

A STRATEGY TO ESTABLISH TREES AMONG HIGH-DENSITY HOUSING

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Abstract. High-density housing (HDH) ranks as one of the most hostile of planting environments. The best success rates are realized after the implementation of a planned tree-planting strategy. A strategy converts what is commonly addressed as an annual one-off task into an all-encompassing process of events, which when placed into a logical order provide optimal circumstances for ensuring successful tree establishment. The tree-planting strategy developed in Lambeth, United Kingdom, based on observations and consultation with users, has proved to reduce failure rates. It is possible to apply the principles of the strategy developed for HDH to the range of planting environments presented to the tree manager.

Key Words. Planting strategy; tree failure; tree establishment; high-density housing.

Planting trees is one of the most exciting and satisfying aspects of arboriculture and forestry. Conversely, it can also be the most disappointing and soul-destroying element. The tree planter may, from time to time during the course of his or her life, return to the planting site to see trees flourishing in the landscape, which surely arouses a sense of pride and contribution. On the other hand, the sight of dead or dilapidated young trees provides a very visual and powerful sense of failure.

In towns and cities, all too often public trees do not reach maturity. Tree death is a very visual loss of public finance, which is often viewed with contempt by the local community. A variety of reasons may be attributed to this: poor planting, poor planning, impoverished soil, neglect, vandalism, accidental damage, and/or weather extremes. Of thousands of trees planted each year, it is commonly expected that a proportion of these trees will be lost prematurely (Hibberd 1989; Bradshaw et al. 1995; McEvoy and McKay 1997). This is especially true in urban areas where human habitation is concentrated. Such areas within the urban context are referred to here as high-density housing (HDH). Replacement trees and many new trees are planted annually to compensate for losses.

Figures obtained from the London Tree Officers Association (R. Ball, personal communication 1995),

show on average throughout the 33 London boroughs some 13,000 new 12- to 14-cm girth (3-in. caliper) or 16- to 18-cm girth (4-in. caliper) trees are planted each year. Of these, approximately 50% are replacements, or will act as replacements, either for failed saplings or young trees. In monetary terms, for just this one city, this equates, based on £175 (US\$290) per 14- to 16-cm (3-in.) girth tree, planted, to an average of approximately £2.3 million (US\$3.8 million), of which £1.15 million (US\$1.9 million) is used for replacements annually. The figures are sufficiently high to warrant a strategic look at young tree preservation involving planning, planting techniques, and future management.

Much recent work and documentation have been devoted to recording the quantities and distribution of living trees. Publications such as *Trees in Towns* (Land Use Consultants 1993) and surveys such as "Action for London's Trees" (Cobham Resource Consultants 1993) are excellent examples of statistical studies of tree populations in the United Kingdom. By taking a close look at the numbers of dead or failed trees, however, we may find useful guidance on the economic sustainability of tree cover in areas where living space is at a premium.

Open, grassed areas among HDH must rank as one of the most hostile of planting environments. A combination of poor soil structure, poor fertility, compacted soil, competition for moisture and nutrients from grass, and a vulnerability to physical damage amount to a harsh but commonplace planting environment. Equally, establishing trees in these areas must rate as one of the most challenging and ultimately beneficial tasks presented in arboriculture (Hibbert 1989; Souch and Souch 1993; Struve 1994; Bradshaw et al. 1995; Sullivan and Kuo 1996).

This paper concerns itself primarily with identifying tree establishment problems experienced among the London borough of Lambeth's housing estates (public housing developments) and offers possible solutions by adopting a tree-planting strategy specifically for HDH. The strategy is based on the

observations of the author between 1991 and 1998. It is not an attempt to tackle the advantages and disadvantages of the myriad planting techniques that could be adopted to establish trees among HDH (Harris et al. 1998). It is, however, an attempt to identify a planting strategy that would be successful within and beyond the subject location.

