LIGHTING IN
LANDSCAPE

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(ADVANCED LANDSCAPE
DESIGN)
CONTENTS

1. INTRODUCTION

2. BASIC FUNCTION OF LIGHTING
   - POWER OF LIGHT

3. LIGHTING FUNDAMENTALS
   - ELECTROMAGNETIC SPECTRUM
   - HOW THE EYE WORKS
   - RODS AND CONES
   - EYE PERFORMANCE AND LIGHTING CRITERIA
   - LUMINANCE CONTRAST

4. LIGHT AND COLOUR
   - LIGHT SPECTRUM
   - COLOUR TEMPERATURE
   - COLOUR RENDITION

5. LIGHTING AND BEHAVIORAL RESPONSE
   - LIGHTING LEVEL

6. LAMPS

7. LIGHT FIXTURES
   - LANTERNS
   - BOLLARD AND PATH FIXTURES
   - POST, WALL-MOUNTED, AND HANGING FIXTURES
   - SURFACE-MOUNTED FIXTURES

8. FACTORS TO BE TAKEN INTO CONSIDERATION
   - BRIGHTNESS
   - GLARE
   - DISCOMFORT GLARE
   - DISABILITY GLARE
   - DISTANCE AND ANGLE OF LIGHT
• DEPTH
• REFLECTANCE
• CHOOSING LIGHT BULBS
• COLOUR RENDERING
• COLOUR TEMPERATURE
• LIGHT BULB LIFE
• ENERGY EFFICIENCY
• CHOOSING A SYSTEM
  ▪ HALOGEN PROJECTOR BULBS
  ▪ HALOGEN DICHROIC BULBS
• POSITIONING

9. TYPES OF GARDEN LIGHTING

• TYPES OF LIGHT FITTINGS
• LINE – VOLTAGE LIGHTING
• LOW – VOLTAGE LIGHTING
• WIRING APPROACHES
  ▪ MULTIPLE-FEED WIRING METHOD
  ▪ MULTIPLE-TRANSFORMER WIRING METHOD
• SOLAR LIGHTING
• DIRECTIONAL LIGHTING
• PATH AND STEP LIGHTS
• AREA LIGHTING
• FLOOD LIGHTS
• SECURITY LIGHTS
• LINEAR LIGHTING
• STRING LIGHTING
• TAPE LIGHTING
• FIBRE – OPTIC LIGHTING

10. THE PURPOSE OF LIGHTING

• ORNAMENTAL LIGHTING
• AMENITY LIGHTING
• TASK LIGHTING
• ACCESS LIGHTING
• SECURITY LIGHTING
11. SOME EXAMPLES

12. GARDEN-LIGHTING EFFECTS

- DOWNLIGHTING
- UPLIGHTING
- GRAZING
- WASHING
- CROSSLIGHTING
- ACCENT LIGHTING
- SPOTLIGHTING
- MIRRORING
- SILHOUETTING
- THE HALO EFFECT
- AREA LIGHTING
- FLOODLIGHTING
- STEP AND VISTA LIGHTING
- SPREAD LIGHTING
- SHADOWING
- MOON LIGHTING
- DIRECT LIGHTING
- INDIRECT LIGHTING

13. LIGHTING GARDEN FEATURES

- WATER FEATURES
  - MOVING WATER
  - STILL WATER
  - COMPLEX WATER FEATURES
  - UNDERWATER LIGHTING
  - FOUNTAINS
  - WALL FOUNTAINS
  - POSITIONING UNDERWATER LIGHTS
  - LIGHTING FISH PONDS
  - BRIDGES AND STEPPING STONES
  - WATERFALLS
  - UPRIGHT WATER FEATURES
  - LOCATING FIXTURES ABOVE THE WATER’S SURFACE
  - SAFETY
  - LAMPS
- FIBRE OPTICS
- PLANT MATERIALS
- SCULPTURES
  - UPLIGHTING VERSUS DOWNLIGHTING
  - ONE VIEWING DIRECTION
  - multiple viewing directions
- WALKWAYS AND STAIRS
LIGHTING IN LANDSCAPE

Lighting can optimize outdoor spaces all year round. Proper lighting has long been heralded as number one theft deterrent, but it need not be harsh or merely functional. One can achieve a wide range of effects with lighting like highlighting outdoor master pieces, using accent lighting to create silhouettes and shadows, and spread lighting to maximize their beauty.

The basic function of lighting is to extend the hours in the day. Visible light is the light that our eyes detect, and the aim of artificial lighting is, on the whole, to provide conditions that approximate natural light, so that we can see objects at night as we do during the day.

Power of light

Lends character to city at night

Recessed uplights placed close to the base of the rocks emphasize the surface textures, as well as revealing colour and shape against the dark backdrop of unlit trees.

Illumination is provided by hidden light sources so the beauty of the garden scene is not compromised by the obvious presence of lighting hardware.
An illuminated statue provides a beautiful focal point in a garden.

Uplighting a mature tree adds vertical drama to the night time view of the illuminated garden.

The ornamental lighting is complimented by terrace lighting, which can be controlled by a separate switch to cater for different uses of this “outdoor” room.

**Lighting Fundamentals**

**Electromagnetic Spectrum**

The electromagnetic spectrum has a range of wavelengths, Gamma to Radio waves. Only a small part is Light waves.
The electromagnetic spectrum shows the continuum of all electric and magnetic radiation. The portion visible to the human eye is the small portion roughly in the middle, called the visible spectrum. The expanded portion showing the visible spectrum shows how it encompasses all colours of the rainbow, from violet to red.

How the eye works

The eye sees images of brightness. Light enters the eye and strikes the retina, a layer of light-sensitive cells along the back wall of the eye. The retina has two types of photoreceptors: cones, high-light-level receptors, and rods, low light level receptors. These receptors generate photochemical reactions that travel along the optic nerve to the brain. The brain collects these signals and translates them into pictures.

The eye reacts to light levels by involuntary action of the iris, a kind of shutter mechanism. In bright light, the iris protects the eye by closing over the pupil, the black, circular opening that allows light to pass to the retina. In dim light, the iris opens to expose more pupil and allow more light into the eye. Adjusting to bright light is called photopic vision, and to dim light, scotopic vision.

The eye perceives an object based on the amount of light reflecting off it. Three factors influence the amount of light that will reflect off the object to the eye: colour, texture, and finish. Light colours reflect more than dark colours. Smooth textures reflect more than rough surfaces. Shiny surfaces reflect more than matte surfaces. The apparent brightness of an object also depends on the brightness of the surrounding area or brightness contrast from one to the other.
Rods and Cones

Eye also can sense shape and colour. Rods in the eye help to determine the shape. Cones distinguishes colour. Rods and cones respond to the colours of light in a different way.

In normal visual conditions with sufficient lights available, rods provide the perception and cones distinguishes colour. This is known as Photopic Vision.

In low brightness levels (0.035 cd/m²), cones do not function but low definition perception with rods are possible and blue is more visible than red. This is known as Scotopic Vision. Transitional state with partial cone function is known as Mesopic Vision.

Eye Performance and Lighting Criteria

Visual Requirements based on Perception:

- Object must have minimum apparent size.
- Object must have minimum brightness (luminance).
- Object must be adapted to the overall luminance in the field of view.
- Object must have certain minimum contrast (brightness and/or colour) with respect to its surroundings.
- Object must be presented for a certain minimum period of time.

Luminance Contrast

A dark surface against a dark background will appear 'lighter' than when placed against a light background.
Light and Colour

Light Spectrum

Wavelength of 380nm - 800nm is occupied by light waves. It is identified by colours violet to red.

Colour Temperature (Tc)

<table>
<thead>
<tr>
<th>Temperature (K)</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>2700</td>
<td>incandescent white</td>
</tr>
<tr>
<td>3000</td>
<td>warm white</td>
</tr>
<tr>
<td>3500</td>
<td>white</td>
</tr>
<tr>
<td>4000</td>
<td>cool white</td>
</tr>
<tr>
<td>5000</td>
<td>daylight</td>
</tr>
<tr>
<td>6500</td>
<td>cool daylight</td>
</tr>
</tbody>
</table>

Light sources having same colour temperature will have same colour appearance.

Correlated Colour Temperature

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Tc</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL Colour 82</td>
<td>2650K</td>
</tr>
<tr>
<td>TL Colour 84</td>
<td>4000K</td>
</tr>
<tr>
<td>TL Colour 54</td>
<td>6500K</td>
</tr>
<tr>
<td>High Pressure Sodium</td>
<td>2300K</td>
</tr>
<tr>
<td>High Pressure Mercury</td>
<td>4000K</td>
</tr>
<tr>
<td>Metal Halide (HPI)</td>
<td>5000K</td>
</tr>
</tbody>
</table>

Different types of lamp produce light with a different colour temperature.
**Colour Rendition**

Colour of any object is due to selective reflection. Colour impression of a surface is determined by the spectral wavelengths in the incident light. For thermal radiators (incandescent lamps), all colours are present as a continuous band. For selective radiator (discharge lamps), only selected colours are present. The number, arrangement and relative intensity of the spectral lines present in the light generated by a lamp, determine how faithful the surface colours can be reproduced under that light. This is the colour rendering of a lamp.

