conventional lawn, low-maintenance lawn:	0.5 years
Ornamental flowerbeds, xeriscape:	1 year
Trees and shrubs	1.5 years[11]
Naturalized meadow/prairie:	2.5 years[12]
Naturalized woodland shade garden:	3 years[13]

It is conservatively estimated that the time requirement to weed and water these landscape types during the establishment phase is twice that required to maintain an established landscape. The resulting establishment phase time MAV's per m2 are outlined in Table 12.

Table 12: Landscape establishment time calculations

Landscape Type	Time MAV (Weeding and Watering)	Establishment Phase (years)	MAV Establishment Phase
Conventional Lawn	0.36 min./m^2	0.5	0.18 min./m^2
Ornamental Flowerbeds	13.55 min./m^2	1	13.55 min./m^2
Ornamental Trees and Shrubs	5.96 min./m^2	1.5	8.94 min./m^2
Low Maintenance Lawn	.37 min./m^2	0.5	0.19 min./m^2
Naturalized Wildflower Meadow	1.8 min./m^2	2.5	4.5 min./m^2
Naturalized Woodland Shade Garden	1.56 min./m^2	3	4.68 min./m^2
Xeriscape	7.67 min./m^2	1	7.67 min./m^2

5.2. The Seven Design Options

OPTION 1. Conventional Lawn

Area Coverage:	
Conventional Lawn	- 359.18 m^2
Ornamental Trees & Shrubs	- 105.38 m^2
Ornamental Flowerbeds	- 41.72 m^2

The conventional lawn design option exemplifies a typical suburban residential landscape most familiar to Canadian homeowners. The lawn is the dominant landscape type, contributing to the design's open character. Ornamental plantings include limited flowerbeds, six ornamental trees, and massed ornamental shrub plantings along the house foundation and property line. Though several native species have been incorporated into the design, plant selections are largely limited to ornamental exotics, including potentially invasive species such as Norway maple.

From an aesthetic standpoint, this design, relative to the other options, is simple and reserved. The limited front yard planting places the house front and centre on the property, in full view of the street. In terms of function, this design offers a substantial amount of open space for outdoor activities and storage. However, by the same token, the design offers only minimal privacy due to limited front yard and boundary plantings (though some measure of privacy is ensured by the backyard fencing). Due to the small number of trees, this design option offers only a limited amount of shade. The installation cost for Option 1 was calculated at $7460.37 (see Table 13)[14].

Table 13. Capital Installation Costs, Conventional Lawn

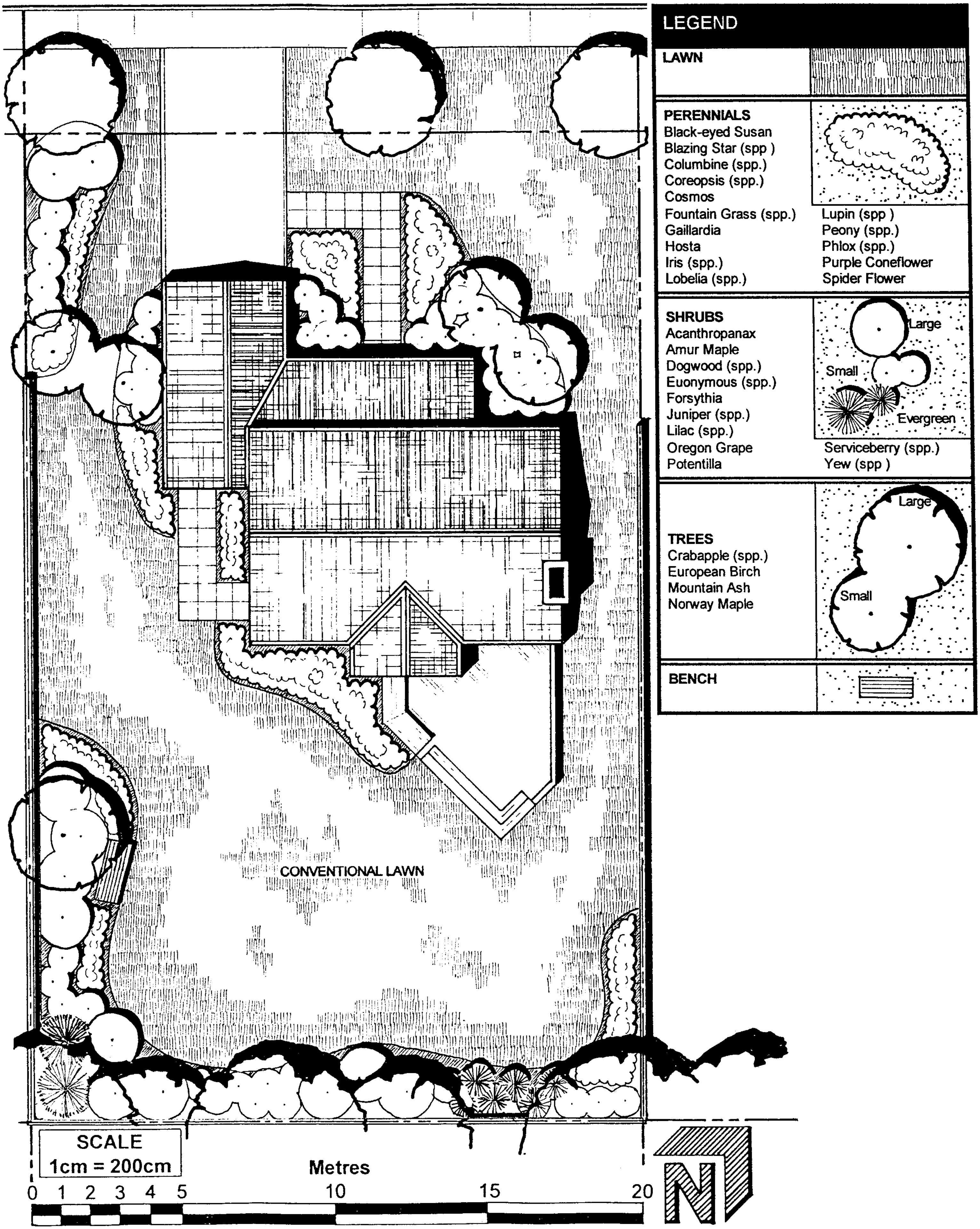
ITEM	QUANTITY	UNIT COST	TOTAL COST
1. Lawn (sod installation)	359.18 m^2	$6.50 / m^2	$2334.67
2. Trees, 45 mm	3	$240.00 / tree	$720.00
3. Trees, 250 cm	3	$85.00 / tree	$255 00
4. Shrubs, 100 cm	12	$35.00 / shrub	$420 00
5. Shrubs, 50 cm	45	$17.50 / shrub	$787.50
6. Evergreen shrubs	8	$55.00 / shrub	$440.00
7. Orn. flowerbeds -includes perennials, annuals and bulbs	41.72 m^2	$60 00 / m^2	$2503.20
		TOTAL	**$7460.37**

The ten-year maintenance costs were determined to be $3975. Total projected life cycle costs are $11,435 (see Table 14).

Table 14: Ten-Year Maintenance Costs and Total Life Cycle Costs, Conventional Lawn

	Conventional Lawn 359.18 m^2	**Orn. Trees & Shrubs** 105.38 m^2	**Orn. Flowerbeds** 41.72 m^2
Cost MAV ($/$m^2$)	$.50	$1.28	$1.99
Annual Maintenance Costs (MAV x m^2)	$179.59	$134.87	$83.02
Ten-year Maintenance Costs	**$1795.90**	**$1348.70**	**$830.20**
		Total 10 Year Maintenance Costs	**$3974.80**
		Capital Costs	$7460.37
		TOTAL LIFE CYCLE COSTS	**$11,435.17**

Figure 24: Landscape design option # 1 – Conventional Lawn (with ornamental flowerbeds, trees and shrubs)



Total projected material inputs (pesticide, fertilizer, gasoline, and water) are outlined in Table 15. Not surprisingly, these are considerably higher, and thus more likely to contribute to environmental degradation, than inputs related to other options emphasizing resource-efficient landscape types. In terms of wildlife habitat, this option is of limited value due to the predominant use of exotic plant species. The massed shrub plantings may offer some shelter for songbirds, while some of the ornamental perennials may appeal to butterflies and other desirable insects. However, the habitat value of these plantings may be counteracted by the use of pesticides. Compared to some of the other more heavily planted options, the extensive lawn area reduces the landscape's ability to contribute to the enhancement of local hydrological cycles. Given the site's proximity to a natural area, there is a danger that the Norway maple and European birch plantings may disperse seed into the adjacent natural area south of the lot.

Table 15: Material Input / Environment Impact, Conventional Lawn

	Conven. Lawn 359.18 m²		**Orn. Tr. & Shb.** 105.38 m²		**Orn. Flowerbeds** 41.72 m²			
Input	**MAV /m²**	**Annual Total**	**MAV /m²**	**Annual Total**	**MAV /m²**	**Annual Total**	**Annual Total**	**10-year Total**
Pesticides	5 24 gm	1 88 kg	6 09 gm	64 kg	3 04 gm	13 kg	**2.65 kg**	**26.5 kg**
Fertilizers	89 96 gm	32 31 kg	167 2 gm	17 62 kg	26 9 gm	1 12 kg	**51.05 kg**	**510.5 kg**
Gasoline	32 94 ml	11 83 L	0	0	0	0	**11.83 L**	**118.30 L**
Water	37 20 L	13 36 m^3	77 98	8 2 m^3	180 9 L	7 55 m^3	**29.11 m^3**	**291.1 m^3**

Projected maintenance time requirements are outlined in Table 16. Once established, this option will require approximately 82 hours in annual maintenance time inputs. Over a ten-year life cycle period, it is estimated this design option will require approximately 844 hours in maintenance time inputs, equivalent to 35 days (or 105 eight-hour workdays).

Table 16: Maintenance Time Requirements, Conventional Lawn

	Conventional Lawn 359.18 m²	**Orn. Trees & Shrubs** 105.38 m²	**Orn. Flowerbeds** 41.72 m²
Time MAV	4.24 min./m²	20.6 min /m²	29 22 min /m²
Annual Total (MAV x m²)	25.38 hrs	36.18 hrs	20.32 hrs
Ten-year Total	**253.8 hrs**	**361.18 hrs**	**203.20 hrs**
Establishment Time (Establ. time MAV x m²)	1.08 hrs	15.7 hrs	9.42
Total Time, Life Cycle	**254.88**	**376.88**	**212.62**
		Total 10 Year Maintenance Time	**844 hrs (35 days)**

OPTION 2. Low-Maintenance Lawn (with xeriscape)

Area Coverage	
Low-maintenance Lawn	- 347.54 m^2
Xeriscape	- 158.74 m^2

Option 2 combines low-maintenance lawn with assorted xeriscapes plantings, and is intended as a low-maintenance, resource-efficient version of the typical landscape depicted in Option 1. The purpose here is to demonstrate how it is possible to achieve a spatially and functionally similar landscape, while markedly reducing the various maintenance cost, material, and time inputs. Again, lawn is the dominant landscape type, covering 347.5 m^2. Xeriscape plantings, which substitute for the ornamentals used in Option 1, cover the remaining area. In this design option, the xeriscape uses locally appropriate drought-tolerant native meadow and woodland species. However, it is assumed that these plantings are not naturalized, but rather more intensively maintained to standards similar to those of ornamental plantings.

From an aesthetic standpoint, this option achieves the same openness and spatial form as the conventional lawn option. The primary difference lies in the details. Whereas the conventional lawn option is intended as a manicured residential landscape, this option will appear somewhat rougher, in that the lawn will not have the all-season, carpet-like uniformity of a conventional lawn. In a similar vein, the herbaceous and woody plantings are not as intensively managed as the ornamental plantings in Option 1. For this reason, homeowners who want to more thoroughly integrate their landscape with that of their neighbours may want to maintain conventional lawn and ornamental plantings in the front yard, while using the low-maintenance alternatives in the less publicly visible backyard. From a functional standpoint, this option offers all of the same advantages as the conventional lawn option, with ample open space for outdoor activities, storage, and other needs. By the same token, it does not offer the privacy and shade afforded by some of the more heavily planted design options.

The capital installation costs for Option 2 are estimated to be $6773.81, and are depicted in Table 17. In calculating these costs, two different meadow installation options are employed. Half of the flowerbed area in the more visible portions of the property uses native wildflower and grass transplants (plugs and container grown plants), while the other half uses seed. Plantings enable faster and more reliable establishment but are more expensive than seeding.

Table 17: Capital Installation Costs, Low Maintenance Lawn

ITEM	QUANTITY	UNIT COST	TOTAL COST
1. Lawn, seed installation	347.54 m^2	$4.90 / m^2	$1702.95
2. Trees (deciduous), 250 cm	10	$85.00 / tree	$850.00
3. Trees (deciduous), seedling	10	$15.00 / tree	$150.00
4. Shrubs, 100 cm	12	$35.00 / shrub	$420.00
5. Shrubs, 50 cm	20	$17.50 / shrub	$350.00
6. Shrubs, seedling	15	$7.50	$112.50
7. Evergreen shrubs	6	$55.00 / shrub	$330.00
8 Native meadow wildflowers/grasses			
a Planting	25 9 m^2	$51 56	$1335 40
b. Seed	25.8 m^2	$6.15	$158.96
9 Native woodland wildflowers/grasses (transplants only)	25 m^2	$54 56	$1364 00
		TOTAL	**$6773.81**

The projected ten-year maintenance costs were determined to be $1545, while the total projected life cycle costs are $8318.84 respectively (see Table 18).