BACKGROUND

The London borough of Lambeth is one of a ring of seven inner London boroughs that surround central London. In common with its neighboring boroughs, Lambeth is characterized by high-density inner-city development. It is located south of the River Thames of which its northernmost boundary comprises the river at Waterloo. Lambeth measures some 11 km (7 mi) north to south, spans 2.4 km (1.5 mi), and has a total land area of 27 km² (10.5 mi²). Its population is 246,000, giving a living density of some 9,100 people per km² (23,500 per mi²). It is an area of mixed industrial-commercial but mainly residential developments. It is these areas that are of particular interest with regard to environmental improvement and in which tree planting plays a major part.

High-density housing is a somewhat conceptual description of a living area and for the purposes of this paper, HDH constitutes areas for which 50% or more of the total land of the housing estate is either hard standing or built upon. In other words, a maximum of only 50% of the total area comprises any type of soft landscape or viable planting opportunities.

Many such areas exist in Lambeth. The borough of Lambeth has approximately 400 separate housing estates, or public housing developments, which are inhabited by an average of about 250 residents each. Of all the estates, no viable planting opportunities arise in approximately 25% of cases. It is often the case that housing estates have limited green space (planting opportunities), and open spaces are used for recreation by the local community. This automatically places high value on open natural amenities. Open space is cherished by residents because it provides a relatively safe area for children to play (often within parental view) and a location for dog walking and also because it induces a feeling of space in otherwise cramped surroundings. Planting trees in such areas can clearly conflict with existing uses of green spaces within HDH.

THE EVOLUTION OF A PLANTING STRATEGY

(Note: "Establishment" here means resuming near or equivalent pre-transplant growth rate [Struve 1994]. Observations are continuing.)

Season 1991–1992 (November to March)

In 1991, the Tree Maintenance Service for the Housing Department of Lambeth Council was exposed to "compulsory competitive tendering," which enables private contractors to bid for arboricultural work. Tree planting formed a part of this service. The arboricultural section within the Directorate Housing Services was given the job of managing the contracts involved, which included purchasing the trees to be planted in the housing estates. Previous to 1991, tree purchases relied on finding suitable sites for a predetermined quantity of trees from a limited species list. The 1991 approach was effectively the reverse and involved site assessment and site-specific trees selected from an extensive species list and ordered from the historically used nursery. During the first 6 months of 1991, suitable planting sites were sought. One hundred and forty one standard bare root trees were ordered (12 to 14 cm girth [3 in. caliper]) for a total of 45 sites. No trees were guarded and no mulch was applied. No irrigation plan was organized; however, some reactive watering was carried out. Forty percent of the trees have established, and a further 20% remain *in situ* but are weak specimens. A traditional single pressure-treated stake supported each tree with a single rubber tie at about 1.7 m (5.5 ft) height. Planting sites were identified on a plan and provided to the contractor.

Season 1992–1993

In 1992, a radical approach was taken toward tree planting. Despite allocating the same quantity of resources as previous years for planting, more than 1,200 trees were planted specific to both site and species. Available funds allowed this because the tree types included were smaller and cheaper bare-rooted whips 60 to 90 cm (24 to 36 in.) tall, feathered trees 1 to 2 m (3 to 6 ft) tall, light standards 8 to 10 cm in girth (2 in. caliper), and a small proportion of heavy standards 14 to 16 cm in girth (3 in. caliper). Trees were selected from a wide-ranging species list. The species range exceeded normal nursery availability lists. Trees included (but were not limited to) *Liriodendron tulipifera*, *Taxodium distichum*, *Taxus baccata*, *Betula pendula* 'Dalecarlica', *Quercus robur*

'Fastigiata', and *Morus alba*. Again, apart from trimmer (string trimmer) guards attached to some of the more vulnerable feathered trees (those planted in mown grass areas), none of the trees was guarded. Only a proportion of the feathered stock and the standards were watered after planting. Of these trees, a mere 25% appear to have established (in 5 years, and these are predominately from the light standard and heavy standard category). Reasons for the high quantity of losses were

1. Naive site assessment and inappropriate selection of tree type in relation to the site, e.g., tree too small and weak to withstand the rigors of grass mowing, strimming (string trimming), and people pressure (pedestrian traffic, adjacent ball games).
2. The wrong tree species planted in the wrong locations.
3. Desiccation of bare-rooted plants (McEvoy and McKay 1997).
4. Insufficient resources available to monitor and ensure proper planting techniques or subsequent maintenance and irrigation.
5. Poor interdepartmental communications.
6. Misunderstanding of community requirements.