![Colour perception under incandescent lamp with yellow filter.](image1)

![Colour perception under low pressure sodium vapour lamp.](image2)

**Colour Rendition of Typical Lamps**

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Ra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent</td>
<td>100</td>
</tr>
<tr>
<td>Fluorescent Colour 33</td>
<td>66</td>
</tr>
<tr>
<td>Fluorescent Colour 54</td>
<td>77</td>
</tr>
<tr>
<td>Fluorescent Colour 84</td>
<td>85</td>
</tr>
<tr>
<td>Fluorescent Colour 94</td>
<td>93</td>
</tr>
<tr>
<td>High Pressure Sodium (SON)</td>
<td>26</td>
</tr>
<tr>
<td>High Pressure Mercury (HPL)</td>
<td>45</td>
</tr>
<tr>
<td>Low pressure Sodium (SOX)</td>
<td>(-44)</td>
</tr>
</tbody>
</table>
Lighting and Behavioral Response

Lighting Level

Typical lighting levels a person is exposed during daytime in outdoor areas.

Lighting level is determined by the level of eye task.

Lighting level is determined by the speed of activity and size of object.

**Soccer:**

*Slower Speed and Large Ball*

*Competition Level: 150 Lux*

**Tennis:**

*Higher Speed and Small Ball*

*Competition Level: 500 Lux*
Lamps

- INCANDESCENT LAMPS
- GAS DISCHARGE LAMPS
- FLUORESCENT LAMPS
- HIGH PRESSURE MERCURY VAPOUR LAMPS
- METAL HALIDE LAMPS
- HIGH AND LOW PRESSURE SODIUM VAPOUR LAMPS
- INDUCTION LAMPS

<table>
<thead>
<tr>
<th>Lamp Defining Parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminous Efficacy</td>
<td>Lumens / watt</td>
</tr>
<tr>
<td>Colour Appearance</td>
<td>Tc</td>
</tr>
<tr>
<td>Colour Rendering</td>
<td>Ra</td>
</tr>
<tr>
<td>Life</td>
<td>Burning Hours</td>
</tr>
<tr>
<td>Size &amp; Shape</td>
<td>Desired optics</td>
</tr>
</tbody>
</table>

Light Fixtures

**Fixture types** – There are two categories of fixtures: decorative and functional. Decorative fixtures need to conform to the style of the landscape during the day and can contribute to the luminous composition at night. Functional fixtures are used to create visual effects throughout the landscape and are typically hidden from view. Some fixtures fall into both categories.

Lanterns

Lanterns are decorative fixtures. The lantern category includes many styles of traditional fixtures that recall outdoor lights of earlier times in history and of different cultures. For example, the Japanese culture produced both portable and permanent stone lanterns. Today, lanterns typically provide a decorative element in the garden, but they can also add soft fill light. Some are not electrified, using candles or gas to produce light. When they are electrified,
the wattage of lamps must be kept low (3 to 15 watts) to avoid having the lens or opening become too bright.

Examples of lanterns.

Bollard and Path Fixtures

Bollards provide task light for walkways and carry a visual design style through the site. Typically, bollards have a substantial size and strong construction to withstand the rough conditions experienced in commercial projects. Path fixtures will be smaller in size and more residential in appearance. All families of lamps, incandescent, fluorescent, and HID are represented in this category. Bollards typically use compact fluorescent or low-wattage HID sources. The fluorescent wattages may be as high as 26 watts and the HID in the range of 35 to 70 watts. However, most path light fixtures will use either incandescent or compact fluorescent lamps. Incandescent wattages range from 7.5 to 25 and compact fluorescent from 5 to 13 watts.
Examples of path fixtures, bollards, and mounting methods for path fixtures. The mounting method determines flexibility or permanence. A. Any 12-volt fixture can be stake mounted, providing ease of movement. This method makes the fixture less physically stable and should not be used in any commercial installation. B. Mounting to a ground-recessed junction box provides more stability. C. Setting the below-grade junction box in concrete bolsters the permanence. D. Mounting a fixture onto another post, in this case wood, provides continuity within a site using wood detailing and strong support.
Post, Wall-Mounted, and Hanging Fixtures

The main purpose of post, wall-mounted, and hanging fixtures is visual decoration, but they can provide walkway light, identification, or general illumination. Post fixtures are often used at a drive or walkway entrance, while wall and hanging fixtures often adorn entrances to buildings. The shape of the fixture needs to coordinate or integrate with the architectural design of the project, and the wattage needs to be planned to provide the light needed while not creating glare on the lens of the fixtures or hot spots on walkway surfaces below the fixtures. The wattage range of incandescent sources for residential wall-mounted or hanging fixtures should be between 3 and 25 watts. The wattage for post fixtures may be slightly higher (up to 40 watts). Compact fluorescent lamps below 13 watts also work. For commercial projects, both compact fluorescent (26 watts and below) and HID (70 watts and below) sources are used.

Examples of post-mounted and wall-mounted fixtures.
Examples of hanging fixtures.

Surface-Mounted Fixtures

Fixtures intended to illuminate steps can be recessed into either the sidewalls of stairs, into the risers, or under the nose of a tread. These fixtures are often quite small in order to recess into walls of limited thickness. Their size also needs to relate to the scale of the stairs. Several manufacturers make units the size of a standard brick so that a fixture can easily be integrated into a brick wall. These fixtures range in wattage from 20 watts (or less) in low-voltage subcompact to 60 watts (or slightly higher) in A-lamp incandescent, 5 to 26 watts in compact fluorescent, and 30 to 50 watts in HID. Designers need to examine the faceplate appearance. Any fixture with a lens will attract attention to itself rather than inconspicuously lighting the steps. Fixtures with louvres or shrouds draw less attention to themselves, but designers should test these fixtures prior to specifying them, as some cast louvre shadows. Designers should consider the light distribution from the step light to ensure that the fixture will adequately illuminate the stairs.
Examples of step light fixtures.

Factors to be taken into consideration:

Brightness

In creative garden lighting, it is always important to avoid glare, which will instantly ruin an otherwise well-lit scene. Brightness and glare, however, are two sides of the same coin.

A combination of lighting under the bridge, underwater lighting, and uplighting of the waterfalls brings this scene to life after dark.
Glare

Glare is a common problem, especially if the light source is itself visible. There are two main types of glare:

**Discomfort glare** is the name given to the type of light in which it is possible to perform a desired function but with some degree of discomfort. We have to squint through the glare towards an object or shield our eyes with a hand in order to see the illuminated area below or beyond the glare.

**Disability glare** is the term for the light in which normal vision is impossible, and we may even become disoriented because nothing useful is visible. It is often the result of unexpected exposure to very bright lighting and is the theory behind security flood lighting.

*Illumination of the garden scene should ensure that glare from the chosen fixtures is eliminated.*

*Avoiding glare: Because the level of ambient light in garden is usually lower than indoors it is especially important to place luminaries carefully to avoid glare.*

*Under-bench lighting will minimize glare.*
Distance and angle of light

The apparent brightness of light falling on an object is affected by a number of factors. The further away the light bulb is from the subject, the brighter the light source must be to achieve the same effect. A further variable is the angle at which the light strikes a surface. If a circular beam is directed at right angles to a wall it will provide a circle of light of a given level. If the light strikes the same surface at the same distance from the same bulb but from a different angle, however the same amount of light is spread over a larger, oval area. The light level is reduced by a factor relating to the angle at which the light strikes the surface. In addition, our perception of the brightness of light depends to some extent on what other lighting is around it: a single accent light will appear brighter if there is little ambient light then if there are other similar areas of light near by.

Depth

Varying the amount of brightness introduced into areas of a scene determines the appearance of depth in the space. To manipulate depth, identify three zones in the scene: foreground, midground, and background. The general rule in creating depth calls for providing the brightest light in the background, with the foreground second in brightness, and the midground darkest. The foreground zone provides the visual transportation from the higher light levels of the interior space to the darker environment of the exterior. Many circumstances call for breaking this general rule:

- Limiting depth to hide an ugly feature in the background such as a power pole. In this case, the background may not be lit at all.
- Limiting depth to add mystery or drama to the scene. Again, light may be withheld from the background.
- Calling attention to a focal point in the middle area while hinting at depth by providing a layer of soft light in the background.

Knowing whether to use this rule, use a modified version of it, or break the rule completely depends on the statement the designer wants to make in the landscape. The effectiveness of the statement will depend on careful introduction of light onto focal areas and then balancing brightness throughout the scene.
Landscape zones. Divide all areas into three zones: foreground, midground, and background. The amount of light used in each zone either increases or decreases depth in the composition. Highest level of light in the front diminishes depth. Highest level in back emphasizes depth, making the space feel larger. The drawing shows ranking the zones to increase depth.