Figure 25: Landscape design option # 2 – Low Maintenance Lawn (with xeriscape)

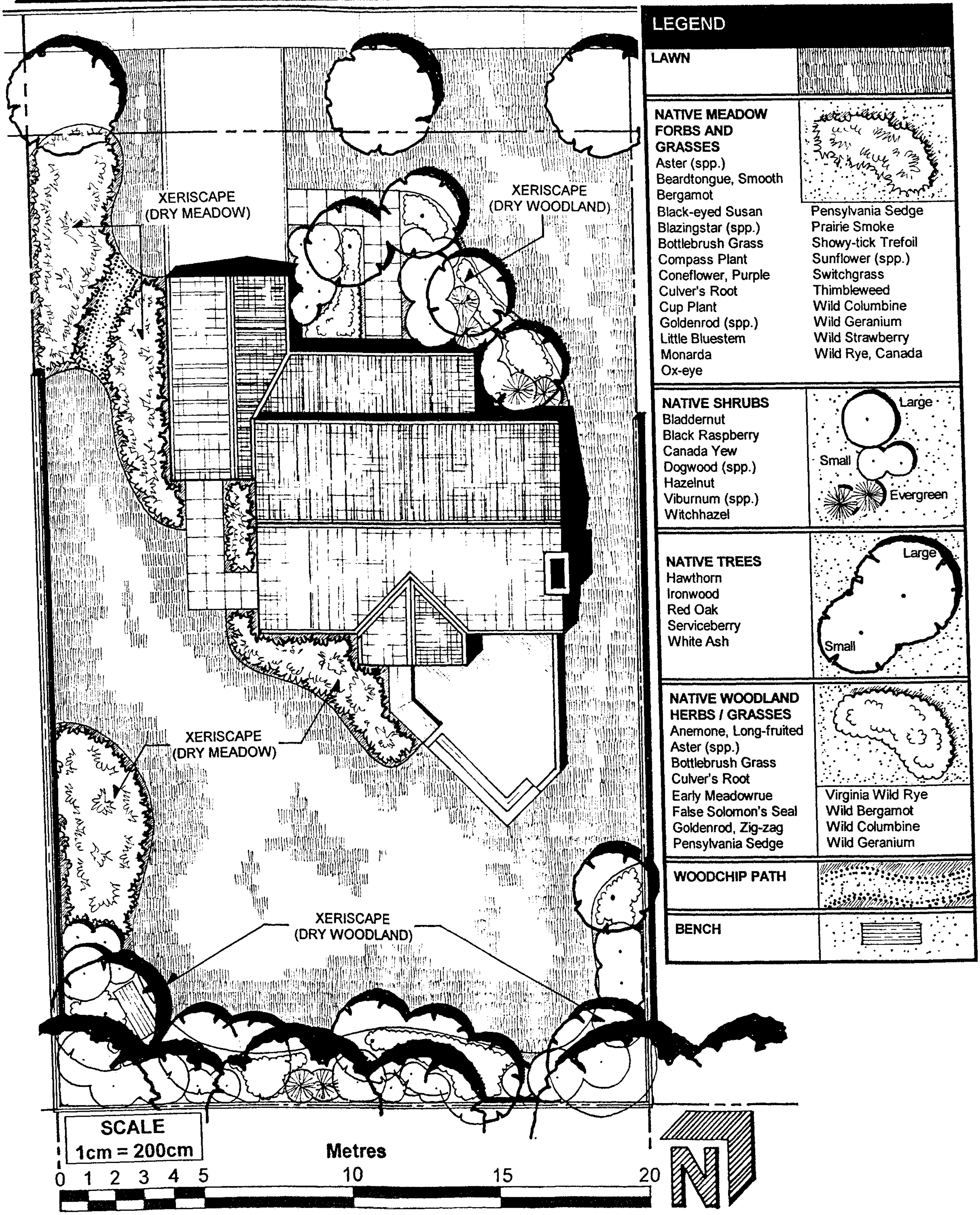


Table 18: Ten-Year Maintenance Costs and Total Life Cycle Costs, Low Maintenance Lawn		
	Low-main. Lawn 347.54 m²	**Xeriscape 158.74 m²**
Cost MAV ($/m²)	$.07	$.82
Annual Maintenance Costs (MAV x m²)	$24.33	$130.17
Ten-year Maintenance Costs	**$243.33**	**$1301.70**
Total 10 Year Maintenance Costs		**$1545.03**
Capital Costs		$6773.81
TOTAL LIFE CYCLE COSTS		**$8318.84**

Total projected material inputs are outlined in Table 19, and are substantially lower than those encountered in Option 1. Pesticide use will be approximately 10 times less than in Option 1, while water use, at 12 m^3, is over 20 times less than for the conventional lawn option. The expansive lawn area minimizes this option's hydrological and wildlife values. However, the limited use of native trees, shrubs, and wildflowers will prove attractive to certain wildlife species.

Table 19: Material Input / Environment Impact, Low Maintenance Lawn						
	Low-Main. Lawn 347.54 m²		**Xeriscape 158.74 m²**			
Input	**MAV /m²**	**Annual Total**	**MAV /m²**	**Annual Total**	**Annual Total**	**10-year Total**
Pesticides	0 gm	0 kg	75 gm	12 kg	**.12 kg**	**1.2 kg**
Fertilizers	13 8 gm	4 80 kg	17 gm	2 7 kg	**7.5 kg**	**75 kg**
Gasoline	17 4 ml	6 05 L	0	0	**6.05 L**	**60.5 L**
Water	0 L	0 m³	7 29 L	1 2 m³	**1.2 m³**	**12 m³**

Projected maintenance time requirements are outlined in Table 20. Once established, this option will require approximately 63 hours in annual time inputs. Over a ten-year life cycle period, it is estimated this design option will require 632 hours in maintenance time inputs, equivalent to 26 days (or 78 eight-hour workdays), representing a 25% decrease over option 1.

Table 20: Maintenance Time Requirements, Low Maintenance Lawn		
	Low-main. Lawn 347.54 m²	**Xeriscape 158.74 m²**
Time MAV	2.10 min./m²	18.47 min./m²
Annual Total (MAV x m²)	12.16	48.87 hrs
Ten-year Total	**121.6 hrs**	**488.7 hrs**
Establish. Time (Est. time MAV x m²)	1 1hrs	20 29 hrs
Total Time, Life Cycle	**122.7 hrs**	**508.99 hrs**
Total 10 Year Maintenance Time		**631.69 hrs (26 days)**

OPTION 3. Woodland Shade Garden

Area Coverage:	
Woodland	- 321.38 m^2
Low-Maintenance Lawn	- 120.58 m^2
Meadow	- 64.32 m^2

Design option 3 combines an extensive naturalized woodland shade garden with a small area of low-maintenance lawn and some limited naturalized meadows to create a distinctly informal, natural-looking landscape. Mimicking the structure and diversity of a natural southern Ontario forest community, the woodland plantings include a diverse mix of trees, shrubs, and shade tolerant groundflora. The natural "forest floor" look could be accentuated through the strategic placement of logs, rocks, and other natural materials. Low-maintenance lawn is incorporated in two locations: within the easement, to conform and integrate with neighbouring landscapes, and in the backyard, to provide at least a minimal open space activity area. The naturalized wildflower meadow areas are located primarily in the front yard..

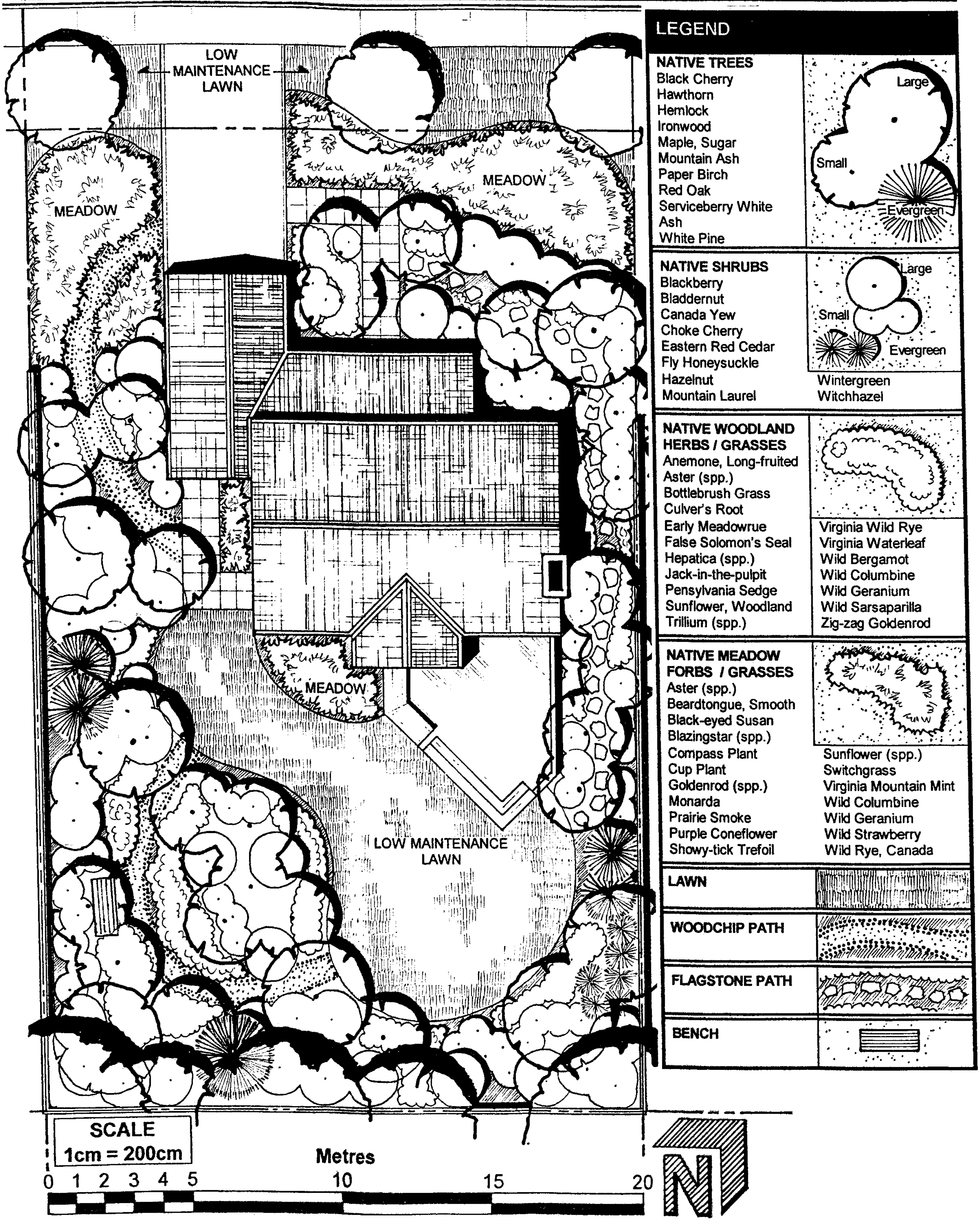
From an aesthetic standpoint, the wide diversity of plantings ensures a great deal of visual interest, in terms of plant form, leaf texture, and bloom colour through all seasons. Additional visual interest is generated through the use of footpaths linking the front and back yards. As well, the design includes secluded seating / retreat area adjacent to the rear lawn. Extensive front yard plantings render the house somewhat less visible from the street than most of the other design options. From a functional standpoint, this option offers significantly less open space for outdoor activities; conversely, it offers more privacy, and provides the homeowner with an abundance of shade during hot summer days.

The projected installation costs for Option 3 totaled $11,219.42, and are outlined in Table 21. It is assumed that the tree and shrub plantings will consist of an even mix of both mature and seedling stock, both to diversify the plant mix and to keep installation costs down. Tree seedling stock will consist of fast growing species, and will be densely planted in combination with the mature stock to achieve reasonable canopy closure within three to four years, at which time woodland groundflora layer can be installed[15]. In the interim, much of the planted area would be covered by a layer of mulch to reduce weed growth and ensure optimal soil moisture and temperature conditions (cost of mulch is factored in the unit plant prices). Both the understory groundflora layer and the open meadow areas will be installed using a 50:50 mix of seed and transplants (2 year-old plants and six-week-old plugs).

Table 21: Capital Installation Costs, Naturalized Woodland Shade Garden

ITEM	QUANTITY	UNIT COST	TOTAL COST
1. Low-Main. Lawn (seed)	120.58 m^2	$4.90 / m^2	$590.84
2. Trees (deciduous), 45 mm	4	$240.00 / tree	$960.00
3. Trees (deciduous), 250 cm	15	$85.00 / tree	$1275.00
4. Trees (deciduous), seedling	30	$15.00 / tree	$450.00
5. Evergreen trees	4	$225.00 / tree	$900.00
4. Shrubs, 100 cm	35	$35.00 / shrub	$1225.00
5. Shrubs, 50 cm	63	$17.50 / shrub	$1102.50
6. Shrubs, seedling	30	$7.50	$225.00
7. Evergreen shrubs	12	$55.00 / shrub	$660.00
8. Woodland grasses/wildflower			
Plantings	32 5 m^2	$54 56 / m^2	$1773 20
Seed	32.5 m^2	$6.15/ m^2	$199.87
9 Dry Meadow			
Plantings	32 2m^2	$51 56 / m^2	$1660 23
Seed	32.1m^2	$6.15 / m^2	$197.78
		TOTAL	**$11,219.42**

Figure 26: Landscape design option # 3 – Woodland Shade Garden (with low maintenance lawn and meadow)



The ten-year maintenance costs, shown in Table 22, are estimated to be $1003.50. The resulting ten-year life cycle cost for Option 3 is $12,222.92.

Table 22: Ten-Year Maintenance Costs and Total Life Cycle Costs, Woodland Shade Garden

	Woodland 321.38 m^2	Meadow 64.32 m^2	Low-Main. Lawn 120.58 m^2
Cost MAV (\$/m^2)	$.27	$.08	$.07
Annual Maintenance Costs (MAV x m^2)	$86.77	$5.14	$8.44
Ten-year Maintenance Costs	**$867.70**	**$51.40**	**$84.40**
		Total 10 Year Maintenance Costs	**$1003.50**
		Capital Costs	$11,219.42
		TOTAL LIFE CYCLE COSTS	**$12,222.92**

The total projected material inputs pertaining to potential environmental impacts are outlined in Table 23, and are amongst the lowest of the seven design options. From the standpoint of environmental benefits, the woodland design option, with its diverse mix of native species and ample shelter and cover, offers the richest wildlife habitat and is guaranteed to be ripe with songbirds and butterflies through much of the growing season. The woodland option, with it highly structured vegetation layers, is likely to be the most effective at contributing to the enhancement of local hydrological cycles, by maximizing the on-site retention and infiltration of precipitation.

Table 23: Material Input / Environment Impact, Woodland Shade Garden

	Woodland 321.38 m^2		Meadow 64.32 m^2		Low-Main. Lawn 120.58 m^2			
Input	**MAV /m^2**	**Annual Total**	**MAV /m^2**	**Annual Total**	**MAV /m^2**	**Annual Total**	**Annual Total**	**10-year Total**
Pesticides	01 gm	003 kg	21 gm	014 kg	0 gm	0 kg	**.017 kg**	**.17 kg**
Fertilizers	0 gm	0 kg	0	0	13 8 gm	1 66 kg	**1.66 kg**	**16.6 kg**
Gasoline	0 ml	0 L	1 41 ml	1 L	17 4 ml	2 1 L	**2.2 L**	**22 L**
Water	29 97 L	9 63 m^3	12 25 L	79 m^3	0 L	0 m^3	**10.42 m^3**	**104.2 m^3**

Projected maintenance time inputs are outlined in Table 24. Annual maintenance requirements are projected to be approximately 39 hours. Over its ten-year life cycle period, this design option will require at total of 421 hours, which is equivalent to just over 17 days (or 51 eight-hour working days).

Table 24. Maintenance Time Requirements, Woodland Shade Garden

	Woodland 321.38 m^2	Meadow 64.32 m^2	Low-Main. Lawn 120.58 m^2
Time MAV	5.53 min./m^2	4.88 min./m^2	2.1 min./m^2
Annual Total (MAV x m^2)	29.62 hrs	5.23 hrs	4.22 hrs
Ten-year Total	**296.2 hrs**	**52.3 hrs**	**42.2 hrs**
Establish. Time (Est. time MAV x m^2)	25 07 hrs	4 82 hrs	38 hr
Total Time, Life Cycle	**321.27**	**57.12**	**42.58**
		Total 10 Year Maintenance Time	**420.97 hrs (17.5 days)**

4. Ornamental Flowerbeds

Area Coverage:	
Ornamental Flowerbeds	- 220 46 m^2
Conventional Lawn	- 153.37 m^2
Ornamental Trees & Shrubs	- 132 45 m^2

Option 3 emphasizes ornamental flowerbeds and flower borders as the primary landscape type, covering approximately 220 m^2. Given the extensive costs and maintenance requirements associated with these extensive flowerbeds, this design option is likely to appeal only to the most devoted of gardeners.