Season 1993–1994

During the months prior to the season 1993–1994, an emphasis was placed on resident consultation and community involvement, an approach considered by Hibberd (1989) and shown to be successful by Sommer et al. (1994). This was effected through public meetings, discussions with residents, and interdepartmental consultations resulting in general awareness of tree-planting programs. Interactive discussions (instigated by distributing leaflets and displaying posters) with residents near the planting sites identified the possible scope and limitations of sites at a pre-emptive stage. An outline of the proposed planting scheme, indicating locations by address only, was circulated to relevant personnel within departments having influence over the landscape. These included the Housing Development Department, which is responsible for the siting of new developments, and the Strategic Planning Department, which sought to provide a communication and logical link between buildings and traffic routes. The grounds maintenance departments and local housing offices were all provided with a mechanism

to either rule out or encourage the possibilities for tree planting. A decision was made to apply the same available funds as previous years to purchasing 16% of the quantity of the previous year but of larger, higher quality trees. Two hundred containerized advanced nursery stock (ANS) 16- to 18-cm girth (4-in. caliper) trees were selected specific to the identified site but based on nursery stock availability lists and historical success rates. To this end, species included *Crataegus monogyna*, *Sorbus aria*, and *S. × intermedia*, *Platanus acerifolia*, *Fraxinus oxycarpa* 'Raywood' and *F. excelsior* 'Jaspidea', *Acer pseudoplatanus* 'Leopoldii', and *Aesculus hippocastanum* 'Baumanii'. It was also decided to protect each tree with a weld-mesh galvanized guard supported by 2 diametrically opposed pressure-treated round wood stakes (Figure 1). To avoid accumulation of litter in the guard, a gap of about 200 mm (8 in.) was left between the bottom of the guard and ground level. Each tree was supported by rubber-sleeved strapping at



Figure 1. Tree supported with 2 stakes and protected with a wire mesh cage.

a point about 1.7 m (5 ft) from the ground. Each tree base was also covered with wood chippings to form a 100-mm (4-in.) deep mulch. The extent of the mulched area was confined to inside the guard (approximately 0.75 m [2.5 ft] in diameter). In addition, each tree was heavily watered at planting.

Of the trees planted during this season, 75% appeared to have established (after 4 years). Only one of the trees was vandalized, and none was damaged through grass maintenance.

In addition to the altered style of planting, an irrigation program was set up. This involved diverting costs that might otherwise have been set aside for the cost of removing failed trees into paying for intensive watering in the spring and throughout the summer.

Season 1994–1995

In the 1994–1995 season, a similar strategy was undertaken as the previous year with the exception that 250 trees were purchased and that they were root-balled. The increase in number of trees had been allowed owing to the slightly lower cost of root-balled over containerized trees. During the summer of 1995, 90% of the trees flushed and showed encouraging signs of permanent establishment. Later observations indicated, however, that approximately 40% of the trees planted in this season showed real signs of reaching maturity despite a reasonable irrigation program. None of the trees had been vandalized, but some losses were probably attributable to the extreme hot summer, and the remaining trees failed in line with expected losses for root-balled trees given the very poor planting medium. None of the trees since the 1991–1992 season was planted using soil amendments or irrigation pipes.

Season 1995–1996 to 1997–1998

By now a pattern was beginning to emerge that success relied on addressing the aspects of tree planting in a

strategic manner (Figure 2). To this end, a similar quantity and approach to planting was adopted during these seasons, as in the 1993–1994 season, which showed the most successful establishment rate. A major improvement on the previous years, however, was the development of a comprehensive inventory of newly planted trees. This inventory was created using computer software and enabled scheduling precise maintenance and monitoring of the young trees planted over the past 4 seasons and in future seasons. One of the major advantages of using computer software is its ability to analyze data quickly, providing usable information. Alternative paper inventories, while effective, can be laborious and as a result become neglected. The intricacies of computer-aided tree management are vast and are for other papers to discuss.