This series of sketches shows how the visual composition changes as the treatment of the midzone varies. A. In this first sketch, the midzone is left dark. This visually separates the foreground from the background, which emphasizes the background and decreases the sense of depth. B. In this sketch, moonlighting introduces a soft pattern of light and shadow in the midground that softly ties the foreground to the background. C. This last sketch shows floodlighting the midground, visually integrating all three zones, and increasing apparent depth.
Reflectance

The word “reflectance” is used to describe the percentage of light reflected from a surface. Dark colours reflect much less light than lighter colours and also absorb more light than they reflect. Rough surfaces scatter light and significantly reduce the amount reflected toward the eye compared to smooth surfaces.

White walls have a high reflectance, relatively low levels of light can be used to light the walls & throw the spiral topiary into silhouette.

Choosing light bulbs

Good lighting is fundamentally about choosing the right bulb for the job. The light bulb or halogen bulb provides a light output appropriate for lighting a patio, illuminating the route from the car to the house, or providing lighting around the front door. Wall lights are typical uses for halogen light bulbs.

Patio spotlights can be timer-operated to provide an illusion of occupation when no one is at home.

Tubular and compact fluorescent bulbs and many of the types used in street lighting come into this category; they provide an all-around light that diffuses in all directions unless controlled or directed by an external reflector. Garden lighting is principally about creating effects, and it requires a considerable degree of control in the direction of the light source. Creative garden lighting cannot generally be achieved by diffusion light sources; instead, we use reflector bulbs. These are bulbs that use a reflective coating or a shaped mirror surface to project a controlled beam of light. Only a few diffusion light sources are used in garden lighting, including metal halide bulbs, and their small size makes them suitable for use with external reflectors to produce controlled beams of light.

Types of lightbulbs used in garden lighting. From left: PAR38 halogen reflector bulb; 12-volt (automotive) halogen bulb; halogen bulb; halogen bulbs in reflector, capsule, and linear types; compact fluorescent bulbs; metal halide bulbs.
A good range of accessories is available if you know where to look; here are various louvres, cowls, lenses and doors.

**Colour rendering**

We take the natural colour of daylight for granted and assume that artificial lighting should strive to match it, a phenomenon known as “colour rendering.” Colour rendering is not always the most important factor in the choice of bulbs, however. Street lighting mainly uses sodium lighting, as its high energy-efficiency and long bulb life outweigh its awful orange-coloured light output. Fortunately, most other light sources aim at a closer approximation to daylight. Metal halide lamps are becoming more popular in particular.

![Image of a tree with bluish hue and a statues in a garden illuminated by white light]

*The bluish hue of the tree is a result of uplighting with a mercury vapour bulb; this contrasts with the colour achieved by illuminating the statues with white light from halogen bulbs.*

![Image of a garden at night illuminated by coloured lights]

*Startling effects can be achieved with coloured lamps or filters, but such strong colours may not always suit everyone’s taste.*
**Colour temperature**

Another measure for light bulb types provides a relative indication of the colour of light. This is the colour temperature, which is expressed in degrees Kelvin or K. What might be thought of as warm colours-yellows and oranges-are, in fact, at a lower temperature than the cool blues. Halogen and the 3000K metal halide bulbs are among the most pleasing to use in garden-lighting design because their fairly white light tends to flatter the natural colours of flowers, foliage, and building materials, and fits in with our perception of “natural” colour. Fluorescent bulbs are available in a range from warm to cool white for different applications. Warm white is favoured in most gardens because it resembles the colour of halogen lighting, which has a mellow look. Cool white on the other hand, tends to look harsh.

**Light bulb life**

Light bulb life is another factor to consider, particularly for lighting that is in regular use – for example, if it is switched on every night by a timer or photocell. Halogen bulbs produce light by incandescence. Other types of “discharge” bulbs produce light by using less energy and are becoming increasingly popular for wall lights and lantern fittings. Long-life, high intensity discharge bulbs, such as the metal halide types, are used for uplighting large trees.

**Energy efficiency**

Energy efficiency is another advantage of halogen bulbs. Not only do halogen capsule and reflector bulbs run on 12 volts – a safer voltage to have outdoors – but they are also very efficient. Compact fluorescent bulbs typically use about 20% of the power of a halogen bulb for the same light output. For higher power applications, such as uplighting large trees, a metal halide bulb will typically save more than 85% of energy of a halogen bulb or 75% of the energy of a liner halogen floodlight bulb doing the same job.

**Choosing a system**

Depending on your requirements, each type of commonly used lighting system has its advantages and disadvantages in terms of cost, colour, energy efficiency, and flexibility.

- **Halogen projector bulbs** – the most common example is the PAR38 bulb, a reflector bulb relatively inexpensive and widely available, requires little specialized knowledge to use to create a simple lighting scheme. Drawback is that it is mainly available in higher wattages, from 60 watts upward, popular bulb for the general uplighting of trees. In this role, a spot of flood beam is suitable for lighting columnar and spreading trees. It is available with colour coatings, usually green, red, yellow and blue.

- **Halogen dichroic bulbs** – creative garden lighting has recently come to be dominated by the MR16 low voltage halogen bulb. It provides a controlled beam of light with little peripheral light spill. These bulbs run on 12 volts. The MR16 is twice as energy efficient as the PAR38 halogen bulb. MR16 bulbs are available in wattages from 10-75 and beam angles from 7-60 degrees, giving much more choice in accurately and precisely lighting subjects without glare. The wide range of bulb choices is reinforced by its small size. The fixtures can be much smaller and yet produce more light than old fashioned halogen fittings, allowing much more flexibility in their use.
An MR16 halogen reflector bulb is about one-tenth of the overall size of a PAR38 halogen projector bulb, but provides the same light output.

Positioning

A higher wattage bulb does not necessarily produce a brighter effect. Spot lighting by using a narrow-beam halogen bulb will produce a more intense circle of light than a wider beam of the same wattage and a narrow beam reflector more tightly focuses the light. This not only makes best use of the wattage capability of a light bulb but also serves to make the subject that is being lit more prominent than the other objects around it. Higher wattage, wide beam bulbs are often used for the general illumination of major shrub borders and spreading trees, while lower wattage, narrow beam bulbs are used to accent individual features.

Bollard lights illuminate this steep flight of steps to provide safe access; line-voltage bollard lights provide high light output that is often more functional than decorative.

A low voltage spreadlight provides a pool of light around a path or low planting, while hiding the light source under the hat on top.

Garden Lighting:

Designing a garden lighting scheme is not just a question of selecting from among the range of wall-mounted, recessed, or spike-mounted lights. It is also important to distinguish the ways in which power can be introduced into the garden and to match the different types of light sources that are available to the appropriate features. Steps, for example, will be lit in a quite different way from a specimen tree, or the area around a barbecue.

This plastic bollard light is from a low-voltage kit powered from an interior transformer. It illuminates a small area of paving or low planting. As the bulb is low power, glare from the unshielded light source is unlikely to be a problem.
Types of light fittings:

Some names given to light fittings simply express what a light fitting does – floodlights and spotlights, for example. Other names, however, may describe the ways in which the fitting is mounted (wall lights and step lights), its direction (uplights and downlights), its power source (solar lights and low-voltage lights) or its function (security lights). Other names have a historical, rather than a functional, resonance—the term “bulkhead lights” derives from the original maritime usage, “coach lamps” dates from the days of horse power, and “lanterns” remind us of the time when this was a convenient way of carrying a candle or oil lamp.

This small solar light is designed to mark the route along the edge of a path rather than light a particular area. The compact design features a small solar-electric cell which provides limited recharge capacity for a battery and a low-wattage bulb.

Regularly spaced spread lights provide effective path lighting without detracting from other illuminated garden features along the route.

Line-voltage lighting

Until a couple of decades ago, nearly all lighting was line-voltage – that is, it was powered from the household current, usually somewhere between 110-120 volts. The light sources used were predominantly the halogen light bulb for wall lights, lanterns of various types, and PAR projector bulbs, mainly the PAR38 bulb, rated at 60-120 watts. These sources still survive in residential use, because of their low initial cost and because energy-saving lighting and lighting design in the home are not widely employed.

Modern line-voltage light sources like compact fluorescent bulbs are gradually taking over from halogen in exterior wall lights and lanterns, while metal halide high-pressure discharge lighting is being mainly used for uplighting large trees and architectural features. Metal halide flood lights and uplights provide a range of energy-efficient lighting power beyond that which can be handled by 12 volt equipment.
**Low-voltage lighting**

In low-voltage systems, line-voltage is reduced through a transformer to 12 or 24 volts, which is a safer level of voltage. This means that flexible wires can be used around the garden rather than the fixed wiring required for line-voltage systems.

**Wiring Approaches**

The basic guideline for wiring starts with circuit load. The total load that can be attached to a wire depends on the wire capacity, the system voltage, and the circuit breaker size (in amperes) back at the main panel. Additionally, the NEC requires that no circuit be loaded more than 80 percent. On a 120-volt circuit, the breaker will typically be either 15 or 20 amperes. Taking into account the 80 percent loading restriction, this translates into a total load of either 1440 or 1980 watts.