Although a limited number of native species are specified in both the flowerbed and woody plantings, the selections consist primarily of horticultural ornamentals, including some potentially invasive exotic species. The flowerbed plantings include many common ornamental perennials, annuals, and bulbs. In terms of aesthetics, this design is thus sure to generate a great deal of visual interest, particularly in terms of an abundant floral display accentuated by a conventional lawn and ornamental tree and shrub plantings.

From a functional standpoint, the design provides only limited open lawn areas for outdoor activities, storage, and other purposes. Though the seating area is well sheltered by tree and shrub plantings, the overall design offers only limited screening for privacy and shade.

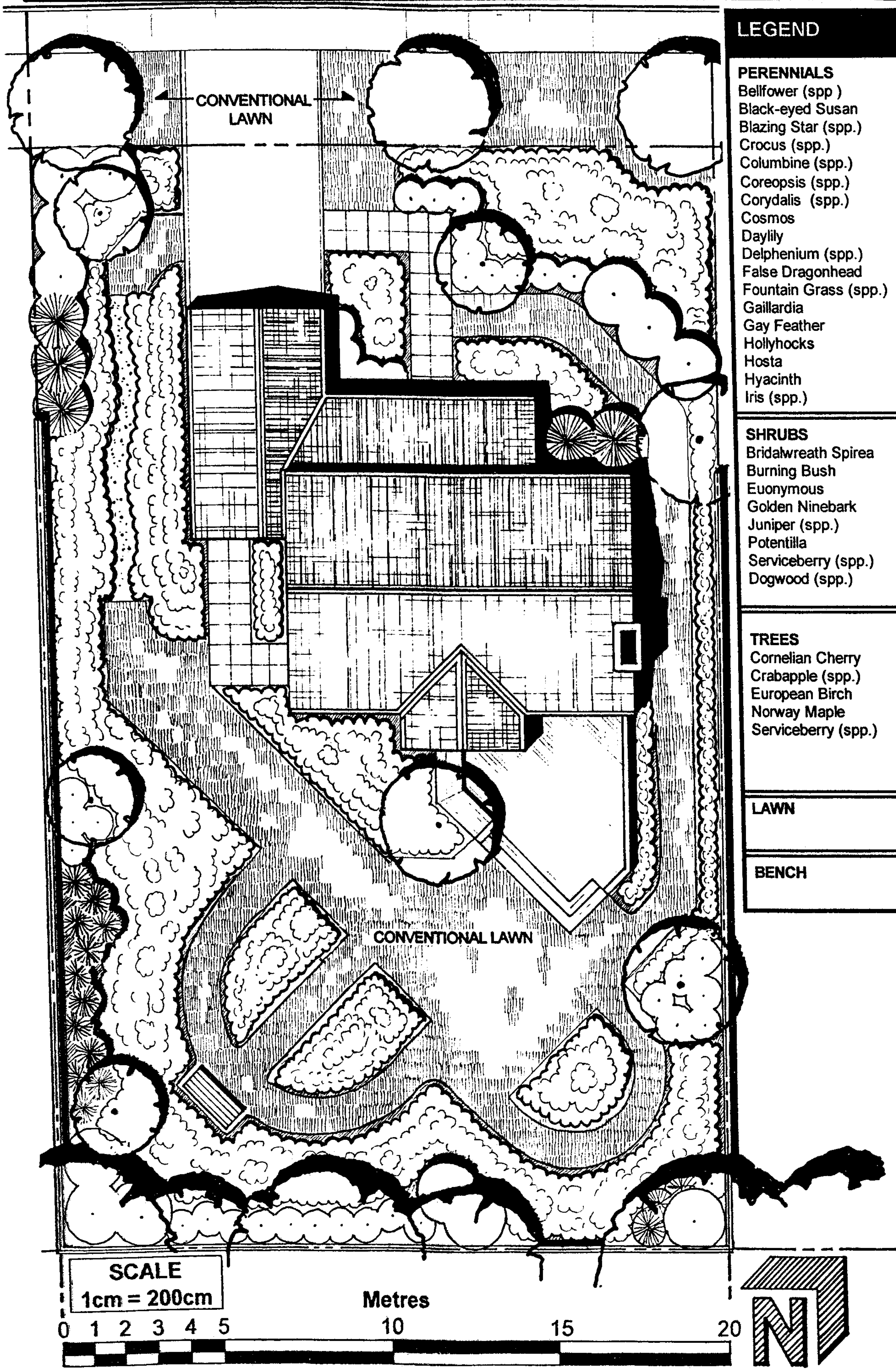
The installation costs totaled $17,329.51 and are outlined in Table 25. By far, perennial plantings represent the most substantial expenditure, at over $13,227.60. Overall costs could be slightly reduced by using seed rather than sod to create the lawn.

Table 25. Capital Installation Costs, Ornamental Flowerbeds

ITEM	QUANTITY	UNIT COST	TOTAL COST
1. Lawn (sod)	153.37m^2	$6.50 / m^2	$996.91
2. Trees, 45 mm	2	$240.00 / tree	$480.00
3. Trees, 250 cm	5	$85.00 / tree	$425.00
4. Shrubs, 100 cm	13	$35.00 / shrub	$455.00
5. Shrubs, 50 cm	40	$17.50 / shrub	$700.00
6. Evergreen shrubs	19	$55.00 / shrub	$1045.00
7. Ornamental flowerbeds	220.46 m^2	$60.00 / m^2	$13,227.60
		TOTAL	**$17,329.51**

Ten-year maintenance and total life cycle costs are depicted in Table 26, and are projected to be about $6850 and $24,179 respectively. In both respects, the flowerbed option is by far the most expensive of the seven design options. Maintenance cost and time requirements are high partly due to use of annuals, which need to be purchased and planted every year.

Figure 27: Landscape design option # 4 – Ornamental Flowerbeds (with conven. lawn and orn. trees & shrubs)



LEGEND

PERENNIALS

Bellfower (spp)
Black-eyed Susan
Blazing Star (spp.)
Crocus (spp.)
Columbine (spp.)
Coreopsis (spp.)
Corydalis (spp.)
Cosmos
Daylily
Delphenium (spp.)
False Dragonhead
Fountain Grass (spp.)
Gaillardia
Gay Feather
Hollyhocks
Hosta
Hyacinth
Iris (spp.)
Japanese Anemone
Lily of the Valley
Lobelia (spp.)
Lupin (spp.)
Shasta Daisy
Pampas Grass
Penstemon (spp.)
Peony (spp.)
Phlox (spp)
Purple Coneflower
Spider Flower
Tulip (spp.)

SHRUBS

Bridalwreath Spirea
Burning Bush
Euonymous
Golden Ninebark
Juniper (spp.)
Potentilla
Serviceberry (spp.)
Dogwood (spp.)

Large
Small
Evergreen

TREES

Cornelian Cherry
Crabapple (spp.)
European Birch
Norway Maple
Serviceberry (spp.)

Large
Small

LAWN

BENCH

Table 26. Ten-Year Maintenance & Total Life Cycle Costs, Ornamental Flowerbeds			
	Orn. Flowerbeds 220.46 m²	**Conventional Lawn 153.37 m²**	**Orn. Trees & Shrubs 132.45 m²**
Cost MAV ($/m²)	$1.99	$.50	$1.28
Annual Maintenance Costs (MAV x m²)	$438.72	$76.69	$169.54
Ten-year Maintenance Costs	**$4387.20**	**$766.90**	**$1695.40**
		Total 10 Year Maintenance Costs	**$6849.50**
		Capital Costs	**$17,329.51**
		TOTAL LIFE CYCLE COSTS, OPTION 4	**$24,179.01**

Total projected material and energy inputs are outlined in Table 27. In terms of pesticide, fertilizer, and gasoline inputs, this design option ranks amongst the top three most resource intensive options. Projected water inputs are estimated to be 560 m^3, the highest amongst the seven options. Given the predominance of exotic species, this landscape option is only of limited habitat value, though some species used in the design attract some wildlife species. However, the use of pesticides – especially insecticides – may be injurious to wildlife species that do frequent the site.

Table 27: Material Inputs / Environment Impact, Ornamental Flowerbeds								
	Orn. Flowerbeds 220.46 m²		**Conven. Lawn 153.37 m²**		**Orn. Tr. & Shb. 132.45 m²**			
Input	**MAV /m²**	**Annual Total**	**MAV /m²**	**Annual Total**	**MAV /m²**	**Annual Total**	**Annual Total**	**10-year Total**
Pesticides	3 04 gm	67 kg	5 24 gm	8 kg	6 09 gm	81 kg	**2.28 kg**	**22.8 kg**
Fertilizers	26 9 gm	5 93 kg	89 96 gm	13 8 kg	167 20 gm	22 15 kg	**41.89 kg**	**418.9 kg**
Gasoline	0	0 L	32 94 ml	5 05 L	0	0	**5.05 L**	**50.5 L**
Water	180 9 L	39 9 m³	37 20 L	5 71 m³	77 98 L	10 33 m³	**55.94 m³**	**559.4 m³**

Projected maintenance time requirements are outlined in Table 28. Not surprisingly, this is the most time-consuming of all the alternatives; only a dedicated hobby gardener would be willing to take on such a planting. Once established, this option will require approximately 163 hours to maintain each year. Over a ten-year life cycle period, it will require almost 1707 hours, equivalent to 71 days, or 213 eight-hour workdays.

Table 28: Maintenance Time Requirements, Ornamental Flowerbeds			
	Orn. Flowerbeds 220.46 m²	**Conven. Lawn 153.37 m²**	**Orn. Trees & Shrubs 132.45 m²**
Time MAV	29.22 min./m²	4.24 min./m²	20.60 min./m²
Annual Total (MAV x m²)	107.36 hrs	10.84 hrs	45.47 hrs
Ten-year Total	**1073.6 hrs**	**108.40 hrs**	**454.74 hrs**
Establish. Time (Est. time MAV x m²)	49.78 hrs	.46 hrs	19.74
Total Time, Life Cycle	**1123.39 hrs**	**108.86 hrs**	**474.44 hrs**
Total 10 Year Maintenance Time			**1706.69 hrs (71.11 days)**

5. Xeriscape

Area Coverage	
Xeriscape	= 228.72 m^2
Low-Maintenance Lawn	= 138.97 m^2
Groundcover (Meadow)	= 138.59 m^2

The xeriscape design option combines low-maintenance lawn with a broad selection of drought tolerant tree, shrub, and herbaceous species, both native and exotic. The xeriscape component of this design consists of four different planting types, including scree gardens, water-efficient ornamental plantings, and groundcovers[16]. To calculate maintenance inputs, the ground cover component of the xeriscape has been rated as meadow. Once established, it is assumed that the groundcovers require minimal maintenance and are in this manner similar to a naturalized wildflower meadow.

From an aesthetic standpoint, the xeriscape design option is visually diverse, combining flowerbeds with trees and shrubs. This design is more akin to an ornamental planting than a naturalized alternative. Other than the groundcover areas, none of the plantings are naturalized, and instead will entail the somewhat more intensive xeriscape maintenance requirements identified through the monitoring survey (which, in turn, are less intensive than for conventional ornamental plantings). From a functional standpoint, the design includes a moderately sized lawn in the backyard for outdoor activities, but offers little in the form of storage space. The density and vertical layering of the planting offers the homeowner a reasonable amount of privacy, both in the front and back yards. However, the number of shade trees is necessarily limited to ensure sufficient sunlight reaches the ground to sustain the various shade intolerant ornamentals.

The capital installation costs totaled $12,200.38, and are outlined in Table 29. Of this amount, ornamental perennials are the single most expensive expenditure, at $3600. The price also includes $465 for a gravel planting bed.

Table 29: Capital Installation Costs, Xeriscape

ITEM	QUANTITY	UNIT COST	TOTAL COST
1. Low-Main. Lawn	138.97 m^2	$4.90 / m^2	$680.95
2. Trees (deciduous), 45 mm	2	$240.00 / tree	$480.00
3. Trees (deciduous), 250 cm	4	$85.00 / tree	$340.00
4. Evergreen trees	3	$230.00 / tree	$690.00
5. Shrubs, 100 cm	10	$35.00 / shrub	$350.00
6. Shrubs, 50 cm	32	$17.50 / shrub	$560.00
7. Evergreen shrubs	32	$55.00 / shrub	$1760.00
8. Woody groundcover	69.3 m^2	$19.75 / m^2	$1368.68
9. Herbaceous groundcover	69.3 m^2	$27.50 / m^2	$1905.75
10 Ornamental perennials (includes some native sp	60 m^2	$60 00 / m^2	$3600 00
11. Gravel for scree gardens	15.5 m^3	$30 / m^2	$465.00
		TOTAL	$12,200.38

Ten-year maintenance and total life cycle costs are outlined in Table 30. Annual maintenance costs are projected to be $208; over a ten-year period, the total maintenance costs will thus amount to just under $2084. Combined with the projected installation costs, the total life cycle costs for the xeriscape design option will amount to $14,284.