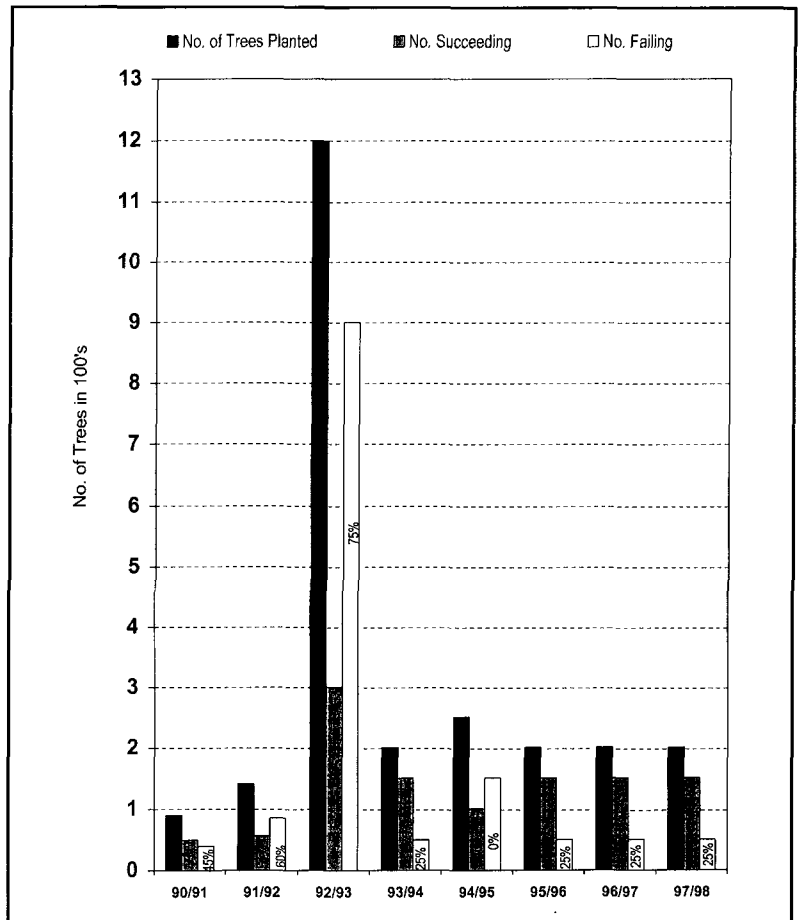


Figure 2. The relative improvement for successful establishment of tree plantings.

THE STRATEGY

Site Assessment

Tree-planting and establishment methodologies have been the subject of much scrutiny and literature. The International Society of Arboriculture publications *The Landscape Below Ground* (Neely and Watson 1994), and *Principles and Practice of Planting Trees and Shrubs* (Watson and Himelick 1997) are recent examples that identify sound methods for establishing trees within the landscape. In *The Landscape Below Ground*, Harris et al. (1994) clearly show a strategy for successful tree establishment: site assessment → site modification and/or design modification → plant selection → good transplanting → healthy tree establishment. Growth and landscape enhancement were described by Watson and Himelick (1997) and by Bradshaw et al. in *Trees in the Urban Landscape* (1995) and earlier by Hibberd (1989) but most recently by Harris et al. (1998).

What the above descriptions have in common is recognition of the importance of site evaluation or assessment to identify species compatible with the physical properties offered by the site. Such criteria as soil type, fertility, moisture content, pH, drainage, root growing space, and aboveground limitations all are considered.

Equally important but seldom addressed, however, when describing tree establishment techniques, is the site assessment in respect to its history, current land use, community requirements of the land, expectations of the site, "shelf life" of the site and the aims of tree planting. When we begin to recognize the purpose of tree planting relative to the site, the scope of planting scheme designs are able to meet the site requirements and determine species selection. It is only then that species selection is determined by the physical constraints or opportunities offered by the site conditions. In short, while site assessment is a primary step in the process of tree establishment, it must be divided into 2 parts. The first stage is to address the purpose or aims of tree planting based on history, future, and community needs, followed by assessment of physical site conditions.

