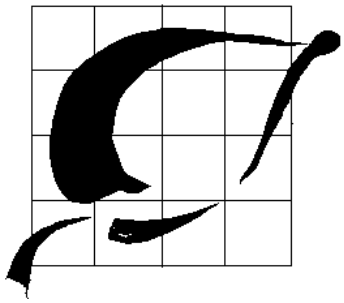

INTERIOR LANDSCAPING DESIGN PARAMETERS REPORT

PREPARED BY:

McCaren Designs, Inc.
760 Vandalia St., Suite 100
St. Paul, Minnesota 55114
651-646-4764
www.mccaren.com

DESIGN PARAMETERS

The purpose of this report is to address the major technical factors affecting a project's interior landscaping success. Many of these factors will need to be addressed by various project consultants, designers and the owners.

This report reviews three areas of design which are of particular importance to the interior landscaping's success and should be shared with those consultants, designers and the owners as they will be affected by the requirements set forth.

Every effort has been made to outline the general environmental requirements necessary for a successful interior landscape.

GENERAL DESIGN OVERVIEW

Our design, installation and ongoing maintenance experience, with a diverse selection of interior landscape plantings ranging from tropical themes to northern themes, has allowed us the opportunity to see firsthand what all the possibilities are for a facility. Based on the type of interior landscape chosen, we work closely with the architects, consultants and owners to assure the following parameters are considered as the project is designed and built.

LIGHTING

Introduction

Interior foliage plants are not solely dependent upon natural lighting, but can thrive quite well utilizing either natural, artificial or a combination of both lighting types. However, intensity, duration and light quality must be considered in determining the best lighting form for the interior landscape. To allow for choices in a design theme, we recommend the maximum amount of daylighting be made available through the daylighting systems and supplementing the natural daylighting with artificial illumination as required.

The minimum level of illumination is 1200 foot-candle hours from lighting sources.

Intensity

Sheer quantity of light will be the strongest determinant in the success of the project's interior landscaping. Sufficient light to promote growth must illuminate all the plants' surface areas. Therefore, the determination of not only horizontal illumination but also vertical illumination is important.

We believe the illumination of 1200 foot-candle hours per day would be considered an absolute minimum for supporting plant growth. The minimum intensity of this lighting should be at 100 foot-candles.

Duration of Luminance

With plants, the benefit of light can be regarded as being cumulative. For example a luminous density of 150 foot-candles for 14 hours (2100 foot-candle hours) is for the most part equal to 250 foot-candles for 8.4 hours (2100 foot-candle hours).

Illumination Periods

Plant materials have a preference for a day length of thirteen hours. Plants do require a period of dark each day to maintain their growth patterns. Continuous illumination will cause undesirable plant growth responses. To avoid any chance of growth irregularities, a minimum dark period of at least four hours should be arranged, though a period of six hours is probably desirable. This means security lighting (levels above 5 foot-candles) should be absent from planted areas.

Light Quality

Although the intensity and duration of light are indeed necessary for plant growth and survival, the quality or color type is also important. The quality of light is the third major factor in lighting for plant growth.

Basically a wide-frequency spectrum is desirable, from 400 to 700 nanometers (nm), to activate all the plants' functions. Ultraviolet and infra-red light are detrimental to plants, and some artificial light sources do deliver wavelengths below 350 nm and above 700 nm. Most generally used artificial light sources do not, however, give enough of these damaging emissions to cause problems for the interior landscape. There is no advantage in using special horticultural light sources for interior landscape lighting. Benefits are too marginal and color rendering is poor.

Artificial Lighting Sources

We will not attempt a full discussion of artificial plant lighting sources and their properties. Rather, if the criteria previously set forth are met, any source is acceptable.

Lighting Orientation

The way light illuminates the planting will affect the growth patterns of the plants. The photomorphogenesis effect makes plants grow towards light. Toplighting is necessary as a direction giver, while sidelighting helps give the planting a balanced shape.

Daylighting Evaluation

It is always our recommendation that the majority of lighting be through natural daylighting. However, using artificial light sources is acceptable. As the project progresses, we evaluate the lighting situation and continue to report our findings.