<table>
<thead>
<tr>
<th>VOLTS X AMPS = WATTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC REQUIREMENT: LOAD CIRCUIT ONLY 80% TOTAL CAPACITY</td>
</tr>
<tr>
<td>120 VOLTS X 15 AMPS X .80 LOADING RESTRICTION = 1,440 WATTS</td>
</tr>
<tr>
<td>120 VOLTS X 20 AMPS X .80 LOADING RESTRICTION = 1,920 WATTS</td>
</tr>
</tbody>
</table>

Prior to laying out the wiring approach, determine which fixtures will be controlled together and total the wattage of these fixtures. This will identify the total anticipated load for each group.

**Multiple-Feed Wiring Method**

The best way to handle voltage drop would be to provide two separate feeds and not link the group in a loop.

*This scheme shows the use of two separate feeds to minimize voltage drop. A wire feeds from the electrical panel to a remote, below-grade junction box. Each fixture is then fed with a separate wire for free range of movement.*
This method uses two feeds from the transformer, each running to a remote below-grade junction box located in the vicinity of each group of fixtures. The load on feed A is 150 watts and the distance to the junction box is 23 feet. Using a large wire size, voltage is preserved. The calculated drop to that junction box is 0.97 or 1 volt. From that junction box each fixture is then fed with a separate cable, allowing free movement.

To determine how long the cable can be from the remote junction box, the voltage drop calculation is used starting with the 11-volt level at the junction box. The load now drops from 150 watts to 50 watts (for each fixture). Calculating from this point allows each cord to be approximately 12 feet long. In this case, only 6 feet is needed.

Feed B would require a no.8 wire to the remote junction box, as the distance is 33 feet with a load of 200 watts. Again, from that point, the length of cord and voltage drop would be recalculated at the voltage occurring at the junction box and with the load dropping to 50 watts per fixture. The length of cord to each fixture could be as long as 30 feet and still stay within an acceptable voltage drop. Feeding each fixture with a separate cable increases both acceptable cable distance and the range of area each fixture can cover.

**Multiple-Transformer Wiring Method**

A better solution for feed B uses two transformers. The original one, located by the electrical panel, drops in size from a 500 watt unit to a 250 watt unit, since it will feed only the three fixtures (total 150 watts) located by the tree in the lawn. From the electrical panel a 120 volt feed is taken to a second transformer mounted in closer proximity to the fixtures (in the closet off the living room). This unit is also a 250 watt size to feed the four fixtures (200 watts) located by the tree beyond the porch. From that location separate feeds go to each fixture and can be as long as 88 feet using no. 12 wire.

The best approach, in this example for 12-volt fixtures, uses not only two feeds, but takes 120volts to a second transformer located closer to the fixtures for feed B. This allows using smaller wire sizes and greatly increases the distances possible for the individual fixture feed wires.
Solar lighting

The idea behind self-contained, solar-powered lighting products is the provision of low-power garden lighting without the need for line-voltage cabling. Common forms include miniature lanterns or pagodas. A small photovoltaic solar panel on top of each fixture charges an internal battery by day, and the light is switched on by a photocell at dusk. Some models include a moment detector to switch on the light when someone passes by. The light sources are usually fairly low power to strike a balance between brightness and battery life. How long they remain lit obviously depends on the power of the light source, the size of the battery and the extent of recharge provided by the duration and intensity of sunlight. Models are lower powered and are intended mainly for marking a path. Solar lights can be rather inconsistent and some makes are unattractive. The battery will need to be replaced at regular intervals. 
A more professional standard of lighting and electrical power can be achieved using a system of batteries charged from solar panels on a roof.

These solar-powered bollards will give up to four hours of bright light or eight hours of dimmer light, giving you a choice of uses.

These solar-powered lights give a glow and they are intended to indicate the route rather than to illuminate the path.

Directional lighting

Projector type of bulb, particularly low voltage halogen dichoric bulbs, also other types of halogen bulbs and some high-pressure discharge types, such as metal halide bulbs, are used to create directional lighting. The range of bulb beams will range from "very narrow spot" to "very wide flood". It can be a spike-mounted spotlight, which performs the function of uplighting, or wall-mounted, which performs the function of downlighting.

Spike-mounted halogen spotlights are versatile tools for lighting a range of subjects. This type of copper spotlight weathers to an attractive mottled brown finish and can utilize a variety of bulb wattages and beam angles to produce different effects.
A simple body, not much more than a lamp holder, carries a mains-voltage PAR spot lamp.

This path-lighter uses all-round louvers to direct the light in a downward direction only.

Path and step lights

Paths and steps are often lit with spotlights mounted on structures or trees. Where there are flanking walls, the use of discreet, surface, recessed step or brick lights provides localized lighting. In the absence of walls, the choice is often between spread lights (lights on a stick). These products may also be used to provide low-level lighting around patios and drives, while area lighting of steps is effective for access purposes, but produces a bland effect devoid of features or emphasis.

A path lit by overspill from other lit features. A perfect set-piece for a small garden or an intimate corner within a large area. The eye is drawn up towards the focal point of the figure, and this is reinforced by the light.
Area lighting

The mounting position may vary from wall mount or pillar top, to column or pole mount, such lights rely mainly on “diffusion” light sources to spread light around them, although some models have internal reflectors to maximize the outward spread of light.

Ornamental lanterns can be chosen for decorative purposes, as well as for garden illumination.

Two simple lanterns fit in beautifully with the style and feet of this terrace, and the cleverly placed mirror gives the illusion of much greater depth than really exists.

Low-level perimeter lighting is a good choice for a terrace.

Floodlights

They aim to reproduce the all-embracing illumination of the sun. It is seen at its most extreme form in sports stadiums, where the aim is to allow sports to be conducted in conditions as near to daylight as possible. Some requirements for high levels of lighting in gardens for which floodlighting may be appropriate—a tennis court, perhaps, or an area where horses are kept in the country. In suburban gardens, the need is usually more for lighting the children’s football game on the lawn or downlighting paved areas for parties.
Security lights

Flood lighting is means of security lighting, but there are alternatives. The term “security light” is usually associated with an individual flood light or wall-mounted fixture with a built-in moment detector that switches on the light when an intruder comes within the zone of coverage.

Lighting emphasizes hard landscaping, which can produce an effect described as “stark” or “minimalist”, depending on your point of view.

Linear lighting

Lighting a structure or a linear feature has been largely achieved by projecting a beam of light toward it or by placing fixtures to diffuse light onto it. A more novel approach called “outlining”, either using the light sources themselves to emphasize the linearity or using a hidden array of light to provide a linear effect. Some types of lighting, such as cold cathode and neon lighting are used by professionals; they require customized configuration. The principal products used in gardens and patios are landscape lighting, and fiber-optic lighting.

Linear lighting outlines the structure of the gazebo & provides some ambient lighting within.

String lighting adds an unusual touch to this line of espalier apple trees in winter.

String lighting

Most familiar as the small lights strung on Christmas trees, as the bulb life is quite short. Most Christmas lighting products are 110 volts and are described as being suitable for exterior use. A variation is rope lighting where a lighting string is threaded through a clear, flexible, plastic
hose. The bulb life is also relatively short, but this is a popular form of inexpensive outdoor lighting for parties and other festive occasions.

Rope lighting is often wound around the trunks of palm trees in middle-eastern countries. Rope light is usually a 110-volt product, so proper installation outside is essential, and use near water is not advised.

Long-life string lighting is a more permanent display. The most stylish way of using string lighting is to achieve an outlining effect on a tree with a less – dense canopy.

**Tape lighting**

Outlining has further developed to provide linear lighting in a more easily concealed strip format. The conductors are contained within a flat, insulated plastic tape, which can be fixed to flat surfaces or in miniature versions where the light string is concealed within plastic or metal strip for fixing under steps, for example. It is widely used as a means of lighting a gazebo or pergola, partly to outline the structure and partly to provide some subtle lighting for the area within.

**Fiber-optic lighting**

It is a new technology. It is available in two forms: side-emitting and end-emitting. Side-emitting fiber is used for outlining. End-emitting fiber-optic lighting is used to provide a pinpoint of light or to project a beam of light on a subject. It is relatively expensive for wide-spread use in domestic gardens. The fact that the fiber-optic cable carries no heat or electricity, which makes it very useful in water features. Only one bulb needs to be replaced for a whole lighting array, and a colour-wheel option means that changing colour effects can be achieved fairly simply, if required. Popular applications include outlining around the edge of a pool and accent lighting within complex water features, where electric lighting would be difficult to install or where it would be difficult to change bulbs. Installation needs to be precisely engineered.
The purpose of lighting

Identifying lighting needs. There are five main types of lighting:

- **Ornamental lighting** is used when garden features are lit for visual appeal. Lighting for aesthetics allows enjoyment of the environment. Lighting the exterior can provide a view from the interior out into the landscape, psychologically enlarge the interior space by visually fusing it with the landscape, and provide for activities such as entertaining and sports.