Figure 28: Landscape design option # 5 – Xeriscape (with meadow and low maintenance lawn)

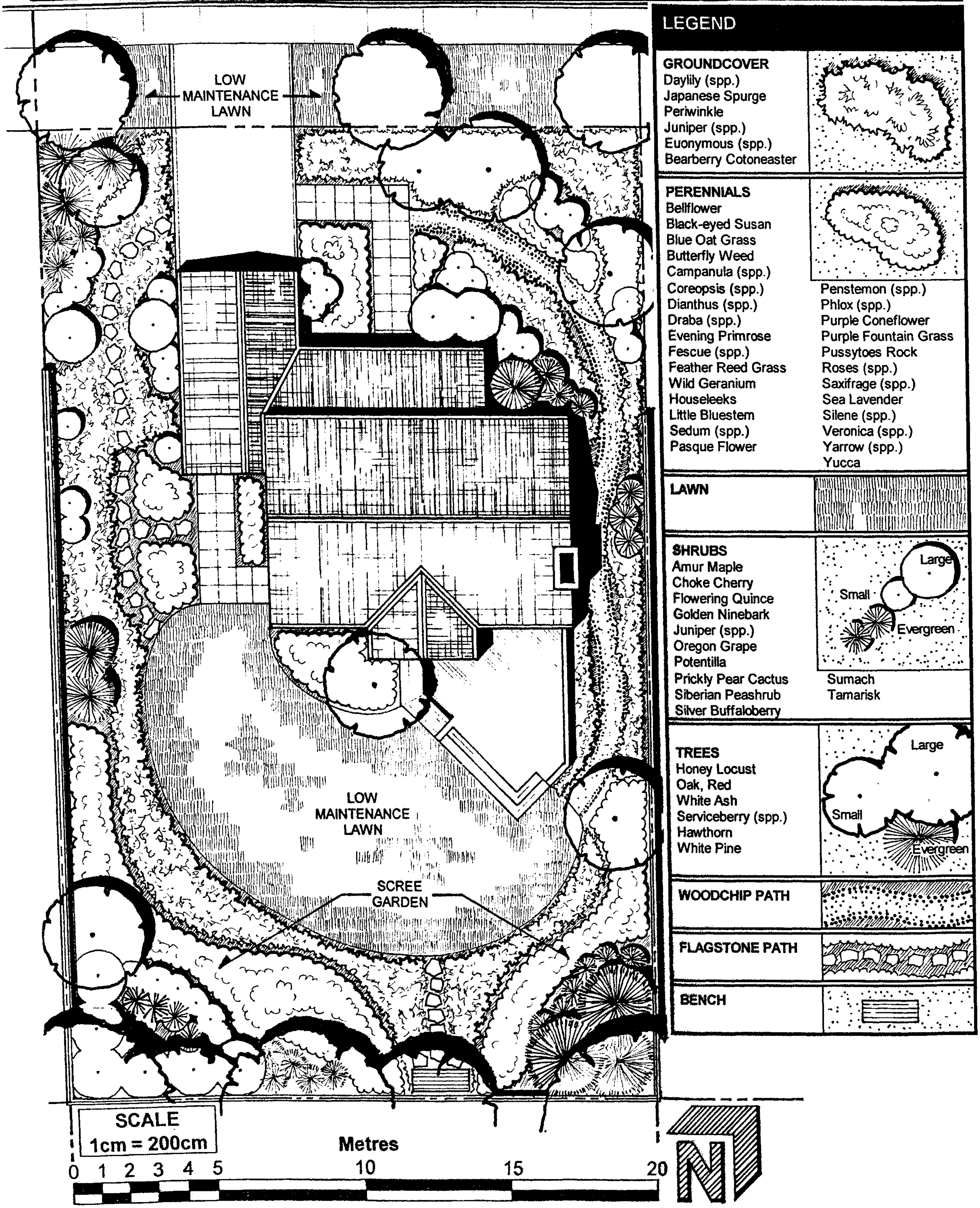


Table 30. Ten-Year Maintenance Costs and Total Life Cycle Costs, Xeriscape			
	Xeriscape 228.72 m²	**Low-Main. Lawn 138.97 m²**	**Meadow (groundcover) 138.59 m²**
Cost MAV ($/m²)	$.82	$.07	$.08
Annual Maintenance Costs (MAV x m²)	$187.55	$9.73	$11.09
Ten-year Maintenance Costs	**$1875.50**	**$97.30**	**$110.90**
		Total 10 Year Maintenance Costs	**$2083.70**
		Capital Costs	$12,200.38
		TOTAL LIFE CYCLE COSTS	**$14,284.18**

Total projected pesticide, fertilizer, fuel and water inputs are outlined in Table 31. In terms of these four key environmental indicators, the xeriscape design option ranks amongst the top two or three least consumptive design options.

Table 31: Material Inputs / Environment Impact, Xeriscape								
	Xeriscape 228.72 m²		**Low-Main. Lawn 138.97 m²**		**Meadow (groundcover) 138.59 m²**			
Input	**MAV /m²**	**Annual Total**	**MAV /m²**	**Annual Total**	**MAV /m²**	**Annual Total**	**Annual Total**	**10-year Total**
Pesticides	75 gm	17 kg	0	0	21 gm	03 kg	**.2 kg**	**2 kg**
Fertilizers	17 gm	3 89 kg	13 8 gm	1 9 kg	0	0	**5.79 kg**	**57.9 kg**
Gasoline	0 ml	0 L	17 4 ml	2 42 L	17 0	0	**2.42 L**	**24.2 L**
Water	7 29 L	1 67 m³	0	0	12 25 L	1 7 m³	**3.37 m³**	**33.7 m³**

Finally, projected maintenance time requirements are outlined in Table 32. Once established, the xeriscape design option will require approximately 86 hours per year to maintain. Total life cycle time inputs are projected to be approximately 905 hours, equivalent to 38 days, or 114 eight-hour workdays.

Table 32: Maintenance Time Requirements, Xeriscape			
	Xeriscape 228.72 m²	**Low-Main. Lawn 138.97 m²**	**Meadow (groundcover) 138.59 m²**
Time MAV	18.47 min./m²	2.1 min./m²	4.88 min./m²
Annual Total (MAV x m²)	70.40 hrs	4.86 hrs	11.27 hrs
Ten-year Total	**704 hrs**	**48.60 hrs**	**112.7 hrs**
Establish. Time (Est. time MAV x m²)	29.23hrs	.44hrs	10.39 hrs
Total Time, Life Cycle	**733.23 hrs**	**49.04hrs**	**123.09 hrs**
		Total 10 Year Maintenance Time	**905.36 hrs (38 days)**

6. Naturalized Wildflower Meadow

Area Coverage:	
Meadow	- 242.21 m^2
Woodland	- 125.71 m^2
Low-Maintenance Lawn	- 138.36 m^2

The naturalized wildflower meadow option combines native grass and wildflower plantings with several small woodland patches and a low-maintenance lawn. The naturalized wildflower meadow areas consist of a wide range of drought-tolerant species typically associated with southern Ontario's tall grass prairie communities. Four distinct woodland patches are intended as vertical accents to the otherwise low-lying meadow zones. The naturalized woodland areas incorporate some groundflora plantings, helping to weave the treed areas with the meadows. The low-maintenance lawn encompasses a small area in the backyard, including a footpath through the meadow, as well as the easement in the front yard.

Aesthetically, the design is informal and naturalistic. The meadows, once fully established, will generate generous floral displays through all the seasons. From a functional standpoint, this option offers only minimal open lawn area for outdoor activities and storage. However, The woodland plantings do offer some privacy along key sightlines on both sides of the house. Given the need for full sunlight to sustain most of the sun-loving meadow areas, this option offers little shade within the primary activity areas, though the bench is situated within the shade of the large trees on the adjacent property.

Installation costs total $12,302.82, and are outlined in Table 33. Half of the meadow portion of option 6 is planted with a combination of 2 year-old plants and 6-week seedlings while the other half is seeded. Woodland wildflowers are all planted (none seeded). The installation includes a combination of both mature and seedling trees and shrubs.

Table 33: Capital Installation Costs, Naturalized Wildflower Meadow

ITEM	QUANTITY	UNIT COST	TOTAL COST
1. Low-Main. Lawn	138.36 m^2	$4.90 / m^2	$677.96
2. Trees (deciduous), 45 mm	2	$240.00 / tree	$480.00
3. Trees (deciduous), 250 cm	13	$85.00 / tree	$1105.00
4. Trees (deciduous), seedling	15	$15.00 / tree	$225.00
5. Evergreen trees	2	$225.00 / tree	$450.00
4. Shrubs, 100 cm	17	$35.00 / shrub	$595.00
5. Shrubs, 50 cm	39	$17.50 / shrub	$682.50
6. Shrubs, seedling	15	$7.50	$112.50
7. Evergreen shrubs	8	$55.00 / shrub	$440.00
8. Woodland wildflowers	10 m^2	$54.56 / m^2	$545.60
9 Meadow			
Plantings	121 11 m^2	$51 56 / m^2	$6244 43
Seed	121.11 m^2	$6.15 / m^2	$744.83
		TOTAL	**$12,302.82**

The ten-year maintenance costs, shown in Table 34, are estimated to be $630.10, the lowest of any design option. The resulting ten-year life cycle cost for Option 6 is $12,932.92.

Figure 29: Landscape design option # 6 –Nat. Wildflower Meadow (with low maintenance lawn and woodland)

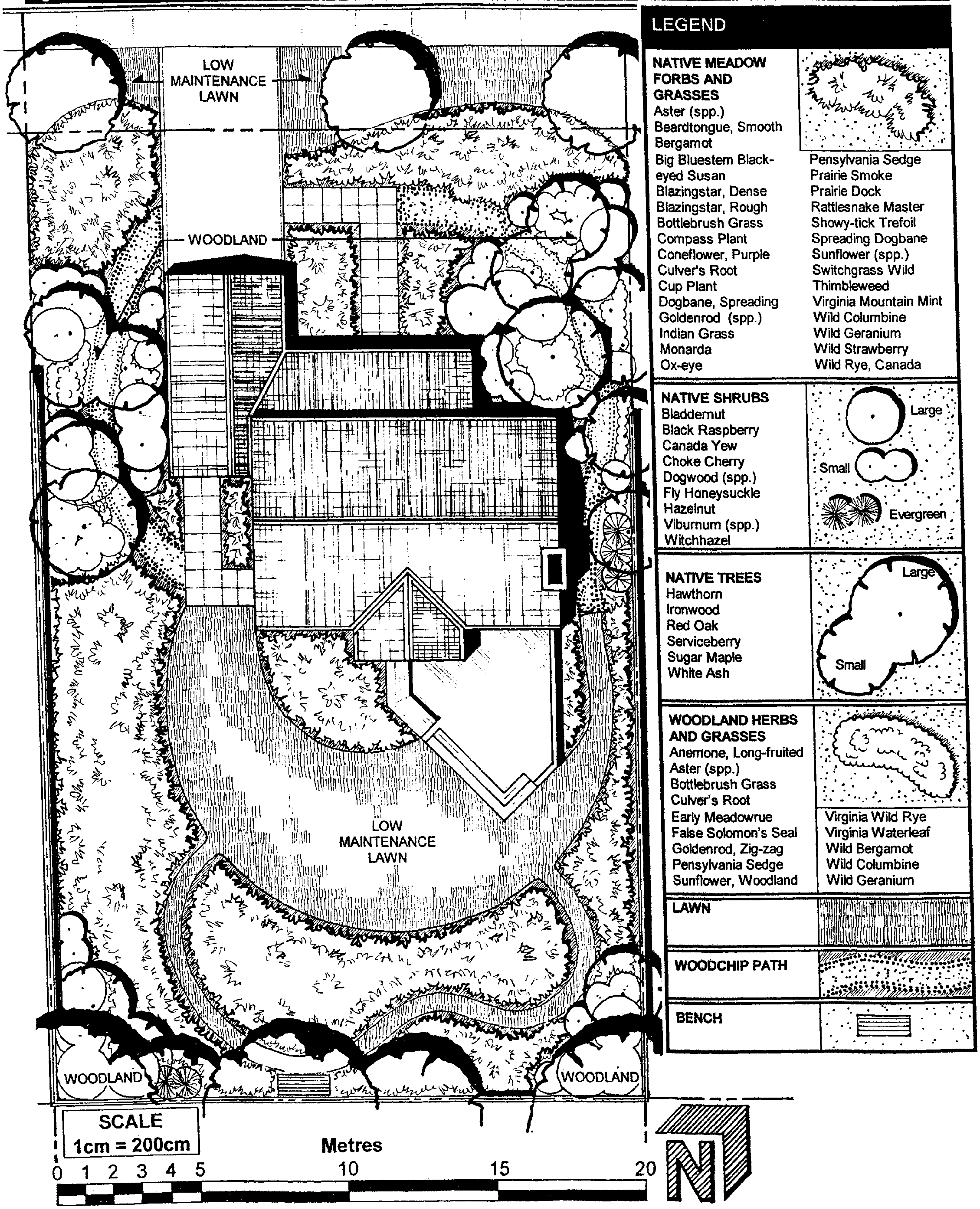


Table 34: Ten-Year Maintenance & Total Life Cycle Costs, Naturalized Wildflower Meadow

	Meadow 242.21 m^2	Woodland 125.71 m^2	Low-Main. Lawn 138.36 m^2
Cost MAV (\$/m^2)	\$.08	\$.27	\$.07
Annual Maintenance Costs (MAV x m^2)	\$19.38	\$33.94	\$9.69
Ten-year Maintenance Costs	**\$193.80**	**\$339.40**	**\$96.90**
		Total 10 Year Maintenance Costs	**\$630.10**
		Capital Costs	\$12,302.82
		TOTAL LIFE CYCLE COSTS	**\$12,932.92**

The total projected material inputs pertaining to potential environmental impacts are outlined in Table 35, and are amongst the lowest of all seven design options. The meadow option will be highly effective as wildlife habitat. Its diverse mix of native grass and wildflower species will provide an important food source for various songbirds, butterflies, and other beneficial wildlife, while the woodland pockets will offer nesting areas and shelter from predators. The dense ground cover vegetation will also help enhance local hydrological cycles, by promoting on-site retention and infiltration of precipitation.

Table 35: Material Inputs / Environment Impact, Naturalized Wildflower Meadow

	Meadow 242.21 m^2		Woodland 125.71 m^2		Low-Main. Lawn 138.36 m^2			
Input	**MAV /m^2**	**Annual Total**	**MAV /m^2**	**Annual Total**	**MAV /m^2**	**Annual Total**	**Annual Total**	**10-year Total**
Pesticides	21 gm	051 kg	01 gm	001 kg	0 gm	0 kg	**.052 kg**	**.52 kg**
Fertilizers	0	0	0	0	13 8 gm	1 91 kg	**1.91 kg**	**19.1 kg**
Gasoline	1 41 ml	34 L	0	0	17 4 ml	2 4 L	**2.74 L**	**27.4 L**
Water	12 25 L	2 97 m^3	29 97 L	3 77 m^3	0	0	**6.74 m^3**	**67.4 m^3**

Projected maintenance time inputs are outlined in Table 36. Annual maintenance requirements are projected to be approximately 36 hours. Over its ten-year life cycle period, it will require at total of just over 390 hrs, equivalent to 16 days, or 48 eight-hour workdays. This represents the lowest time requirement of any of the seven design options.

Table 36: Maintenance Time Requirements, Naturalized Wildflower Meadow

	Meadow 242.21 m^2	Woodland 125.71 m^2	Low-Main. Lawn 138.36 m^2
Time MAV	4.88 min./m^2	5.53 min./m^2	2.1 min./m^2
Annual Total (MAV x m^2)	19.70 hrs	11.59 hrs	4.84 hrs
Ten-year Total	**197 hrs**	**115.9 hrs**	**48.4 hrs**
Establish. Time (Est. time MAV x m^2)	18 17 hrs	9 81 hrs	44 hr
Total Time, Life Cycle	**215.17**	**125.71**	**48.84**
		Total 10 Year Maintenance Time	**389.72 hrs (16 days)**

7. Ornamental Trees and Shrubs

Area Coverage:	
Ornamental Trees & Shrubs	- 236.66 m^2
Conventional Lawn	- 150.48 m^2
Ornamental Flowerbeds	- 44.83 m^2
Woody Groundcover	- 74.33 m^2

In this design option, ornamental trees and shrubs are the primary landscape feature, complemented by conventional lawn and some limited ornamental flowerbeds. The planting design emphasizes exotic ornamental species, though a small number of native species are also incorporated. Some of the more specialized shrub species, including various roses and azaleas, contribute to this design's high maintenance requirements. Unlike the naturalized woodland option, the growth and spread of the plants is rigorously controlled through regular pruning and trimming, in order to maintain desired plant forms and arrangements. As well, no herbaceous understory plantings are included in the design, relying instead on a combination of woody groundcovers and mulch. For the purposes of this analysis, these have been rated as equivalent to naturalized meadow. Many of the row plantings are intended as hedges, while many of the specimen plants are to be regularly pruned to maintain their desired form. Consequently, this design option, like the flowerbed option, is demanding of both maintenance time and resources.

In terms of aesthetics, this option is formal in appearance, defined by a strong spatial geometry. The diversity of species, leaf textures, and forms will lend the design a great deal of visual interest. Where possible, plantings have been layered to create a tapering effect, with shorter plants positioned ahead of taller plants. The large number of evergreens will ensure some amount of visual interest through all seasons, including winter.