THE INTERIOR ENVIRONMENT

Good ventilation is necessary in the photosynthesis and transpiration cycles because it helps dissipate the diffused water vapor molecules resulting from transpiration. One could say, ventilation performs an indirect function that determines how efficiently these cycles work. Ventilation, if provided around the foliage plants, reduces water vapor pressure buildup and allows the plants' transpiration to continue normally. Therefore, good ventilation is necessary to maintain a normal transpiration rate, which in turn, is necessary for the normal photosynthetic rate.

Placement of HVAC grilles directly next to the planting can result in problems of drying and even burned foliage, due to excessive moisture loss (i.e. forced transpiration). This is mainly a problem during the winter heating season when hot, dry, blowing air comes in direct contact with the foliage of the plant. Plants should not be subject to linear air speeds in excess of 1.5m/sec. Care should be taken to see the HVAC grilles are positioned such that supply air does not blow directly on plant material.

Temperature

The plant varieties used will determine the temperature range. For example, when using semitropical and tropical plants, temperatures of 72 degrees Fahrenheit in the winter and 75 degrees Fahrenheit in the summer, are acceptable. Night temperatures should at best be 10 degrees cooler, or 62 to 65 degrees F. The temperature should never be allowed to slip below 50 degrees F. or damage to the plant materials may occur.

Drafts

Plants should not be subject to drafts of hot or cold air. Even a rapid change of 15 to 20 degrees has the potential to damage foliage plants. In effect, when using semitropical and tropical plant varieties, consistent temperatures are best. Heat and cold radiation close to glass will damage plants, unless it is modified through air circulation.

Humidity

The humidity levels must be maintained in excess of 25% R.H. If these humidity levels cannot be sustained though normal HVAC sources, supplemental humidity needs to be added.

Moisture Loss

It may be necessary for purposes of evaluating HVAC loads to estimate the amount of evaporation and transpiration of moisture from the planting. In normal situations the water loss from interior planting is equal to that of open water.

Indoor Air Pollution

We are now just beginning to understand that some indoor air pollution can be minimized if not eliminated through thoughtful design and construction. It can constitute a potential problem to the interior landscape, especially during the construction phase and therefore should at least be understood.

There are many sources of indoor air pollution. Some may cause toxic damage to foliage plants. Fortunately, studies have shown many of these volatile organic chemicals (VOCs) are actually removed by the dynamic processes of foliage plants. Here is a brief listing of VOCs and their sources:

1. Formaldehyde - Emitted from: caulking compounds; ceiling tiles; draperies; fabrics; floor coverings; paints; particleboard; plywood; stains and varnishes; and upholstery
2. Xylene/Toulene - Emitted from: adhesives; bioeffluents; caulking compounds; ceiling tiles; floor coverings; paints; particleboard; stains and varnishes; and wall coverings.
3. Benzene - Emitted from: adhesives; caulking componds; ceiling tiles; floor coverings; paints; particleboard; stains and varnishes; and wall coverings.
4. Ammonia - Emitted from: bioeffluents; and cleaning products.
5. Alcohols - Emitted from: adhesives; bioeffluents; carpeting; caulking compounds; ceiling tiles; floor coverings; paint; particleboard; stains and varnishes; and wall coverings.
6. Acetone - Emitted from: bioeffluents.

Some pollutants damaging to plants are:

1. Hydrocarbons - automobile exhaust, heating systems
2. Ammonia - Cleaning fluids
3. Chlorine - pools and fountains
4. Smoke - Cigarettes, cigars in excess

IRRIGATION

Introduction

The supply of moisture to the soil mass is critical in the survival of the interior foliage plants. Although it may sound like an elementary process, the supply of moisture to the plants in the project is in fact, a rather complex operation. The supply of water, how it will be supplied and some inherent problems with water types, are all factors to be considered in the design process, if the interior landscaping is to be successful and economical. Irrigation of the plant materials will be covered in greater detail in the irrigation design process, however, there are technical questions which must be addressed at this time.