Reasons for Failure

The difficulties experienced by trees in the early years of life in heavily populated areas are wide ranging (Bradshaw et al. 1995). When establishing trees among HDH, most problems can be addressed in

some way, for example, physical damage or poor planting. Others problems, however, remain insurmountable, such as poor soil structure or even theft. Nevertheless, by looking at the reasons for young tree failure, we can at least devise methods of reducing losses to an acceptable minimum and provide conditions commensurate to satisfactory establishment.

One of the first jobs is to identify the most likely causes of failure relative to the planting environment. Sources of failure can be divided into 2 types; direct and indirect. Direct causes of tree failure are those relating to technical arboricultural issues that can be addressed by the tree manager in situations where immediate or relatively quick results can be realized (Table 1). Trees can also be lost through indirect or procedural sources. This type of failure is addressed over a longer period and in conjunction with others, e.g., raising community awareness of tree planting, developing cooperation with other departments within organizations responsible for tree planting, and pre-planning (Figure 3). Some problems faced by trees fall into both categories and are addressed accordingly by the relevant party.

Owing to the quantity and variety of problems likely to be experienced by trees planted among HDH, a summary of problems is presented in Table 1. These problems were experienced in Lambeth, and the list is not exhaustive. Similarly, solutions presented here are those particular to Lambeth and no doubt alternatives exist. While an attempt has been made to prioritize the problems, it is recognized the prioritization also is particular to Lambeth and that a change of emphasis is likely to exist in different geographical locations.

Pre- and Post-Planting Considerations

A high proportion of the losses in the early years of this study could be attributed to a lack of planning prior to planting. In physical terms, trees suffered most from drought brought about not by weather extremes but by not watering sufficiently. It has become clear that, before anything else, sufficient resources must be available to support the planting and aftercare process. Neither must it be ignored that aftercare continues after the first year. Resources allocated to the trees planted first, however, become less with time. It is recognized that aftercare is often difficult, particularly if funding relies on factors beyond the control of the tree manager. However, these