From a functional standpoint, this design offers only limited outdoor gathering and storage space. It generates a fair amount of privacy in both the front and backyards, and offers substantial shade, particularly adjacent to the bench and seating areas. Canopied pathways along both sides of the house ensure an effective transition from the front to the rear of the property.

Installation costs total $11,648, and are outlined in Table 37. Ten-year maintenance and total life cycle costs are shown in Table 38, and are projected to be $4733. The resulting life cycle cost is thus projected to be approximately $16,382.

Table 37: Capital Installation Costs, Ornamental Trees and Shrubs

ITEM	QUANTITY	UNIT COST	TOTAL COST
1. Conventional Lawn (Sod)	150.48 m^2	$6.50	$978.12
2. Trees, 45 mm	3	$240.00	$720.00
3. Trees, 250 cm	6	$85.00	$510.00
4. Trees, seedlings	12	15.00	$180.00
5. Evergreen trees	4	$225.00	$900.00
6. Shrubs, 100 cm	25	$35.00	$875.00
7. Shrubs, 50 cm	60	$17.50	$1050.00
8. Shrubs, seedling	25	$7.50	$187.50
8. Evergreen shrubs	38	$55.00	$2090.00
9. Woody groundcover	74.33 m^2	$19.75	$1468.00
10. Ornamental perennial flowerbeds	44.83 m^2	$60.00 / m^2	$2689.80
		TOTAL	**$11,648.42**

Figure 30: Landscape design option # 7 – Ornamental Trees and Shrubs (with convent. lawn & orn. flowerbeds)

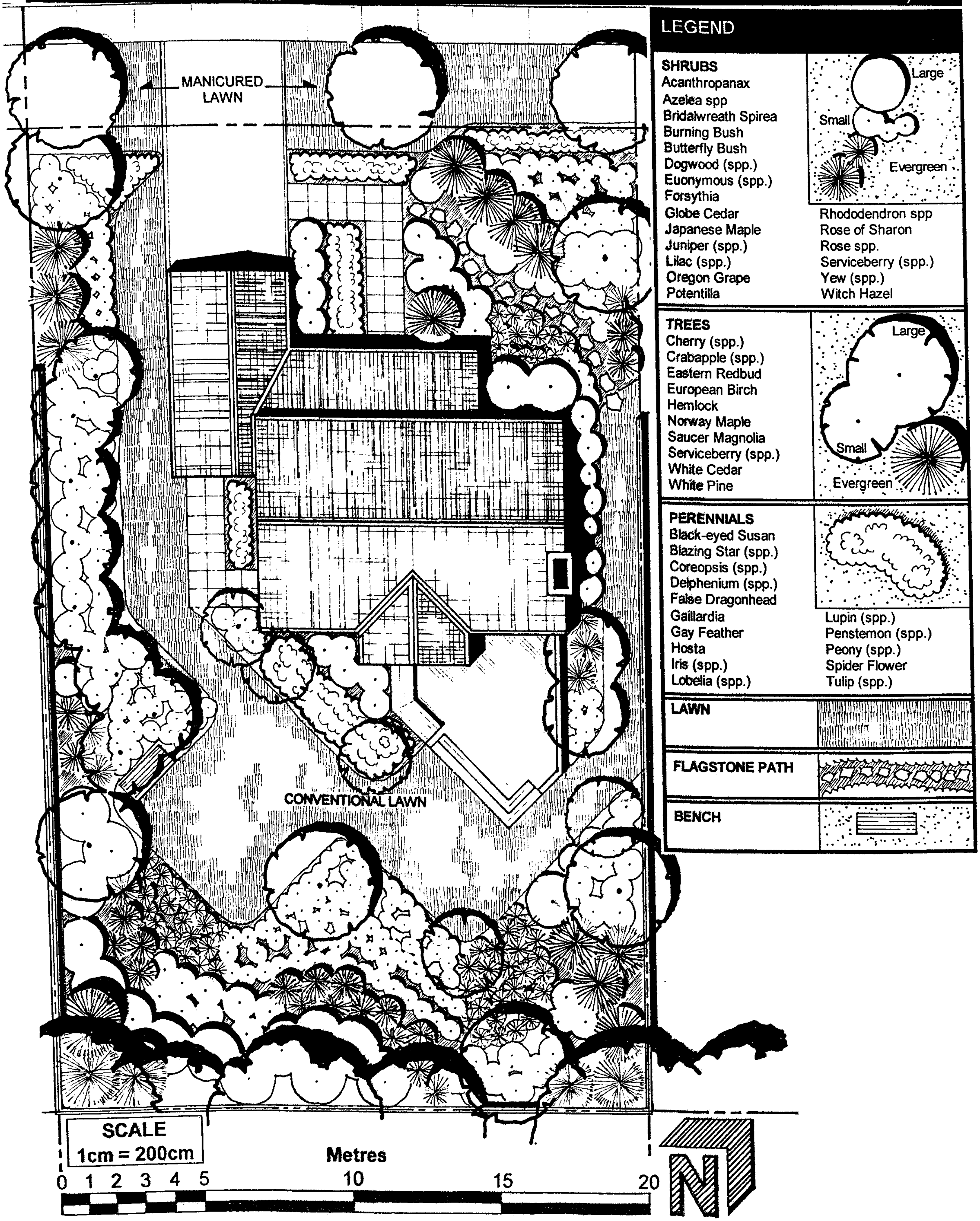


Table 38: Ten-Year Maintenance Costs and Total Life Cycle Costs, Ornamental Trees and Shrubs				
	Trees & Shrub 236.66 m²	**Conven. Lawn 150.48 m²**	**Flowerbeds 44.83 m²**	**Groundcover (rated as meadow) 74.33 m²**
Cost MAV ($/m²)	$1.28	$.50	$1.99	$.08
Annual Maintenance Costs (MAV x m²)	$302 92	$75 24	$89 21	$5 95
Ten-year Maintenance Costs	**$3029.20**	**$752.40**	**$892.10**	**$59.50**
			Total 10 Year Maintenance Costs	**$4733.20**
			Capital Costs	$11,648.42
			TOTAL LIFE CYCLE COSTS	**$16,381.62**

Total projected inputs are outlined in Table 39. In terms of all four input categories, the ornamental tree and shrub option is amongst the most consumptive of all the design options. In terms of environmental benefits, this option has the potential to provide some habitat in terms of both shelter, and to a lesser extent, food supplies generated by the native selections. However, such benefits are likely to be counteracted by the use of pesticides, especially insecticides, which can harm wildlife. Some of the exotic species used in the design, including Norway maple and European birch, are highly invasive and may eventually spread into the adjacent natural area.

Table 39. Material Inputs / Environment Impact, Ornamental Trees and Shrubs										
	Tr. & Shb. 236.66 m²		**Conven. Lawn 150.48 m²**		**Flowerbeds 44.83 m²**		**Groundcover 74.33 m²**			
Input	MAV /m²	Annual Total	MAV /m²	Annual Total	MAV /m²	Annual Total	MAV /m²	Annua l Total	**Annual Total**	**10-year Total**
Pesticides	6 09 gm	1 44 kg	5 24 gm	79 kg	3 04 gm	14 kg	21 gm	02 kg	**2.39 kg**	**23.9 kg**
Fertilizers	167 2 gm	39 57 kg	89 96 gm	13 54 kg	26 9 gm	1 21 kg	0	0	**54.32 kg**	**543.2 kg**
Gasoline	0	0	32 94 ml	4 96 L	0	0	0	0	**4.96 L**	**49.6 L**
Water	77 98 L	18 45 m³	37 20 L	5 6 m³	180 9 L	8 11 m³	12 25	91 m²	**33.07 m³**	**330.7 m³**

Projected maintenance time requirements are outlined in Table 40. Once established, this design will annually demand approximately 120 hours in maintenance time, and in this respect is second only to the flowerbed option. Over the ten-year life cycle period, the total projected time inputs are 1249 hrs, equivalent to 52 days, or 156 eight-hour workdays.

Table 40: Maintenance Time Requirements, Ornamental Trees and Shrubs				
	Trees & Shrub 236.66 m²	**Conven. Lawn 150.48 m²**	**Flowerbeds 44.83 m²**	**Groundcover 74.33 m²**
Time MAV	20.60 min./m²	4.24 min./m²	29.22 min./m²	4.88 min./m²
Annual Total (MAV x m²)	81.25 hrs	10.63 hrs	21.83 hrs	6.04 hrs
Ten-year Total	**812.5 hrs**	**106.3 hrs**	**218.3 hrs**	**60.4 hrs**
Establishment Time (Establ. time MAV x m²)	35 26 hrs	45 hr	10 12 hrs	5 57 hrs
Total Time, Life Cycle	**847.76**	**106.75**	**228.42**	**65.97**
			Total 10 Year Maintenance Time	**1248.94 hrs (52 days)**

[1] A typical life cycle analysis measures and assesses the total environmental impact (i.e., solid and energy waste generation, air and water emissions, etc.) of a given product through its entire lifetime, from "cradle to grave". It considers all impacts arising from obtaining and transporting raw materials (for instance, mining or logging), manufacturing processes, retail operations, the product's use in the home, and its eventual disposal. In this respect, an analysis can obviously be a highly complex endeavour, and has been most commonly used to compare the environmental impacts associated with individual products such as paper and Styrofoam cups, cloth and disposable diapers, or plastic and paper shopping bags.

[2] In this way, a life cycle analysis can help consumers choose from various product alternatives, by comparing their costs over a given period of time. For example, the purchase price for an energy-efficient light bulb or furnace may be significantly higher than for a conventional model. However, a life cycle cost analysis is likely to reveal that the energy savings accrued over the product's projected life span will result in a lower total cost to the consumer.

[3] For many homeowners, aesthetics and function are obviously two other important considerations. However, neither has been directly factored into the analysis equation, though they are discussed in general terms as part of the description and analysis of each landscape option. Notions of landscape aesthetics and beauty are highly subjective, and can vary widely from one person to the next. However, each option has been designed to maximize the aesthetic potential and qualities associated with a given landscape type. Landscape function is also a subjective quality, one entirely dependent on the homeowners specific landscape requirements. For the sake of consistency, all of the designs reflect similar functional criteria.

[4] This reflects the fact that a typical residential landscape is not likely to consist exclusively of just one type. As a rule, alternative landscape types were typically combined together, as were the conventional types. In reality, a homeowner could choose to combine both conventional and alternative landscape types.

[5] In actual fact, it is not unusual for homeowners with alternative landscapes to extend their gardens into the street easement.

[6] A 1992 Statistics Canada (Che-Alford, 1992) study reported that on average, half of all Canadian adults (including both renters and homeowners) move over a 5 year period, while two thirds move once over a 10 year period.

[7] Unit prices were derived from the author's own record of cost calculations used for estimates on residential design and construction projects. Obviously, different contractors may offer different unit prices. As a rule of thumb, unit prices generally reflect the wholesale cost of materials and equipment, multiplied by a 2.5 (to account for labour, delivery, warranty, clean-up, overhead, and other ancillary costs). All unit costs are reasonably compatible with unit prices outlined in *Hanscomb's Yardsticks for Costing· Cost Data for the Canadian Construction I*ndustry (Ferguson, 1998). Unless otherwise noted, unit prices for woody plant material are based on bareroot stock. Homeowners are responsible for post-installation maintenance activities, such as watering and weeding, and were not factored in these unit costs. The wholesale costs of plant material prices reflect current rates offered by commercial Southern Ontario nurseries, and may vary from one region to the next. The costs of native plant stock, in particular, may be significantly higher in regions of the country where they are not as readily available.

[8] Inflation has not been factored into the cost MAV's over the ten-year period. All projected maintenance costs are set at 1999 rates, as are the capital installation expenditures.

[9] No time inputs have been calculated to install the design options, since it is assumed that a landscape contractor will undertake the work.

[10] Time values based on the author's landscape maintenance experience.

[11] Balled and burlapped and container grown trees generally take up to 2 years to become well established, whereas shrubs can generally be established within a single year; 1.5 years represents an average of these two values.

[12] Seeded meadows and prairies generally take up three or more years to become fully established, whereas planted meadows generally take no more than two years. Since it is assumed that a combination of both seed and plants will be used to install the meadow landscapes, a mean value of 2.5 was used.

[13] Woodland plantings will generally become established within 2 to 2.5 years, and are not likely to require supplemental water inputs beyond that time. However, until canopy closure is achieved (3-5 years depending on the size and density of plantings), some on-going weeding may be required. The 3 year establishment phase represents a rough average of these time values.

[14] This price is based on the use of larger plant stock; the use of tree and shrub seedlings could have further reduced installation costs. However, it was assumed that most homeowners, on a small scale planting such as this, would prefer to use mature stock for a more immediate effect.

[15] Costs may be significantly reduced by planting more seedlings and fewer mature trees. However, this will extend the canopy closure to five or more years, depending on the spacing and size of the plant stock, and will result in a longer establishment maintenance period. As well, the planting of shade dependent groundflora species in the understorey will be delayed until there is sufficient shade.

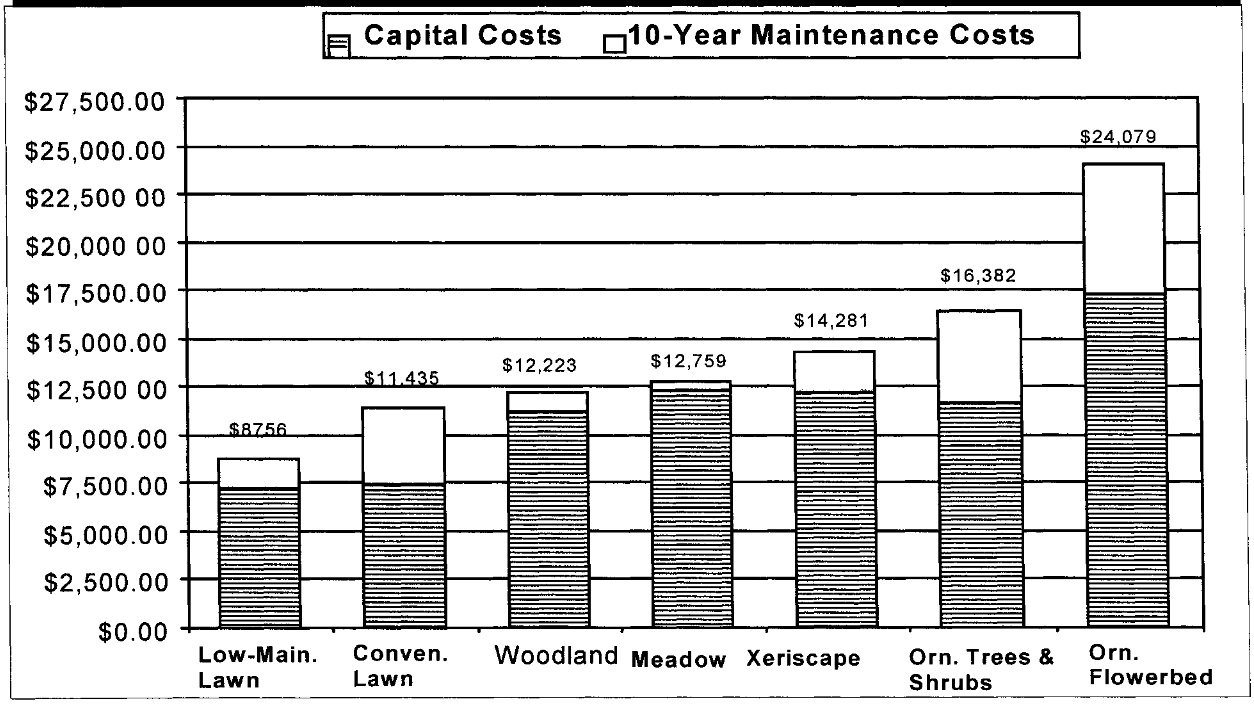
[16] As discussed in Chapter 2, scree gardens consist primarily of herbaceous perennials planted into a rapidly drained raised gravel bed. Water efficient plantings refer to conventional planting beds planted with drought-tolerant ornamental perennial, tree, and shrub species. Finally, groundcovers refer to low, spreading herbaceous and/or woody plantings, and are selected primarily for their low-maintenance and drought tolerance.