- **Amenity lighting** is introduced for safety and practical purposes – for example, on a patio to light a dining area, on a driveway, or near steps to make them safer and to avoid injury. Landscape lighting should provide a clear view of any potential obstacles in the environment, such as steps, intersection of land and water, and children’s toys left out on the patio.

- **Task lighting** makes it possible to carry out specific jobs, such as cooking on a barbecue or getting objects from an outbuilding.

- **Access lighting** permits safe movement around the garden by lighting paths, steps, doors, and water.

- **Security lighting** deters intruders, creates an illusion of occupation, and reassures home-owners. Security lighting is provided to avoid intrusion by trespasser. Light can be a deterrent to an intruder and it adds psychologically to an inhabitant’s feeling of protection. Security lighting can be a separate system, one layer of the overall composition controlled separately (for use when other layers are not needed), or an integral part of the overall system.
Some Examples

Underwater lighting of the wall fountain is framed by the lighting of the large urns, drawing the eye downward in this courtyard and away from the city lights outside. Downlighting the paved area adds foreground illumination for alfresco dining.

Ornamental lighting of statues, trees, and shrubs provides a continuous vista around the pool, while underwater lighting diffuses to provide general illumination of the poolside.

Uplighting of the house facade, coupled with downlighting of the decking and linear lighting of the steps produces an impression that is both ornamental and practical.

Uplighting reflects from the white walls to provide illumination within a small courtyard garden, helping to distract the eye from the surrounding buildings.
Uplighting and spreadlighting at intervals along this 400-foot driveway lined with Cupressus leylandii conspire to provide ornamental access lighting.

The underwater lighting in the pool defines the area of hazard for anyone walking around this area of the garden. Recessed uplights with low-wattage bulbs are a subtle way of marking out the pool edge for safety.

A twin PAR38 light with an integral passive infrared movement detector is an inexpensive but unattractive form of security lighting. A good example of detail lighting using twin up-spotlights with colour filters.
A less happy arrangement where the garden is largely ignored.

The pool of light within the garden balances the lighting within the conservatory, making the juncture between the two less apparent. You would scarcely notice that you had changed from one environment to another.

Providing brightness at the end of a passageway creates a visual destination. MR11 uplight fixtures tucked into a clipped hedge on the viewer's side of the arbour and aimed at the curve of the arches accentuates the structural shape and floral display. Utilizing a tight aiming angle with a deeply recessed lamp and 45° shielding louvre eliminates glare as someone walks along the arbour.
Garden-lighting effects

Achieving distinctive effects will require the use of the full range of lighting methods, which range from the comparatively straightforward techniques of uplighting and downlighting to the more subtle results that can be achieved by grazing, moon lighting and accent lighting.

Downlighting

Lighting in a downward direction from a structure to provide a pool of light on a surface or feature below can provide general illumination for safety, security, and appearance, as well as a contrast to the uplighting of other features. Possibilities include downlighting from a pergola beam onto a dining table or path below, downward grazing and wall washing from under eaves, and spotlighting downward onto statues and other features. Downlighting is a useful way to illuminate flowering plants because flowers tend to face upward rather than downward; pergola-, wall- and tree-mounted fixtures can be used for this purpose. Downlighting generally uses lower-power bulbs than uplighting because the applications tend to involve lighting downward toward the eye.

Downlighting highlights the shape of topiary which would otherwise be hidden in shadow by uplighting from below.

Uplighting

Lighting from below produces an effect that demands attention because it reverses the effect of daylight. The fixture should be aimed away from the viewpoint or shielded from view to avoid glare. Where there are multiple viewpoints, external glare shields or internal glare louvres can be used. Recessed uplights are recommended in flat areas to avoid visual intrusion,
maintenance problems like mowing a lawn and trip hazards. In other instances, spike-mounted uplights or spotlights are preferred as they are cheaper and can be moved easily or adjusted to suit plant growth or seasonal changes. It can produce effects like accent lighting, washing and grazing. Used where special emphasis on a feature such as a tree, statue, house facade or wall is required. Also ideal for “infill” lighting of shrub borders to provide a visual link between individually illuminated features and underwater lights below the surface.

Two metal halide recessed uplights punch light up through the structure of this cedar. Ground mist reveals the light beams.

A very dramatic effect is achieved by burying these spots under a layer of gravel. They illuminate the plants while marking the edge of the path.

Grazing

Where texture is an obvious aspect of a feature or surface, lighting at an acute angle from a position near the surface will emphasize it by casting a strong shadow. The light is “grazing” the surface (also called “texturing”) as well as being reflected back towards the viewer. An uplight placed close to the trunk of a tree will emphasize colour, form and texture. The same is true where an uplight placed close to a columnar tree, such as a conifer, can be used to emphasize the textural appeal of the foliage. A principal application is lighting stone or brick walls. Also using step and path lights to highlight decorative appeal of the colour and texture of the building material.

Grazing light up the brick wall emphasizes its texture, particularly in contrast with the adjacent rendered walls.
Washing

Providing an even coverage of light on a wall is called “washing” or “wall washing”. In modern gardens with painted, rendered walls lacking in texture, washing will draw attention to colour or reflect from light walls to define the space and create an intimate atmosphere. The key to this effect in a small or intimate space is to use a low level of lighting, which contributes to a subtle ambience. The fixtures used may be surface or ground-recessed and may feature either reflector bulbs (perhaps with frosted lenses to diffuse the light) or capsule bulbs within separate reflectors to provide diffused light. Manufacturers may use terms such as “wall washer” or “miniflood” for such fixtures. Washing can also be used to light hedges or conifer screens to provide visual links or backdrops to individually lit features, such as statues or urns. On a larger scale, wall washing from ground-mounted floodlights can be used for facades. A less common method of wall washing is to use small floodlights or diffuse downlights under the eaves of a house. Focused down the wall of the house, such fixtures can light the facade as well as the planting, entrance, and path areas below to provide security lighting.

Crosslighting

Crosslighting is another term that describes the position of the fixture and the direction of light rather than the resulting light effect. It means placing the fixture to the side of the subject so that the light travels across it. Crosslighting a hedge by means of spotlights fitted with wide-beam bulbs can result in washing or grazing effects just as effectively as uplighting from directly in front.

Crosslighting is most often used where lighting from the side will emphasize texture and form more than lighting from the front. This is particularly useful where the form of a light-coloured statue or relief on an urn would be visually flattened by frontal lighting to the point where the feature would appear as a flat cutout. Lighting from one side will often display this well, although part of the form is lost in shadow, which can be rectified by adding another fixture on the opposite side, either a little further away or fitted with a less-bright bulb, so that infill lighting is sufficient to blank out part of the shadow without negating the textural effect of the first spotlight. Spike-mounted fixtures will offer the most flexibility in balancing the lighting where two sources are used, but wall-mounted spotlights fixed to adjacent structures can be effective alternative.

Uplighting the statue from within the temple is complemented by crosslighting from the right which emphasizes the structure.
Accent lighting

Accent lighting uses directional fixtures to emphasize individual plants, focal points, or other features so that they stand out within the view, either against a dark background or where a backdrop of a hedge, wall, or planting is less brightly illuminated. It can be achieved by any positional technique – uplighting, downlighting, or crosslighting – and from any point of origin – under water, in a tree, in the ground, or on a structure. It is achieved by focusing a relatively intense beam of light on the subject that requires careful positioning and aiming.

Spotlighting

The term “spotlighting” is often confused with “accent lighting”, and quite often it is the same thing. It usually refers to circumstances where the fixture is placed at some distance from the subject to be lit, often because there is no nearer practical mounting position. Examples could include spotlights under the eaves of a building used to illuminate focal points or paving features at ground level, or lighting the canopy of a tree from a planted border some distance from the trunk to avoid the use of a spike-mounted fixture in an intervening lawn area. Narrower, more intense “spotlight” beams may be used to compensate for the distance from the subject or to achieve a tight circle of light around the feature.

Mirroring

Mirroring is achieved quite simply by accent lighting a feature on the far side of a body of water so that its image is mirrored in the water when it is seen from a viewpoint on the patio, in the house or from a strategically placed seat. The best subjects are those with a light colour and clear outline reflected in sharp focus on the water – for example, simple urns and classical features, such as a stone temple.

Mirroring of these busts of Bacchus and a Bacchae in the dark water of the swimming pool is a creative alternative to leaving the pool lighting on.

Mirroring effect will be achieved as long as the body of water is large enough to accommodate the size of the reflection from a given viewpoint. Because it depends as much on the angle of view as it does on the size of the subject, it can even be achieved on a miniature scale on a roof garden. The mirroring will succeed only if the subject is brightly illuminated and the water
is sufficiently dark. The lighting must be bright enough to outweigh any moonlight or glow from city lights on the surface of the water, and stray light from interior illumination or area lighting near the water must be eliminated. Underwater lighting should be avoided and lighting of adjacent areas limited in brightness.