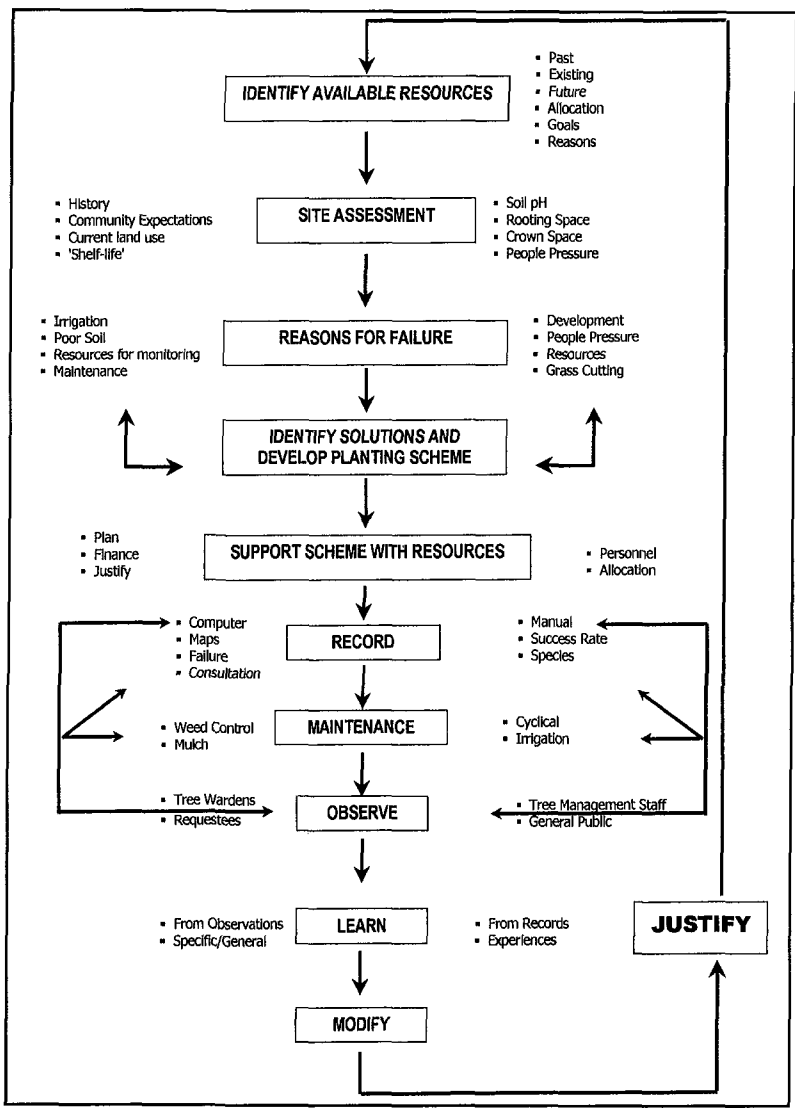


Figure 3. Tree-planting strategy adopted for high-density housing developments.

for the best start in a tree's life (in a new location) to organize the practical planting process in a logical and efficient way. To achieve this, it is necessary to identify available resources, assess the planting sites, and build a purchase order for stock by late summer (August).

Once all the trees have been planted, it is necessary to record their progress. By keeping accurate records, valuable lessons are learned about local site conditions, community feeling about trees, and the appropriateness of certain species at the site.

The record of planting is essential when implementing both irrigation and maintenance programs. In addition, clear records can quickly identify the successes and failures. In turn, the need to either repeat or modify the planting style can be readily highlighted. Computer software can expedite the analysis of recorded data. In the same way, it is simple to instigate a strategic maintenance program. Perhaps one of the greatest advantages of computer software, in respect of planting records, is the ability to accurately forecast financial implications for the future. Together with a planned approach to tree planting, accurate accounting provides further justification for resources, should this be an issue.

problems too should be considered as part of the pre-planting planning process.

It was generally found to be the case that trees planted early in the season had the best survival rates. This was particularly found to be the case with the bare-root stock planted in 1991–1992 and the root-balled trees of 1994–1995. It would seem, therefore, that better success rates are reaped from organizing the delivery of stock and planting by about mid-November.

In the 1992–1993 scenario, many trees failed owing to the oversight of practical details. It is crucial

However, tree progress must depend on field observations. It was during site inspection that stem girth and shoot elongation were measured and compared. The information gained from this led to better site-specific species selection. Possibly the most useful effect of physical observation is the impact that is created on the tree manager when witnessing both successful and failed tree-planting schemes. Figure 3 is a diagram of the strategy adopted in Lambeth. The events shown in the boxes could, however, apply to any planting environment.

CONCLUSIONS

Enabling trees to grow among HDH is one of the most challenging tasks in arboriculture. Difficulties are not limited to the physical constraints of selected sites. Successful tree establishment depends on the implementation of a carefully constructed tree-planting strategy. Consideration of the important criteria must be applied at the very earliest stages of developing the planting scheme. This is the identification of available resources to sustain not only the purchase and planting of the trees (Iles 1998) but also a comprehensive and systematic method of aftercare.

The evolution of the strategy adopted in Lambeth's Housing Services Department is based on an analysis of the results of different planting and planning methods. More emphasis has been placed on the assessment of the planting site by considering not only the opportunities the site offers but also its history, existing and future use, local resident requirements and their feelings toward trees, and the life expectancy of the planting scheme.

It became very clear that while the introduction of new species was desirable, the ultimate aim of establishing trees in traditionally difficult areas is best achieved by selecting species with a proven track record of establishment in the locality. *Fraxinus excelsior* 'Jaspidea', *F. oxycarpa* 'Raywood', *Ailanthus altissima*, *Sorbus aria*, and *Acer pseudoplatanus* 'Leopoldii' showed a high degree of success.

It was observed that planting relatively big containerized trees (14- to 16-cm and 16- to 18-cm girth [3- to 4-in. caliper]) early in the season, i.e., before mid-November, achieved the best success rates. Tree guards and mulch also helped protect the

trees from people pressure and grass cutting machinery. An equally important factor was planting the number trees that could be regularly watered at the onset of growth and during the summer months. This was achieved only by adopting a strategy that enabled drawing all relevant and important factors together.

The strategy described here is particular to HDH in Lambeth; however, it is probably fair to say that the majority of the issues covered by the strategy

Table 1. Direct and indirect problems, and possible solutions, for establishing trees in public housing developments.