[17] Although meadow MAV's are used to calculate inputs for groundcover, no annual mowing is required. Therefore, no fuel data was inserted.

6.1. Capital and Total Life-cycle Costs

Capital and total life-cycle costs for the seven different planting options described in this chapter are depicted in Figure 5.1.

Figure 31: Total Life-cycle Costs: Seven design options



In terms of estimated capital costs, two of the design options came in just below $7500: low-maintenance lawn and conventional lawn. Two of the options were valued under $12,000: naturalized woodland and ornamental trees and shrubs. The xeriscape and meadow options were estimated to be just over $12,000. Not surprisingly, the most expensive installation of the seven designs is the ornamental flowerbed option.

With respect to 10-year life-cycle maintenance costs, the four options emphasizing the alternative landscape types – naturalized meadow, naturalized woodland, low-maintenance lawn, and xeriscape – are estimated to be least expensive to maintain. The most expensive to maintain were the conventional options: the conventional lawn, the ornamental tree and shrub, and the ornamental flowerbed options.

Total life-cycle costs were determined by adding the capital cost estimates and 10-year maintenance costs. By a wide margin, the least expensive of the seven design options is deemed to be the low-maintenance lawn. The conventional lawn option is the second least expensive option, followed by the naturalized woodland and meadow options. At the opposite end of the spectrum, the flowerbed option was estimated to be the most expensive option, followed by the ornamental tree and shrub option

For many people, one of the most surprising results in this cost analysis will be the conventional lawn option's ranking as the second least expensive of the seven designs. While its 10-year maintenance costs significantly exceed those of the four alternative landscapes, the installation costs were much lower, resulting in a lower life cycle cost. This finding is to some extent due to the type and size of plant stock used in the installation. As previously noted, the size of plant material and the use of seed over plants can have a dramatic impact on overall installation costs, which in turn have a direct influence on life-cycle costs. In the case of the xeriscape, meadow, and woodland, significant amounts of mature plant stock were used. If cost-effectiveness is a criteria of major concern, homeowners should consider using seed and seedling stock to install alternative landscapes. While it takes longer for the landscape to become established, the savings can be substantial.

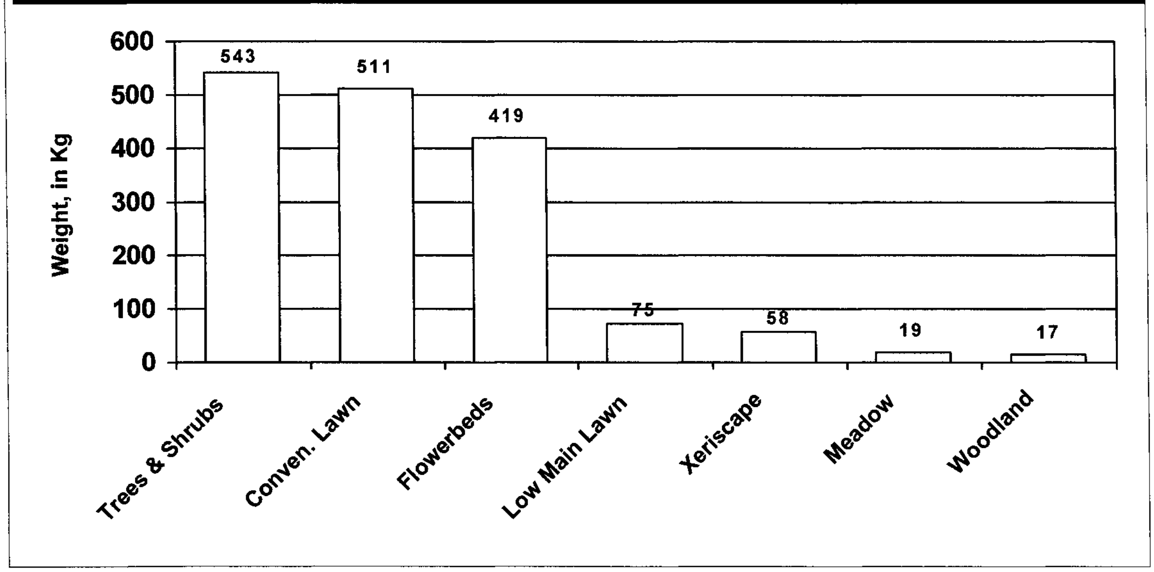
6.2. Material and Energy Inputs / Environmental Impacts

The life cycle analysis revealed that the three conventional design options would receive the heaviest pesticide, fertilizer, fuel, and water inputs (see Figures 5.2 to 5.5 below). Consequently, the maintenance inputs associated with these three options are the most likely to result in some form of environmental impact. Results would have been somewhat different had conventional landscape types been combined with the less resource intensive alternatives. This might be a viable option for a homeowner who prefers a conventionally manicured lawn, for instance, but would prefer to reduce (but not completely eliminate) potentially harmful inputs by choosing naturalized meadow or xeriscape over flowerbeds, or naturalized woodland over ornamental trees and shrubs. Sometimes, change can happen in small steps.

Pesticides

Based on the survey, the 10-year pesticide use is estimated to be the highest for the conventional lawn design option, at well over twenty times that of the low-maintenance lawn option. Estimated pesticide use for the ornamental tree and shrub design option far exceeds the amount estimated for the naturalized woodland option. In a similar vein, pesticides used on the flowerbed landscape option is over ten times that used on the xeriscape option, and almost 50 times that used on the naturalized meadow.

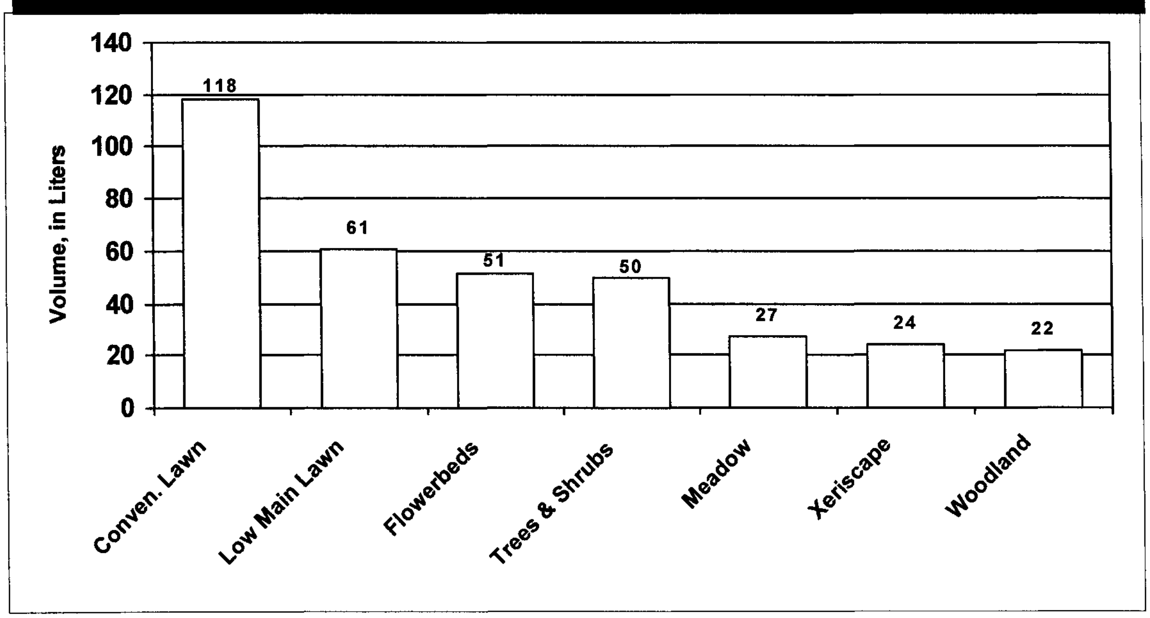
Figure 32: Total Ten-year Pesticide Use



Gasoline

Total gasoline consumption is primarily a function of a) the amount of lawn incorporated into each design option, and b) whether it is a conventional or low-maintenance lawn. Fuel consumption was highest for to the conventional lawn option, followed by the low-maintenance lawn option. The estimated fuel consumption to maintain the ornamental flowerbed and ornamental tree and shrub options, which both incorporated small conventional lawns, was significantly lower. The meadow, xeriscape, and woodland design options, which all included small low-maintenance lawn areas, had the lowest gasoline use. Again, electricity use in the study was negligible.

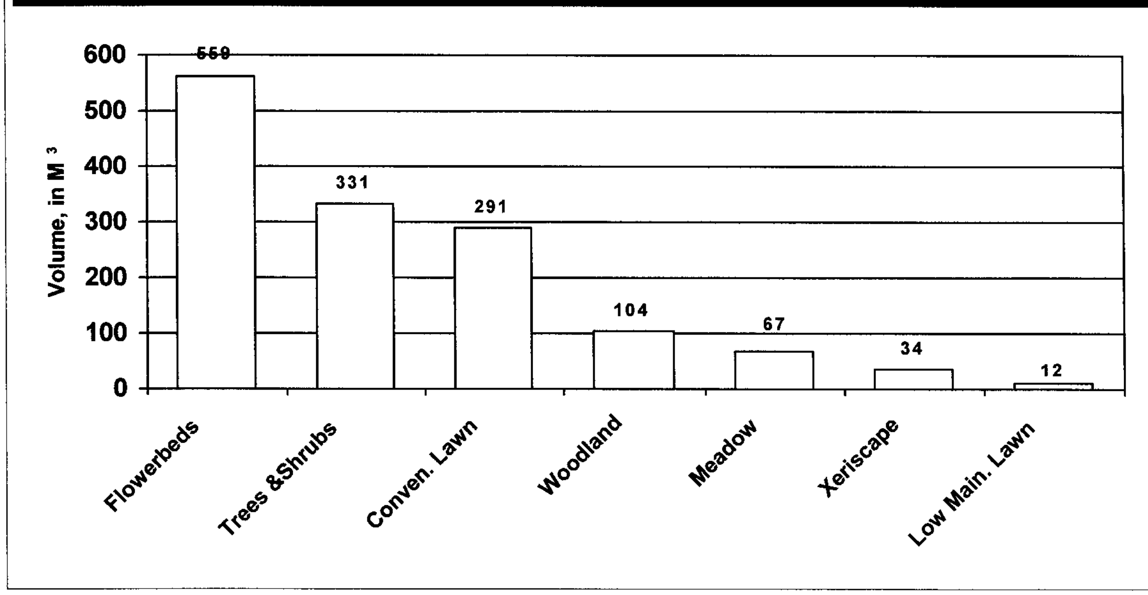
Figure 33: Total Ten-year Gasoline Use



Water

The lowest water-user is associated with the low-maintenance lawn option. At the opposite end of the spectrum, the flowerbed option is projected to consume the most water over a ten-year period, over eight times the water requirements for the meadow option and 17 times that of the xeriscape option. The ornamental tree and shrub option is estimated to require over three times the volume required to maintain the woodland option. Finally, the conventional lawn design would require over 22 times the amount used on the low-maintenance lawn option.

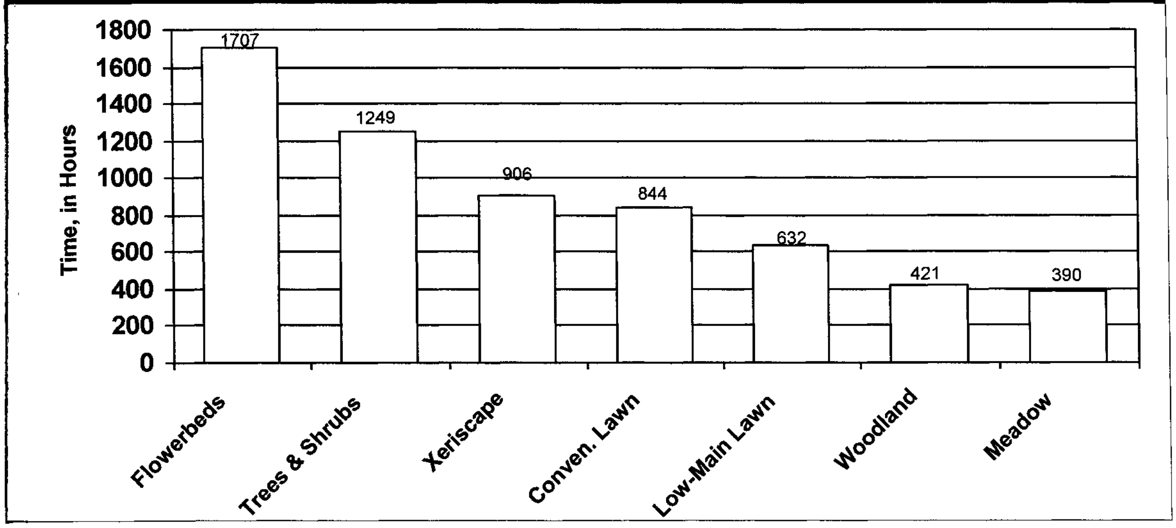
Figure 34: Total Ten-year Water Use



6.3. Maintenance Time Requirements

Maintenance time requirements were generally highest for the conventional landscape options, and lowest for those involving alternative landscape types. The most time-consuming was the ornamental flowerbed option. Conversely, the naturalized meadow option would require the least amount of time. The ornamental tree and shrub option would require almost 3 times more hours over a 10-year period to maintain than the naturalized woodland. The xeriscape option was the third most time-consuming option. The two lawn options fell in the middle, which is surprising given that they were the two biggest time savers identified through the monitoring survey data outlined in Chapter 3. This is due to the fact that in the design options illustrated in this Chapter, the lawn landscape types were combined with other landscape types, such as ornamental flowerbeds and trees and shrubs, which are more labour intensive than the lawns.