Water Quality

There can be several problems associated with the quality of the water supply. The water supply specified for use as plant irrigation should always be tested. If the water supply has high levels of soluble salts (200 PPM or over), continued use will cause a build up of salts in the planting media. If soluble salts are in excess of 200 PPM the water source should be treated by the Deionization process. Water for plant irrigation should never be "softened" by the Zeolite process.

As the design progresses, McCaren Designs may submit a water sample of the domestic water supply for horticultural water quality analysis. Based upon the results of this analysis we will recommend appropriate water treatment.

Water Temperature and Source

The water should be delivered to the irrigation room via a 1" line and the temperature should be between 60° and 70° F. This may dictate the mixing of hot and cold water.

Drainage

Proper watering procedures dictate the entire root ball be moistened at each watering. This will produce excess water runoff. It is mandatory this excess be drained away. Therefore, it is necessary that a drain line to each planter be incorporated in the design or an acceptable percolation through the subsoil be achieved.

Waterproofing

Planting areas not draining into the subsoil must be watertight. Waterproofing is not straightforward because of the chemical condition created by the soil. The wide range of waterproofing is available for the waterproofing of the planters, but we prefer one called Commercial Industrial Membrane, CIM1000. Pipework and wiring entering the planters for the watering system and accent lighting must be allowed for in the design of the waterproofing.

ONGOING MAINTENANCE
Introduction

It is critical to consider post-construction and ongoing interior landscape maintenance issues during the design process. A well designed landscape is one in which there are virtually "no surprises", financially nor physically, when the building is turned over to the owner and maintenance begins. The smooth, day to day running of the plant maintenance begins with planning for it in the design phase.

Wash Down

In many atrium situations, the entire planted area needs to be designed as a "wet zone". This allows for the plants to receive a wash down to keep them clean. When dust is allowed to accumulate, the plants' leaves receive less light. Washing the plants with water keeps them free from dust and assists in insect control. It's almost like an "indoor rain" for the plants and thus has many of the same benefits as outdoor plants receive with a summer rain.

Biological Controls

The environmentally friendly solution today for insect and related pest issues includes biological controls. Basically, biological controls consist of predators feeding on the detrimental insects. Maintaining the appropriate balance between the predator and the pest is vital. Design issues which need to be considered to maintain this balance include: the ability to wash down the plants; and maintaining temperatures conducive to the predators. Ongoing maintenance of a biological program is dependent on having experienced personnel with the technical tools (microscope) to keep the interior landscape balanced.

Supplemental Lighting Systems

If supplemental lighting systems are required for the landscape's health, the design needs to consider how the building's maintenance team will access the lights for changing. In addition, the replacement of the lights needs to be budgeted based on the hours of usage and the hours of the bulb's life. All too often the lighting simply decreases over time with little notice by the human eye that this is happening, but accompanying this is plant decline.

Pruning

Overstory trees will require regular pruning to regulate growth and shape. Safe access to these trees via scissors lifts, ladders and other methods needs to be considered during the design process.

Work Room Space

Depending on the intricacy of the irrigation and fertilization system designed, an additional work room may be required to house all the technical equipment such as: fertilizer mixing tanks and related supplies. Specialized horticultural equipment and materials such as fertilizers need to be stored properly and safely as well.

DESIGN CHECKLIST

- have the proper light levels been achieved, and if daylighting is a source for these light levels have these been verified though daylighting analysis
- is the light of the proper spectrum to support plant growth (400 to 700 nm)
- does HVAC expose plants to linear air speeds in excess of 1.5m/sec.
- will adequate temperatures be maintainable at the appropriate levels
- will humidity levels be maintained in excess of 35%
- are there any sources of possible air pollution
- has the water supply to be used for plant irrigation been tested. (less than 200 PPM soluble salts)
- are there provisions for delivering irrigation water at a temperature of between 60° and 70° F.
- do all planting areas have adequate drainage
- have all planting areas been waterproofed, including electrical and plumbing entrance points
- has the entire planted area been designed as a “wet zone”
- have all the design factors been considered for the effective use of biological controls
- can maintenance crews easily access the supplemental lighting systems and have all the related ongoing costs been budgeted
- can the trees be pruned safely
- has an additional work room been planned for storage of all horticultural equipment and supplies