![Uplighting the wall from behind the urn throws the phormium into silhouette against the background of textured brickwork.](image)

**Silhouetting**

This effect occurs when a dark image of a subject is created by lighting a wall or other vertical surface behind it. While the colour and texture of the subject are hidden, the interesting shape of a small tree, an architectural plant, or an object with a distinctive outline can make a fascinating focal point. An alternative is where screening plants are “silhouetted” against a pale wall to produce a textured tableau: bamboos are particularly good subjects for this treatment. Wide diffused beams, as used in straightforward wall washing, will give the best result. Occasionally, the effect comes not from garden lighting but from interior lighting silhouetting the exterior planting against the illuminated background of plain blinds, or perhaps “shoji” screens in a Japanese context to provide a pleasing backdrop to a terrace. Courtyards can benefit from this effect.

**The halo effect**

It is backlighting trees to produce a silhouette effect. What backlighting does is produce a halo of light around the edges of the trunk and branches in the case of a spreading tree or the foliage outline in the case of a conifer. The halo shows the shape or structure of the tree and is a subtle effect against a dark background. The halo treatment is often used where there is a need to provide variety among other trees and shrubs that are lit more from the front or side. If the lighting comes from directly behind the subject, the effect may be too subtle to have any impact. It is often better to place the fixture behind and slightly to one side of the tree to produce a more pronounced halo effect on one side. It works better where light filtering up through translucent foliage, such as that of some maples, adds a more colourful effect.

**Area lighting**

The function of area lighting is to provide sufficient general illumination within an area so that it is possible to do whatever activity is appropriate. It is the principal method of providing the kind of lighting we regard as essential in an outdoor room. On a patio that might include lighting to eat or read by, to help us navigate around the table and toys, and to carry food and utensils to and from the table. It is sometimes referred to as “ambient lighting”.

42
In the garden setting, area lighting should be sufficiently soft, diffuse, and flattering to create an ambience that is subtle, relaxing, and perhaps a little romantic. Unless ornamental techniques such as moon lighting from trees or wall washing from under the eaves of the house are feasible, area lighting is generally achieved by the use of line-voltage, wall-mounted lights on the house or on other adjacent walls, sometimes built for that purpose. These may be supplemented by column-mounted lights or by low-level lighting from spread lights.

A large garden may have more than one sitting area, each of which will require its own lighting.

Downlighting from between overhead beams is a subtle way of lighting an area for relaxation if the light sources are both obscured from view and limited in power.

Floodlighting

Floodlighting is, of course, the ultimate type of area lighting, designed to mimic the high power and bland spread of daylight. Its main application in residential premises is security lighting.

Downlighting from garden structures produces more subtle effects than floodlighting from house walls.

150 watts is more than adequate for many domestic applications. Using small, 100 to 150 watt halogen floodlights or 50 watt wide-beam downlights under the eaves of a two-storey house can provide adequate security lighting as well as washing the facade and lighting the planting, path, and entrance below. Floodlights should be focused downward within an angle of sixty degrees from vertical to avoid light trespass and glare to neighbouring properties, paths, or roads.
**Step and vista lighting**

Step lighting is a functional requirement rather than a lighting technique. Where overhead lighting is not an available option, lighting at step level becomes necessary. Each individual tread should receive direct lighting, unshadowed by the riser above, from light sources shielded within the fixture so the pedestrian is not blinded or distracted by glare while ascending the stairs.

Fixtures fixed in the risers of steps will be directly in the line of vision, but this is sometimes the only available option – where there is no flanking wall, bank, or balustrade, for example, or on circular staircases. It is better to provide step lighting through small lights set into, or mounted on, a flanking wall. Choose types that are characterised by shields, grilles, inset bulb housings, or “eyelid” hoods that hide the light source from passing overhead view.

Step lighting can also be useful when it is important to protect a vista – for example, when foreground lighting of steps, patio, or deck must be directed downward so that it does not make it impossible to see a view beyond.

**A louvred stainless steel recessed light adds a modern touch to glare-free step lighting.**

**Recessed step lighting provides safe access without excessive visual intrusion into the surface finish.**

**Spread lighting**

Manufacturers use the terms “spread light” or “path light” for their products, while consumers tend to call them “mushroom lights”. Spread lighting is the use of low-level fixtures to provide a glare-free, usually circular pool of light for a path, step, patio, or area of low planting. They
commonly have halogen bulbs or halogen capsule bulbs of around 20 watts and provide a circle of light 8-13 feet across. Where moon lighting cannot be used and where there are no walls or structures on which to mount recessed or discreet lights, spread lights must be used to fulfil essential safety functions in lighting path and steps, as well as to fill in areas of darkness.

Copper spread lights provide pools of light around decking and low planting. Weathered copper blends well with timber and gravel.

Shadowing

The shadow of a plant or small tree can be projected onto a wall behind by placing a spotlight in front of the plant so that the light shines through the foliage toward the wall. This simple technique uses a low-power, wide-beam bulb in a spike-mounted spotlight, typically 20-35 watts. Vary the distance between the light source and the object being lit to alter the size of the image that is projected on the wall. Shadowing is an easy way of achieving maximum effect from a small tree in a newly planted courtyard garden, and may also be used to cast the shadow of water spray from a fountain. Shadowing is usually directed at a vertical surface and its potential for paving is often overlooked.

A narrow flood, placed bottom left, illuminates the trellis, throwing patterns of shadow from the plants, while the small spot down lighter to the right provides support accent.
Moon lighting

Trees can be excellent lighting platforms for illuminating all manner of garden features and areas below, including herbaceous and shrub borders, terraces, lawns, driveways, paths, steps, and seating areas. A favourite technique is “moon lighting” down from low-power lights fixed in a tree to shadow the lower branches and foliage onto the ground below. This provides a wonderfully subtle, dappled, lighting effect over a tree seat and is also a creative way of integrating the lawn into the lighting scene.

Moon lighting down through the open structure of a deciduous tree throws a strong shadow of the branch structure onto the ground below. Uplighting of the trunk could link the two areas together more positively.

In a small garden, a halogen spotlight suspended from a branch about 16 feet above the ground with a 35 watt, 60 degree bulb would be a good choice. For denser foliage or higher mounting points, move up to a 50 watt bulb, but for smaller trees reduce the power to 20 watts.

If the light source is positioned 20-23 feet above ground, maintenance may become more difficult, so discharge light sources (metal halide or mercury vapour) are usually preferred because of their longer bulb life. Using “cooler” discharge bulbs of 4000-4500K colour temperature will also give you the slightly blue light of true moonlight, an effect you can also achieve with halogen fixtures by inserting a pale blue filter.

It is especially important to ensure that fittings are high enough above a walkway or seating area and not so bright as to invite an upward glance, which will only pierce glare. Internal honeycomb louvres can help to shield the light source from view, and glare guards are essential for fixtures directed away from the trunk. In the latter case, fittings must be directed downward, within a maximum of 30 degrees angle from the vertical to avoid glare toward viewpoints or neighbours.

Moon lighting from a tree should be accompanied by uplighting of the trunk to anchor the tree to the ground, avoiding an impression of glowing foliage floating above the ground.

Direct Lighting

Indirect Lighting
Lighting garden features

Lights can be used to create the illusion of, say, a path where none actually exists in order to draw attention to a feature.

Water features

The trickling water of a stream, the rush of a waterfall, the sparkle of a fountain, and the sheen of light on still water are all mesmerizing in their own ways. At night, water contributes a magical range to the palette of garden-lighting effects. However, electricity can be hazardous, particularly where water is involved, so proper precautions need to be taken and a professional needs to be hired.

Subtle uplighting preserves the serenity of this Japanese garden, while underwater lighting provides a charismatic central focus.
Moving water

The main interests in lighting lie in exploiting two properties of water – refraction and reflection. Refraction is the property by which light is bent as it passes through the surface of water. If the surface of water is moving – because it is disturbed by a nearby waterfall or the cascade from a fountain, for example – the refraction at the water surface is continuously varied and the light coming up through the moving water is similarly varied, the light beam being bent at random, producing a shimmering lighting effect. If we light a wall fountain, in particular, the whole scene becomes one of light dancing on the wall, the fountain and any adjacent planting.

*Underwater uplighting in a ring around the fountain catches the sparkling water falling from the fountain bowl. Crosslighting from outside the water feature reveals the upper features.*

In the above picture, this beautiful marble fountain, set in a formal pool, is lit with great drama from below the water. The up light gives good modelling to the figures and brings out the quality of the stone.

*A spotlight aimed at moving water will cause the light to ‘bounce’ off the water’s surface.*

*Install only luminaries that are specifically made for use underwater in a pool and always read the manufacturer’s instructions. Many of these luminaries use the water as a coolant and should not be switched on until they are submerged.*
**Still water**

The reflection of a statue, focal point, or specimen tree in dark, still water can create a stunning but tranquil scene. It involves a relatively simple technique and can be applied to any swimming pool, lake, or smaller pond or a body of water that cannot itself be lit. Lighting a strongly outlined subject or architectural feature on the far side of the pool produces an image that is reflected on the water in the foreground.