Figure 35: Total Ten-year Time Inputs



6.4 All About Choices

Choosing the right garden means making trade-offs. The most important thing for the individual homeowner may be saving time or protecting the environment or achieving a certain look. What really matters is making an informed choice. Readers can weigh the various options described here and decide what works best for them:

- **Time**: For saving time, the best designs were those that featured wildflower meadows, woodland shade gardens and lawns. Prior to combining the landscape types in the seven hypothetical designs, the results of our survey showed that lawns were the most time-efficient, with low-maintenance lawns being the biggest time saver. But since lawns are usually found in combination with other landscape types, combining them with alternatives such as wildflower meadows and woodland shade gardens, as opposed to ornamental flowerbeds and trees and shrubs, is a good way to save time.
- **Costs**: The lowest capital and 10-year maintenance costs were realized in the lawn options, the lowest being associated with the low-maintenance lawn. Woodland shade gardens, wildflower meadows and xeriscapes followed as the least costly over a 10-year period.
- **Environment**: For reducing gasoline, water, pesticides and fertilizers, the alternative options were the least consumptive. This includes the woodland shade garden, wildflower meadow, low-maintenance lawn and xeriscape options.
- The woodland shade garden and wildflower meadow were the best options for attracting wildlife, protecting bio-diversity, and minimizing the spread of invasive exotics. To protect local hydrological cycles and contribute to improved air quality in your region, the woodland, wildflower, xeriscape, tree and shrub and flowerbed options are the best.

Function and aesthetics are key considerations when choosing landscape options. Of course the choice is highly subjective. Many homeowners prefer a manicured look with trimmed, consistent lawns, pruned shrubs and trees and a scattering of ornamental flowers. Lawns offer recreation opportunities particularly attractive to families with children. This type of landscape is the convention; although many homeowners associate it with matters of civic pride, others default to it simply because they are not aware of the alternatives. Others prefer the more natural aesthetic offered by woodland shade gardens and wildflower meadows. They like shady, private nooks and the songbirds and butterflies these gardens attract.

If homeowners wish to balance their aesthetic preferences with time and cost savings and a reduction in potentially harmful inputs, they may want to consider the alternative landscape options. For example, if they want floral displays, but also want to save time, money and protect the environment, they could consider wildflower meadows or xeriscapes. If they want a lush, shady garden that's also time-efficient and eco-friendly, they could consider a woodland shade garden. If they want the passive play opportunities that lawns offer, but want to maximize time, cost and resource-efficiency, low-maintenance lawns are an excellent alternative.

The analysis indicates there are few, if any, cost/benefit tradeoffs associated with the alternative landscape options. Over the ten-year life-cycle period, low-maintenance lawn, meadow, woodland, and xeriscape all proved to be amongst the least expensive of the seven options. As previously noted, costs could have been further reduced through the use of seed and seedlings, while employing less mature stock. While this would help reduce costs, it would conversely also prolong the establishment period. Mature plant stock installations cost a great deal more, but generate more immediate results.

All of the alternative landscape options are friendlier to the environment in two ways. First, they generally require only a fraction of the potentially harmful pesticide, fertilizer, and fuel inputs associated with the conventional options, and consumed a great deal less water. Secondly, the naturalized native meadow and woodland options - and to a lesser extent, the xeriscape - also have the added benefit of providing wildlife habitat. Certainly, the habitat value of the ornamental flowerbed and ornamental tree and shrub options could be enhanced through the use of native plants.

No doubt, there will always be homeowners – perhaps even a majority of them – who prefer manicured lawns and ornamental gardens. This is understandable - not everyone will want to surround their home with woodland or meadow (or even a xeriscape). Many like the simplicity of an open lawn accented by a flowerbeds, shade trees, and shrub beds and their ability to withstand foot-traffic and play. For these homeowners, a low-maintenance lawn is a viable, cost-effective alternative to the conventional lawn. If a manicured aesthetic is important, then alternative, environmentally friendly maintenance approaches, such integrated pest management, use of native species and organic lawn and ornamental garden care, could be adopted to reduce or eliminate their reliance on potentially harmful chemical pesticides and fertilizers.

Ultimately the decision is up to the individual. The purpose of this study is to provide readers with information to enable them to make an informed choice about which landscape options work best.

Recommended Future Research

Landscape maintenance requirements vary widely from one garden to the next. The amounts of water, time and other inputs depend on climate, soil type, aesthetic standards and so on. The results of this study are indicators, therefore, based on a sampling of typical gardens in each category. They are not absolute values. As alternatives such as xeriscapes, woodlands and wildflower meadows become more common, it may be possible in the future to study a larger sample size in each category. This would help to balance some of the variation in the study results within each category caused by factors such as soil type and aesthetic standards.

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Appendix A

A Brief History of the Lawn

Canadian homeowner's deep-seated affinity for the lawn is perhaps most aptly expressed in the naturalistic, lawn-dominated images used to sell new houses. Leaf through the "homes" section of your local paper, and you are likely to encounter dozens of advertisements depicting freehold, single family houses on expansive estate-like, lawn dominated properties bordering along natural areas, with nary a neighbouring house in sight. Notwithstanding that, in reality, the houses, when built, will likely to be tightly crowded side-by-side along suburban streets, these lawn-dominated images capture the public's imagination and sell homes.

How is it that the lawn has become so deeply ingrained in our collective psyche? Historically, this affection is rooted in the gardening traditions of seventeenth and eighteenth century Europe, most notably France and England. The precursor to the modern lawn was the formal French "parterre" typified in famed aristocratic gardens such as Versailles. These were small raised beds of cropped turfgrass shaped in intricate geometric patterns, often laid out in combination with similarly formalized tree, shrub, and flower beds. The strict formality expressed both artistic abstractions of the natural world, and a desire to domesticate and impose a human order over wild nature.

Up until the early 1700's, English estate gardeners espoused this strict formality in their garden designs. The English Romantic movement and its new concepts of nature changed all of that. The Romantics were philosophers, poets, artists, and gardeners, among others, who cultivated a radically different idea of nature. Largely as a counterpoint - and antidote - to the Industrial Revolution raging all around them, theirs' was a pastoral concept of a benevolent, healing nature existing in harmony with its human stewards. Eschewing the strict geometric order favoured by their French contemporaries, English estate landscapers undertook to create naturalistic landscapes that emulated and accentuated natural form, through the skillful use of rock, water, trees and other natural elements. The lawn, adapted from the French parterre, was central to this new aesthetic, the canvas upon which these images of nature were painted. By carpeting these "naturalistic" landscapes with lawn, it was possible to create the illusion that the estate property extended beyond its boundaries to merge seamlessly with the surrounding natural landscapes.

Perhaps the most famous of these English landscapers was Lancelot "Capability" Brown. Equipped with armies of gardeners, he (and his clients) spared no expense in converting formal estate gardens, ancient hedges, and mature tree lines into these picturesque, lawn-dominated creations. Often, the land was reshaped and contoured to accentuate natural forms and to create idealized, gently rolling landscapes. Maintaining these expansive lawns was arduous, expensive, and labour intensive work involving constant scything, brushing, sweeping and rolling to make them smooth and verdant. Ultimately, "the success of Brown's landscapes became the keystone of a revolution in aesthetics that cemented the lawn as the great icon of late eighteenth century British society" (Bormann et al., 1993).

The turfgrass species used to create these pastoral "lawnscapes" were cool-season species ideally suited to the British climate, characterized by damp, mild winters and moderate summer temperatures. This, however, did not prevent eighteenth century British colonists to the New World from importing the lawn to the much harsher and more varied climates of North America. Surrounded by infinite tracts of wild, hostile nature, the colonists clung to the Romantic visions. One of the most famous early examples of the North American lawn was Thomas Jefferson's design for the University of Virginia. The campus' most distinctive feature was a central lawn encircled by a complex of buildings - to this day, this common green is still referred to simply as "The Lawn" (Bormann et al., 1993).

Through the eighteenth and early parts of the nineteenth century, lawns were not uncommon on the estates of the rich and powerful, as a symbol of their elevated status. For the most part, these early North American lawns were confined to relatively small, easy to maintain tracts mown by hand with scythes or grazed by sheep and deer. However, the lawn, or more precisely, lawn maintenance, was beyond the economic means of the common folk.

By the middle of the nineteenth century, a number of events cleared the way for the widespread adoption of the lawn across all sectors of North American society. Chief amongst these was the invention of the mechanized lawn mower in 1830. This simple gear-driven device, precursor to the modern motorized mower, revolutionized the lawn and brought it within the reach of the average citizen by eliminating the need for intensive labour. Homeowners could now cut the lawn themselves without the expense of gardeners or shepherds and sheep. A second major event was the emergence of the City Beautiful Movement, which advocated for public lawn-dominated parks and civic gardens in cities across the continent, both for their aesthetic benefits and as a moral, healthy refuge from the pollution, disease, and unsanitary conditions of urban centres. A third major event was the advent, in the mid-nineteenth century, of the American suburb (Jackson, 1985). The suburb popularized the concept of the single-family house enrobed by swaths of lush lawns and gardens to provide a clean and healthy home environment. Virtually overnight, the lawn went from being the icon of the British elite, to the icon of democratic suburban North American life. To the new suburbanites, the lawn and its connotations of nature became a symbol of prestige and status that reflected their newly acquired wealth.

The fourth event continues to this day, in the form of the many agricultural, technological and scientific innovations that have permitted the lawn's widespread adoption across North America (and throughout the developed world), far from the hospitable, lawn-friendly climate of the British Isles. Through practices such as selective breeding and genetic engineering, turfgrass species can now more effectively withstand harsh winters and dry summers. Turfgrass science has lead to the production of synthetic chemical fertilizers to improve soil fertility, pesticides to combat weeds, diseases and insects, and complex irrigation systems to satisfy watering needs. Sod farms and sodding technologies have made it possible to create instant lawns at reasonable cost. A budding landscape industry began mass-producing these and other products to make them more affordable to the average homeowner, ensuring that by the mid-1900's the lawn was firmly rooted as the residential landscape of choice across the continent.

Appendix B

Resources

Internet Sites

The following is a selection of Internet sites consulted during the preparation of this report, as well as other sites of potential interest to readers. This limited listing is by no means comprehensive; however, all of these sites include links to other related organizations and web pages.

California Environmental Protection Agency: Department of Pesticide Regulation
http://www.cdpr.ca.gov/

Canada Saskatchewan Agricultural Green Plan Agreement: Landscaping Prairie Style
http://www.agr.ca/pfra/pub/csagft2.htm

The Chesapeake Bay Program
http://www.chesapeakebay.net/

Citizen's Guide to Pesticides and Toxic Substances
http://www.in.net/wellness/progwell/pesticid.htm

City of Kamloops
http://ipinet.city.kamloops.bc.ca/utility/watersmart/xeriscape.html

Environment Canada: The Green Lane
http://www.ec.gc.ca/envhome.html

Evergreen
http://www.evergreen.ca

EXTOXNET: The Extension Toxicology Network – Pesticide Profiles
http://ace.ace.orst.edu/info/extoxnet/ghindex.html

Health Canada, Pest Management Regulatory Agency
http://www.hc-sc.gc.ca/pmra-arla/qcont-e.html

Go For Green
http://www.goforgreen.ca

Guelph Turfgrass Institute
http://www.uoguelph.ca/GTI/

Landowner Resources Centre -Ontario
http://www.lrconline.com/inexnts.html

Michigan State University Extension Service
http://www.msue.msu.edu/#Other WWW Resources

National Parks Service – Integrated Pest Management
http://www/colostate.edu/depts/IPM/natparks/natpark.html

National Wildlife Federation: Backyard Wildife Habitat Program
http://wbu.com/alliances/bwh.htm

Naturescape British Colombia
http://www.env.gov.bc.ca/hctf/naturescape/about.htm

Northwest Coalition for Alternatives to Pesticides
http://www.pesticide.org/default.htm

Pennsylvania State University: Pesticide Information Program
http://www.pested.psu.edu/index.html

Pesticide Action Network of North America
http://www.panna.org/

Professional Lawn Care Association of America
http://www.plcaa.org/

Seattle Public Utilities - Ecologically Sound Lawn Care for the Pacific Northwest: Annotated Bibliography
http://www.ci.seattle.wa.us/util/rescons/n_bib.htm

Seattle Public Utilities: Natural Lawn Program
http://www.ci.seattle.wa.us/util/rescons/n_home1.htm

Society for Ecological Restoration
http://ser.org/

United States Environmental Protection Agency (USEPA)
http://www.epa.gov/

USEPA: Endocrine Disruptors Research Initiative
http://www.epa.gov/endocrine/

USEPA: A Sourcebook on Natural Landscaping for Public Officials
http://www.epa.gov/grtlakes/greenacres/toolkit/index.html

United States Geological Survey: Water Resources
http://water.usgs.gov/

Virginia Cooperative Extension
http://www.ext.vt.edu/resources/

The Wild Ones Handbook: A Voice for the Natural Landscaping Movement
http://www.epa.gov/greenacres/wildones/#HANDBOOK

Xeriscape Demonstration Project: Saskatchewan Irrigation Development Centre
http://aceis.agr.ca/pfra/sidcpub/sidcft13.htm

Books

The following are a few helpful resources for readers who want more information on the alternative landscapes discussed in this report.

Aboud, S. and H. Kock. (1994). *A Life Zone Approach to School Yard Naturalization*. Guelph, ON: University of Guelph Arboretum.

Austin, R.L. (1986). *Wild Gardening – Strategies and Procedures for Using Native Plants*. New York: Simon and Schuster.

Bennett, Jennifer. (1988). *Dryland Gardening: A Xeriscape Guide for Dry-Summer, Cold-Winter Climates*. Willowdale, ON: Firefly Books.

Bormann, Herbert F., Diana Balmori and Gordon T. Geballe. (1993). *Redesigning the American Lawn: A Search for Environmental Harmony*. New Haven, Conn.: Yale University Press.

Cox, Jeff. (1991). *Landscaping With Nature: Using Nature's Designs to Plan Your Yard.* Emmaus, PA: Rodale Press.

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Johnson, Lorraine. (1998). *Grow Wild! Native Plant Gardening in Canada and Northern United States.* Toronto: Random House.

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Morgan, J.P., D.R. Collicut and J.D. Thompson. (1995). *Restoring Canada's Native Prairies: A Practical Manual.* Argyle, Manitoba: Prairie Habitats.

Pettinger, April. (1996). *Native Plants in the Coastal garden: A Guide for Gardeners in British Colombia and the Pacific Northwest.* Vancouver: Whitecap.

Stein, Sara. (1993). *Noah's Garden: Restoring the Ecology of Our Back Yards*. Boston: Houghlin Mifflin.

Wasowski, Sally. (1992). *Requiem for a Lawnmower (and Other Essays on Easy Gardening With Native Plants*. Dallas: Taylor.

White, David J., Erich Haber and Cathy Keddy. (1993). *Invasive Plants of Natural Habitats in Canada*. Ottawa: Canadian Wildlife Service.

Williams, Sara.(1997). *Creating the Prairie Xeriscape: Water-efficient Gardening.* Saskatoon: University Extension Press, University of Saskatchewan.

Wilson, Jim. (1992). *Landscaping with Wildflowers: An Environmental Approach to Gardening.* New York: Houghton Mifflin.