Problem	Possible solutions
Direct	
1. Irrigation	Planting maintenance techniques Develop irrigation plan Balance planting quantity with resources
2. Soil compaction or poor quality	Species selection Site selection and assessment Trench planting
3. Direct damage	Planting style (physical barriers) Location selection Site assessment Care during transport and storage
4. Poor planting	Reduce extent of planting Monitor planting techniques
5. Poor tree quality	Develop quality purchase system Build relationships with suppliers Mix suppliers periodically
6. Maintenance (lack of)	Plant in accordance with available resources Maintain accurate records
7. Planting logistics	Plan planting exercise
Indirect	
1. Physical damage (from other service, delivery, e.g., grass cutting)	Notification of planting sites Interdepartmental consultation Pre-planning
2. Limited finance/resources	Planting style/quantity Establish priority requirements Explore sources of finance Contract management Adopt a tree-planting strategy
3. Development/refurbishment	Interdepartmental consultation/agreements Planting awareness, advertising Accept scheme has a limited "shelf life"
4. Neglect	Establish sense of ownership Satisfy requests for trees Plant for personal reasons, e.g., commemorative Promote maintenance by residents
5. Vandalism, people pressure	Public consultation Establish the level of tree desirability

could equally be applied to a whole range of sites encountered by tree managers both within local authorities (municipalities) and outside.

Tree planting should have a lasting impact on the landscape and be satisfying to both the planter and the user. The economics show that the act of tree planting should not be regarded as merely an annual task but rather a horticultural process comprising an ongoing cycle of events modified only to benefit the local or wider environment and to achieve the ultimate aim—enhancing impoverished landscapes through establishing trees.

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Résumé. Les zones d'habitations à forte densité se rangent parmi les milieux environnementaux les plus hostiles pour la plantation. Les meilleurs taux de succès sont obtenus après la mise en place d'une stratégie planifiée de plantation d'arbres. Cette stratégie converge dans ce qui est communément appelé une tâche annuelle répétitive s'incluant dans un processus d'événements qui, lorsqu'ils sont organisés dans un ordre logique, fournissent les circonstances optimum assurant un succès lors de l'implantation des arbres. La stratégie de plantation d'arbres développée à Lambeth a prouvé qu'elle permettait de diminuer le taux de pertes. Il est possible d'appliquer les principes de cette stratégie développée pour les zones d'habitation à forte densité aux autres types d'environnement qui se présentent au gestionnaire d'arbres.

Zusammenfassung. HDH wird als eine der besten Umgebungen für Pflanzungen angesehen. Die besten Erfolgsraten wurden nach der Umsetzung einer geplanten Pflanzstrategie für Bäume erzielt. Diese Strategie wandelt die bislang jährlich wiederkehrende Entscheidungsfindung ab in einen allumfassenden Prozeß, der alle Ereignisse und Vorkommnisse, die, wenn sie in eine logische Ordnung

gebracht wurden, die optimalen Umstände für die erfolgreiche Etablierung von Bäumen darstellt. Diese Baumpflanzstrategie wurde in Lambeth entwickelt und hat unter Beweis gestellt, daß sie die Versagensrate reduziert. Es ist möglich, die Prinzipien dieser für HDH entwickelten Strategie auch für die Spannweite von Pflanzstandorten anzuwenden, die dem Baummanager präsentiert werden.

Resumen. La categoría de Densidad Alta de Vivienda (HDH, por sus siglas en inglés) se distingue como una de las más hostiles a los proyectos ambientales. Las mejores tasas de éxito se obtuvieron después que fue implementada una estrategia de plantación de árboles. Esta estrategia convierte lo que comúnmente es una tarea anual en un proceso de eventos; los cuales cuando son colocados en un orden lógico proporcionan las circunstancias óptimas para asegurar el éxito del establecimiento de los árboles. La estrategia de plantación de árboles desarrollada en Lambeth ha probado reducir las tasas de fracaso. Cuando se proponen al Administrador de los Árboles, es posible aplicar los principios de la estrategia desarrollada para HDH a los rangos de ambientes para la plantación.