**Complex water features**

Water features that combine many different lighting opportunities within one area are found only in larger gardens. Sophisticated lighting design is achieved by looking at individual parts and the appropriate lighting effects and then by integrating them into a complete design.

![Complex lighting in and around this large pond includes underwater uplighting of waterfalls, lighting of planting that is reflected in darker areas of water, and underlighting the bridge. The overall effect is perhaps a little fussy and overly bright.]

**Underwater lighting**

Underwater uplighting of moving water, for example, a simple waterfall or fountain using a waterproof underwater spotlight, is a common and effective technique. The light adds the dimension of movement to otherwise still surfaces around the central cascade. The rippling of water by the wind can provide interesting movement.

Lighting a water feature from under the water’s surface creates dramatic effects. Sprays of water from fountain jets glow against the night sky’s darkness. Falls of turbulent water glow, accentuating the water’s power. Fixtures for these effects can sit directly on the pool bottom, be recessed into the bottom, or sit in an architectural recess below the bottom.

When water falls over a smooth weir, it falls as a sheet—with no air bubbles. In this case, the location of a fixture must be in front of the water, shining at it. This creates a sparkle of light on the water’s surface.

When the weir is rough, the water moving over it contains air bubbles. This means that the water will be agitated and should be lit internally using an uplight to create a glow as light interacts with the air bubbles in the water. The location of the fixture in the body of water below becomes critical, and there is little room for error. The fixture must be situated at the point where the falling water hits the surface of the lower body of water in order for the light to travel from this lower body of water up into the falling water.
Aerated effects should be lit from below, while smooth water effects need to be lit from the front.

Examples of below-water fixture locations for various types of water features.

**Fountains**

Where a fountain is only a gush of water propelled upward by an underwater jet, the foaming water is the feature to be lit. Positioning an underwater light immediately next to the source of the water spout will make sure that it is lit while concealing the light source within the luminescence of the foaming water. Often, the origin of the water flow may be a statue or another ornamental feature. In that case, the design needs to adopt some of the principles of statue lighting, particularly the need to avoid strong shadows that can obscure lighting sources and from too close to the feature.

Another consideration may apply with regard to tiered fountains. In larger tiered fountains it may be necessary to use two sets of fixtures. One will uplight the fall of water from the upper basin, the other will sit on the outer edge of the base pool or within the upper basin to light the feature from which the water flow originates. In most fountains, 35 to 50 watt bulbs are the norm.

**Uplighting from the lower pool is complemented by lighting of the upper feature from inside the tiered basin.**
In fountains, the configuration of the water display must be identified, including the number of jets; the type of water effect(s) (column or stream, cascade, mound, dome) and patterns they create; the height of each effect; and the overall width of the display.

**Examples of fountain types.**

When a single jet or group of individual streams is used to create a pattern shining straight up, each stream should have a minimum of two fixtures. This ensures that the lighting effect will be visible from all sides of the stream.
Plan and elevation of the lighting for a fountain.

**Wall fountains**

To avoid heavy shadows in lighting wall-mask fountains, avoid placing the fixtures underneath the water spout. The ideal technique is to position the fixture with a narrow or medium beam bulb so that light appears to travel up the water spout to accent the mask against the surrounding surface. While wider beam bulbs may be preferred for wall masks mounted on ornamental walls or to produce a wider area of shimmering light from below moving water, narrower beams will emphasize the water flow and mask. For larger wall fountains that feature several spouts, accent lighting of individual spouts while using low power, wider beam bulbs for an overall wash can be effective. 20 watt bulbs are powerful enough to illuminate most wall fountains.

![Wall fountain with lighting](image1)

The “sunburst” wall fountain provides a perfect focus for lighting upward from the cobblestone-filled basin.

![Uplighters](image2)

A pair of uplighters gives drama and form to this wall fountain.
Each gargoyle is cleverly lit from a concealed point under the lip of the pool, and there is sufficient ambient light from these three spotlight to illuminate the whole setting.

Underwater lighting is sometimes used to light upward from the bottom of a still pool or one without a central cascade to provide an overall luminescence that emphasizes the shape of the pool. This is particularly effective in a strongly geometric design. Using frosted lenses and locating the fixtures at the bottom of the pool helps to diffuse the beams when there is no foaming spout to mask the light source. Alternatively, lighting recessed into the side walls, as in swimming pools, or set on planting shelves to crosslight the pond and illuminate marginal planting can be used. This works well only where the interior surface of the pool is smooth and dark, or has a decorative or tiled finish, because the lighting will inevitably light the pool’s interior. The underwater lighting should be on a separate switch so that it can be turned off.

**Positioning underwater lights**

Unless the underwater lights are used for uplighting in a still pond, locating lights in the bottom of a pond can be less than effective. Murkiness can mask light output; oxygenating weed can quickly grow over the fixtures; pumps, piping, and filters are often revealed; and uplighting using a narrower beam bulb may be undermined by the effects of refraction. Locating lights separately from the pump usually provides better lighting opportunities. The best way to uplight a feature fountain or wall fountain is to position the underwater light so that the front lens is about 6 inches below the water surface, where water movement helps to hide the light source.

In shallower water features it is essential that there is enough depth in which to submerge and conceal the body of the fixture. Some models rely on water cooling to maintain bulb temperature and life, and so should be positioned at least 2 inches below the surface.

**Lighting fish ponds**

Mounting lights nearer to the surface, rather than at the bottom of the pond, has another benefit if there are fish: they are attracted to the illumination at night and stay active. Lighting koi ponds requires special attention to lighting, especially where there are valuable, prized specimens; smooth, fully recessed lighting is recommended.

**Bridges and stepping-stones**

Stepping-stones across a stream or pond can be lit by placing fixtures that shoot narrow beams of light alongside to mark the way ahead. This need not be too bright – a narrow beam,
20 watt bulb will probably suffice – as long as the underwater light has a guard above it or a grid across the lens to shield the bulb glare. Simple plank bridges can be dealt with by placing underwater lights under the bridge to shine out on either side and define the edges. Avoid this technique in a pond with a wrinkled butyl liner.

Lighting a bridge often provides sufficient illumination to define the positions of the horizontal pathway, vertical structure, and water’s edge. Obvious surface-mounted lights on the bridge structure are ugly, although small copper spotlights can often be acceptable because they weather attractively to blend with timber structures. Alternatively, spiking a spotlight into the bank close to each end of a bridge can light the structure well. Setting the lights at an acute angle will usually hide the light source from view as pedestrians cross the bridge, while using glare guards and internal glare louvres will control glare on the approach es to the bridge.

If walkway lighting is required, products that can light under a handrail or from the interior uprights can be used, but these need to be carefully positioned so they do not protrude into the walkway or intrude into the daylight view of the bridge. Spotlights mounted under the bridge shine down onto, beneath, and around the water, and this is attractive where there are rocks or plants to flatter the water area below. Take care to ensure that light bounced off the water surface does not become glare from another viewpoint. Though lighting emphasizes sparkle in water. Moon lighting from waterside trees is a better and more natural-looking way of lighting routes around and over water.

Waterfalls

Whether the water flows over a rocky precipice in a tumbling cascade or flows in a shimmering sheet over a metal chute or the flat edge of machined slate, the sparkle and luminescence as it falls into a basin below demand emphasis by lighting at night. The underwater spotlight is usually best located immediately below the entry point of the cascade of the water into the pool beneath so that it will be shielded among the foaming luminescence while the light beam is directed up the flow of water to create prismatic effects.

Uplighting the plank walls and timber structures provides an architectural framework for recessed crosslighting of this azure lagoon. The sheet of falling water receives light from the fixtures recessed into the decking, as well as from underwater lighting in front.
Where there is an interesting rock formation behind the waterfall, moving the fixture slightly behind the cascade can create the illusion of a rock grotto with a sparkling curtain in front. Underwater fixtures must be mounted on brackets, which can be tightened to maintain focus, and fixed on secure supports, which can withstand buffeting from water turbulence. The support must be moveable so that the optimum position can be achieved and so that the fixture can be removed from the water for occasional bulb changing and maintenance. Even in the cleanest water feature there will be a certain amount of encrustation resulting from waterborne salts and algae; this will have to be removed from time to time.

*Underwater uplighting of the waterfalls is complemented by infill lighting of the rocks and planting, which can't be reached by underwater fixtures.*

*Falls that are made to appear artificial give greater licence. These falls, though informally shaped, are non-the-less made to look ‘built’; the submerged uplighting adds to the fantasy and enhances the drama of the pool.*

*A waterfall can be either uplit or backlit.*

*A complex water course will require several light sources.*
The illusion of nature is deliberately broken here by the inclusion of the fossils and the submerged light at the foot of the fall.

An elegant, naturalistic fall is well lit by the side-light, focused to catch the movement of the water.