Appendix C

Maintenance Monitoring Survey Form

Thankyou! ...

for participating in this landscape maintenance monitoring survey for the 1999 growing season The data collected through this survey will be used in a study commissioned by the Canada Mortgage and Housing Corporation (CMHC) entitled *Comparison of Costs and Resource-efficiency of Seven Residential Landscape Options*

The overall purpose of this study is to analyse and compare the time requirements, material and energy inputs, costs, and environmental impacts/benefits associated with the maintenance of eight different residential landscape "types" Three of these are considered high-maintenance, resource-intensive landscapes, and include 1) manicured lawn, 2) ornamental flower beds/borders, and 3) ornamental trees and shrubs. The other five are considered low-maintenance, resource-efficient types, and include. 1) organic lawn, 2) low-maintenance lawn, 3) naturalized woodland, 4) naturalized meadow, and 5) xeriscape The purpose of this monitoring survey is to compile the field data needed to undertake a comparative analysis of the maintenance inputs for each of the eight landscape types

The results of the research study will be compiled in an educational publication geared to homeowners and public land managers. Your participation in the study will be acknowledged in the final publication. The $100 honorarium will be paid at the end of the survey, following receipt of the completed survey forms

Instructions

Please take a few moments to carefully read the following step-by-step instructions and fill out the required information. If you require clarifications or have any questions, please call Jean-Marc Daigle toll-free at 1-877-467-2079 (or 939-8498 if you are calling locally)

A. BEFORE BEGINNING THE MONITORING STUDY

STEP 1: IDENTIFY THE LANDSCAPE TYPE

Please check off the landscape type that your are monitoring for this survey

Manicured Lawn	**Low-Maintenance Lawn**
Organic Lawn	**Ornamental Flowerbeds**
Ornamental Trees & Shrubs	**Xeriscape**
Meadow	**Woodland**

STEP 2: MEASURE THE LANDSCAPE STUDY AREA

Determine as accurately as possible the size of the landscape you are monitoring (in square feet or metres). Please provide the measurement in the space provided below. *If you were a survey participant in 1998, we already have this information on file; please go to Step 3*

- Restrict the area measurement to the specific landscape type you are monitoring. If, for instance, you are monitoring a lawn, exclude planting beds, walkways, shrubs, and other portions of the site that are not lawn.

- **Ornamental Tree and Shrub Landscapes** If you are monitoring an ornamental tree and shrub landscape that consists solely of massed plants in large beds, borders, or hedges, you need only measure the area of the planting bed However, if the landscape also includes individual, free-standing (or "specimen") trees and/or shrubs, you will have to measure the area covered by each individual plant in order to calculate the total area coverage

Begin by measuring the ground surface area within the dripline (i e , the outer branch tips) of each plant If your property includes both free-standing trees and shrubs, please list the number of plants and their area coverage separately in the appropriate lines below Add up these figures to determine the total area covered by the individual specimens Finally, add the area covered by specimen plants with that of massed plantings to determine the total area

TOTAL AREA.______________________________

Tree and Shrub Landscapes

Specimen trees·	Quantity·_______	Total Area _______
Specimen shrubs	Quantity._______	Total Area·_______
Massed trees & shrubs		Total Area _______

TOTAL AREA, TREES AND SHRUBS. _______

STEP 3: DEFINE YOUR MAINTENANCE PHILOSOPHY

Check off one or more of the descriptions below that define your particular maintenance standards and philosophy, specifically with reference to the landscape you are monitoring.

I consider myself a hobby gardener and enjoy spending time working in and "editing" the landscape (i e , adding new plants, moving plants around, pruning and thinning, etc.)

I don't mind occasional maintenance chores, but I don't consider myself a hobby gardener

I have very little time (or money) to spend in the garden, and strive to keep the maintenance work down to a bare minimum

I aspire to maintain the landscape to high aesthetic and horticultural standards (i e , neatly cropped or pruned, regularly weeded, disease and insect free, etc)

I prefer a more relaxed landscape maintenance approach, and can live with some imperfection

I use pesticides as required to keep the landscape free of insects, disease, and weeds

I never use pesticides

I use pesticides selectively, only when absolutely necessary

Other:____

STEP 4: IDENTIFY YOUR MAINTENANCE EQUIPMENT

Please indicate the specifications for any gas-powered or electrical equipment you intend to use in the maintenance of the landscape type you are monitoring (eg lawn mower, leaf blower, trimmer, edger, hedge clipper, lawn de-thatcher, etc). We will later use this information to determine the amount and cost of energy consumed

a. Gas-powered Equipment

Equipment type/description	Brand	Horse-power	Engine type/size	Fuel consumption rate*
example *21" self-propelled lawnmower*	*Lawnboy*	*4 5 hp*	*4 stroke*	*250 ml, 18 minutes*

Note To accurately determine the fuel consumption rate for gas-powered equipment, insert a small measured amount (eg 250 or 500 ml, 1 to 2 cups) of fuel in an empty gas tank, and operate the equipment until the fuel runs out. In the fuel consumption column, indicate the amount of fuel consumed over what time period (see sample entry)

b. Electric Equipment

Type of equipment	Brand	Amp.	Horse-power
example *string trimmer*	*Lawnboy*	*3.5*	*2 5 hp*

STEP 5: DETERMINE IRRIGATION EQUIPMENT CAPACITY

As part of this survey, you are asked to record water consumption Water consumption is calculated by multiplying the rate of flow (capacity) of the sprinkler, nozzle, soaker hose, or other irrigation equipment by the duration of a given watering event (eg., 12 5 liters/min x 20 minutes = 250 liters)

To calculate the rate of flow, determine the number of minutes needed to fill a bucket of a known volume with the attached sprinkler, nozzle, other implement, employing the same water pressure as that used during watering To determine a sprinkler's capacity, contain the spray in a large plastic bag, which can be used to funnel the water into the bucket Divide the volume of water by the number of minutes required to fill the bucket to determine the rate of flow If, for instance, a 25 liter bucket is filled in 2 minutes, the rate of flow is roughly 12 5 liters per minute

Please indicate the rate of flow (in liters or gallons per minute) for your irrigation equipment below Later, when filling out water consumption data in the monitoring forms, you will only have to identify which implement was used, over what timespan

	Rate of flow
Sprinkler 1.	______________
Hand-held nozzle·	______________
Soaker hose	______________
Other· (specify)	______________

STEP 6: DETERMINE WATER AND HYDRO RATES

To determine the cost of water and electricity consumed in your landscape maintenance activities, please indicate the rates for your community (not required if you do not intend to use water or electricity).

Water. $_____ per cubic meter

Electricity $_____ per kilowatt hour

STEP 7: PHOTOS

A limited selection of photos of the survey monitoring sites will be included in the final publication If possible, please submit one or two photos (i e., slides or photos and negatives) of the landscape you are monitoring If we reproduce one of your photos, you will be properly credited All photos, negatives, and/or slides will be returned

STEP 8: SPECIES LIST

If possible, and to the best of your knowledge, provide a full (or partial) listing of plant species associated with the landscape you are monitoring A plant list form is supplied at the end of this booklet If you participated in the 1998 survey, you need not provide this information again.

STEP 9: LANDSCAPE ESTABLISHMENT AND SHORT-TERM AFTERCARE

Using the form provided at the end of this booklet, please provide any information you can offer on the various activities and inputs that went into installing and establishing the landscape. If you participated in the 1998 survey, you need not provide this information again

B. USING THE MONITORING SURVEY FORMS

The appropriate sections of the attached monitoring charts should be filled out each time a maintenance activity or input is undertaken To ensure data accuracy, the form should be filled out immediately upon completion of the maintenance tasks, while the information is fresh in your mind. The types of data to record are noted below.

Note: Any activities undertaken in March or early April, prior to the start-up of the monitoring survey, should be reported in one or more of the columns as required

1. Time Chart - Maintenance Activities: We have identified the key seasonal and on-going tasks typically associated with the eight landscape types. Each time you undertake a maintenance task, complete an individual column in the time chart. Note the date of the event at the top of the column, bearing in mind the following tips and pointers·

- Time data should be as accurate as possible, recorded in time increments of no more than 10 minutes (5 minute increments are preferred)
- If you have undertaken a maintenance activity not noted in the chart, please list and identify it under "other". Please do not include any time inputs that are not essential to the actual maintenance of the landscape in question. For instance, do not record time spent on expanding the landscape (eg enlarging a planting bed) or on the installation of garden features such as birdhouses and walkways If you are unsure about a given activity, list it and we'll decide whether or not to use the data
- If more than one person is involved in carrying out a given task, time inputs should be calculated as total personhours per visit (for example, 2 people @ 2 hours each = 4 hours total).
- Be sure to track only the time spent on the specific landscape type you are monitoring For example, if you a tracking your maintenance inputs for ornamental trees and shrubs, and spend a total of 2 hours doing a variety of garden chores, indicate only the time directly related to the maintenance of the trees and shrubs
- **VIP Note re: watering:** If you are using hand-held watering equipment, record the total amount of time required to assemble the hoses and water the garden If, however, you are using a sprinkler, record only the amount of time needed to assemble and put away the hoses

2. Material and Cost Input Chart· This chart outlines the principal material inputs typically associated with the maintenance of the eight landscape types Complete a column on this chart each time a material input occurs, noting the date of the event, the quantity used or applied, and its cost If only a portion of a packaged product is used, estimate the cost of the amount used Quantities can be listed by weight, volume, or other appropriate measure You may use either English or Metric measurements, but please be consistent Identify as "other" any material inputs not listed in the chart.

Please provide product specifications for materials used, as follows

- **Fertilizers** - note the nutrient ratio indicated on the packaging (eg. 10-10-10), and specify whether the fertilizer is a fast release or slow release type
- **Weed and Feed Fertilizers** - note the nutrient ratio, and identify the active herbicide ingredient (eg mecoprop) and its percentage by weight or volume, as noted on the package
- **Pesticides** - note the type of insecticide (eg. diazinon), herbicide (eg. glyphosate), or fungicide (eg. malathion); indicate, as specified on the package, the percentage of active ingredient by weight or volume and the recommended application rate in diluted form
- **Plantings** - if you are planting annuals or new and/or replacement plants, please indicate the quantity, plant type (annual, perennial, shrub, tree), and species (optional)
- **Water** - Calculate your water inputs by multiplying the rate of flow by the length of the watering event (see above, step # 3)

- **Mulch** - Specify the type (eg. woodchip, barkstrip, straw, or leaf) and quantity (by volume, if at all possible) of mulches applied
- **Top-dressing:** Indicate the composition of any top-dressing applied to lawns (i e., topsoil, seed, etc.)

If you hire a contractor to apply fertilizers and/or pesticides, please note this on the form and obtain the product specifications from the contractor

3. Energy Inputs Chart: Fill out a column in this chart each time gas-powered or electric equipment is used. Indicate the date, the type of equipment used, and its operating time We will subsequently refer to the data you supplied us earlier in Step # 4 to determine the amount and cost of the fuel or electricity consumed.

C. COMPLETING THE STUDY - OCTOBER 3, 1999

The last day of the monitoring study is **Sunday, October 3, 1999** A reminder notice will be mailed prior to that date If you expect to undertake maintenance activities beyond this date, provide estimates in the monitoring charts of the time, materials, energy, and costs required to complete these tasks

Promptly complete the summary chart included at the end of this booklet, by adding up the totals of all the monitoring forms Photocopy the completed forms so that there is a second copy in the event packages are lost in the mail. Mail the forms, along with slides and/or photographs, in the enclosed envelopes by no later than October 5 (we are working with tight deadlines to complete the final report). If you prefer, fax the forms to us at (905)939-7044. Your honorarium will be mailed shortly thereafter

Important Note: Biannual or Less Frequent Inputs.

Once you have completed your summary chart, please take a moment to consider whether there are any activities that did not occur this year, but which you have undertaken in previous years For instance, you may only apply pesticides once every two or three years, as required, or may aerate or de-thatch your lawn only every second year In the space provided in the summary chart, list any activity you consider part of the on-going maintenance of the landscape, but which did not occur in 1999. Provide ballpark estimates of the time required to complete the task, the types and costs of material and/or energy inputs involved, and the frequency of the event (eg every two years)

Landscape Type: ______________________________

Recorder: ____________________________________

	Date		Date		Date		Date		Date	
1. TIME INPUTS	**hrs**	**min**	**hrs**	**min**	**hrs**	**min**	**hrs**	**min**	**hrs**	**min**
Fertilizer application (chemical and organic)										
Pesticide application (chemical and organic)										
Cultural pest controls										
Spring/fall cleanup (incl. annual meadow mowing)										
Plant replacements / additions (incl. bed prep)										
Weeding / planting bed maintenance										
Mulching										
Plant thinning / division / transplanting within										
Edging										
Pruning / pinching / deadheading										
Watering										
Other (please specify)										
Other (please specify)										
Other (please specify)										
Lawn Only: Mowing and Trimming										
Lawn Only: Raking (clippings)										
Lawn Only: De-thatching										
Lawn Only: Aerating										
Lawn Only: Top-dressing										
Lawn Only: Re-seeding										
Lawn Only: Leaf-raking (spring and fall)										
Total Time										

Notes

			Date	Date	Date	Date	Date
2. MATERIAL INPUTS	Type / Specifications	Application method	Quantity & Cost	Quantity & Cost	Quantity & Cost	Quantity & Cost	Quantity & Cost
Fertilizer (chemical)			$	$	$	$	$
Fertilizer (organic)			$	$	$	$	$
Pesticide (chemical)			$	$	$	$	$
Pesticides (organic)			$	$	$	$	$
Plants / seeds (incl. annuals, spot repairs, new plantings, etc.)			$	$	$	$	$
Top-dressing			$	$	$	$	$
Water	(Specify irrigation equipment type)		$	$	$	$	$
Mulch			$	$	$	$	$
Other			$	$	$	$	$
Other			$	$	$	$	$

		Date	Date	Date	Date	Date
3. ENERGY INPUTS	Equipment Type	Operating Time	Operating Time	Operating Time	Operating Time	Operating Time
Gas Powered Equipment # 1						
Gas Powered Equipment # 2						
Electric Equipment # 1						
Electric Equipment # 2						

Summary Charts

The following three summary charts are to be completed at the end of the survey period (Oct 3, 1999) As well, please indicate in the space below any maintenance task that did not occur this year, but which does occur on a bi-annual or less frequent basis.

	1. TOTAL TIME INPUTS	hrs	min
	Fertilizer application (chemical and organic)		
	Pesticide application (chemical and organic)		
	Cultural pest controls		
	Spring/fall cleanup (incl. annual meadow mowing)		
	Plant replacements / additions (incl. bed prep)		
	Weeding / planting bed maintenance		
	Mulching		
	Plant thinning / division / transplanting within		
	Edging		
	Pruning / pinching / deadheading		
	Watering		
	Other (please specify)		
Lawn Only	Mowing and Trimming		
	Raking (clippings)		
	De-thatching		
	Aerating		
	Top-dressing		
	Re-seeding		
	Leaf-raking (spring and fall)		
	Total Time		

2. TOTAL MATERIAL INPUTS	Type / Specifications	Total Quantity & Cost
Fertilizer # 1 (chemical or organic)		$
Fertilizer # 2 (chemical or organic)		$
Fertilizer # 3 (chemical or organic)		$
Pesticide # 1		$
Pesticide # 2		$
Pesticide # 3		$
Plants / seeds (incl. annuals, spot repairs, new plantings, etc.)		$
Top-dressing		$
Water		$
Mulch		$
Other		$
Other		$

3. TOTAL ENERGY INPUTS	Equipment Type	Total Operating Time
Gas Powered Equipment # 1		
Gas Powered Equipment # 2		
Gas Powered Equipment # 3		
Electric Equipment # 1		
Electric Equipment # 2		
Electric Equipment # 3		

BI-ANNUAL OR LESS FREQUENT MAINTENANCE TASKS

Task Description	Estimated Time Input	Estimated Material Input	Estimated Energy Input	Estimated Costs	Task Frequency