At the Seattle Freeway Park in Washington, the water feature incorporates many short falls with rough weirs. The lamps range in wattage from 250 to 1000 watts, depending on the fall height.
**Upright water features**

If it is upright, uplight it. Following this simple rule is usually the best approach because the vertical dimension should be emphasized to enhance the effect of the moving water. In water features such as cobblestone fountains, water drops onto a cobblestone, flint, or pebble layer that masks a supporting grid over the reservoir. This cosmetic layer over the grid is ideal for hiding a waterproof uplight. 20 watt bulbs will be sufficient, and you may need to use an internal glare louvre if the feature is close to a patio or window.

*Underwater uplighting of the waterfall produces shimmering illumination of the brick structure, while crosslighting of the water staircase adds a sparkling sheen to the trickling of the water running down.*

**Locating Fixtures Above the Water’s Surface**

Much lighting from above the water’s surface will be downlighting. Fixtures can be mounted on adjacent architectural structures or in trees. Sometimes the fixtures will be located on land adjacent to the water feature and aim up or horizontally toward the feature.

![Diagram of fixtures above water](image)

*Typical above - water locations for lighting water features.*

**Safety**

In decorative pools, the code requires that exposed cords be limited in length to 10 feet. All fixtures installed in the pool must be installed so that they can be serviced without reducing the water level of the pool. This means that all fixtures recessed into the structure of the pool must be a niche type. All fixtures must have stabilizing bases or must be securely mounted. This means that all fixtures located where water is moving should be attached to the pool bottom.
The fixture lens should be covered with an exterior metal grid, called a rock guard, that prevents people from touching the lens (which could burn the person or break the lens, potentially causing an electrical shock). Additionally, the cord should have a strain-relief fitting to eliminate pulling the fixture’s electrical connection apart.

**Installation details for a submersible accent - type fixture.**

### Lamps

![Diagram of underwater lighting fixture]

**UNDERWATER LIGHTING WATTAGE TABLE**

<table>
<thead>
<tr>
<th>Height of Fountain Effect</th>
<th>5'</th>
<th>10'</th>
<th>15'</th>
<th>20'</th>
<th>25'</th>
<th>30'</th>
<th>35'</th>
<th>40'</th>
<th>45'</th>
<th>50'</th>
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</thead>
<tbody>
<tr>
<td>Light Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wide Flood</td>
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<td>500</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Flood</td>
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<td>500</td>
<td>900</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spot</td>
<td>150</td>
<td>150</td>
<td>250</td>
<td>300</td>
<td>500</td>
<td>600</td>
<td>1000</td>
<td>1200</td>
<td>2000</td>
<td>2000</td>
</tr>
</tbody>
</table>

**MINIMUM BEAM CANDLEPOWER REQUIREMENTS**

<table>
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<tr>
<th>Water Effect Height (ft.)</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candlepower Required (x1000)</td>
<td>4</td>
<td>11</td>
<td>21</td>
<td>24</td>
<td>50</td>
<td>69</td>
<td>91</td>
<td>115</td>
<td>144</td>
<td>170</td>
</tr>
</tbody>
</table>

### Fibre Optics

Underwater lighting can benefit from the use of fibre optic technology. All of the restrictions that accompany putting electrical devices such as lighting fixtures underwater favour fibre optics, since none of the electrical components needs to be in the water. This allows easy access to the lamp for maintenance, minimizes the number of lamps and sometimes the overall wattage, and can create incredible effects.
Multiple fibre-optic filaments embedded into the walls of this cascade create the effect of lit water droplets moving down the fall. An illuminator (light fixture) with a 150 watt MR16 lamp uses an art wheel (template) with a pattern of holes to provide light randomly to the individual bundles, creating the movement effect.

Individual fibre-optic ends can be attached or embedded into the steps of a water fall to create individual pinpoints of light. With fibre optics, the light source is located in a mechanical room, which makes maintenance simple. Also, filters and templates can be attached to the housing to change the colour of light gradually over time or to control which fibres receive light, creating perceived movement of the light.

**Plant Materials**

*Lighting Trees: A light placed behind a dense tree or shrub will throw it into silhouette, emphasizing its shape and size only. When it is lit from the front and below, the tree’s form is evident but there is no indication of scale. When two uplighters are used, the shape and size of the tree are revealed.*
Positioning an uplighter beneath a tree.

The wattage chosen will depend on the height.

Detail and colour technique. Downlighting plant material creates a natural appearance featuring the shape of plants or groupings of plants, colours, and details against the night darkness. The sketch shows aiming angle guidelines for controlling glare. Only when people in the landscape will not see the brightness of the fixture or in adjacent properties should the higher aiming angles be used. The aiming angle guidelines apply to fixtures mounted in trees as well as on structures.
A tree’s physical appearance influences the technique a lighting designer uses on the tree. Here, a high, dense canopy and interesting trunk texture direct the designer to highlight the trunk and wash the canopy.

Many deciduous trees, including Flowering Dogwood (Cornus florida), look best in leaf. This Dogwood lacks interest and looks awkward during dormancy and should remain unlit. Other deciduous trees, such as Harry Lauder’s Walking Stick (Corylus avellana ‘Contorta’), look intriguing or beautiful when dormant. When in leaf, its huge, misshapen leaves obscure this tree’s best feature—the gnarled, twisting branches.

To emphasize the shape of a Giant Sequoia (Sequoiadendron giganteum), left, wash the canopy, aiming fixtures between 15° and 40° off vertical. Graze an upright Irish Yew (Taxus fastigiata) using narrow-beam lamps in fixtures aimed approximately 15° from vertical to
emphasize foliage texture. Plan the fixture distance from the tree (either stake-mounted or direct-burial) based on the plant’s growth habit, including initial and mature size and planned maintenance.

Trees with dense, rounded forms, such as the Southern Magnolia (Magnolia grandiflora) require multiple fixtures outside the canopy. Use 35° off vertical as the maximum aiming angle in the following situations: viewing at close range, viewing from several sides, and when the fixture lens is visible to the viewer.

Dense shrubs such as Rhododendrons, tall enough to block any view of the fixtures, look best washed. Move fixtures away from foliage and aim between 45° and 60° off vertical. When viewing the tree is restricted to one side, one fixture will suffice. If the view encompasses more of the plant, utilize more fixtures to complete the shape.
Italian Stone Pines (Pinus pinea) reach 40 to 80 feet in height and produce a dense, rounded canopy when mature. Uplighting under the canopy creates a wash on the trunk and underside of the canopy.

A graceful, spreading tree lit with one fixture creates a hot spot on a small area of the canopy while the rest remains in darkness. This creates a disfigured, ugly appearance.

Acer palmatum ‘Omuryana’ grows into a rounded, willowy form, 10 to 15 feet tall by 15 to 20 feet wide. With an open, cascading foliage pattern and translucent, brilliant green leaves, it glows when lit from inside the canopy. Use a minimum of three fixtures to show the full shape of the tree.
Plant habit variation within the same genus. Italian Cypress (Cupressus sempervirens) (A) typically has a pyramidal growth habit, but it can naturally produce pronounced lateral branching (B). The Smooth Arizona Cypress (Cupressus glabra) (C) has a more rounded growth habit.

Plant variation within the same genus and species. Two mature birch trees, European White Birch on the left, ‘Trost’s Dwarf’ on the right, display no family resemblance although both are of the same genus and species (Betula pendula).

Plant habit and growth variation within the same genus. Sampling of the growing habits of Pine trees, from left to right: Mugho Pine (Pinus mugo mugo), Austrian Black Pine (Pinus nigra), and Canary Island Pine (Pinus canariensis). The genus Pinus refers to the Pine family, which has at least 45 species. Some grow slowly, eventually attaining a height of 40 feet (Pinus nigra) or only 4 feet (Pinus mugo mugo).
A striking or intriguing trunk pattern accentuates a tree’s lit appearance. This list presents a representative sampling of trees that would benefit from special attention on their trunks.

Group one-ball or rounded tree. Uplight dense trees in this category from outside the branching structure of the tree. Fixture location depends on canopy dimensions, starting height above ground and appearance. Consider highlighting interesting trunks. Locate fixtures inside the canopy for trees with open branching and translucent leaves. Make sure that outer edges of the canopy appear lit. When necessary, provide additional lights outside the canopy. Large mature trees can provide a mounting location to downlight foundation planting, walkways, or lawn.
Group two - pyramidal or columnar/ upright tree. Pyramidal. Approach dense trees from outside the branching structure to show general shape. To ensure that light reaches the entire canopy, plan the fixture location away from the trunk based on the expected mature height of the specimen. With open forms, locate fixtures inside or outside the canopy based on leaf type and desired lighting effect. Translucent leaves and interesting branching formation encourage lighting from inside the canopy. Large, mature trees can provide downlighting-mounting locations. Columnar/upright. Approach both dense and open forms from outside the branching structure. To emphasize texture, place fixtures close to the branching. To emphasize shape, mount the fixtures farther away. Consider internally lighting hedges with open structure and translucent leaves so as to produce a glowing effect.
Group three-vase/fountain or umbrella tree. Vase/fountain shape. Light trees with open forms, especially those with translucent leaves, from within the canopy. Dense forms require moving fixtures farther away from the trunk or outside the branching structure entirely. Umbrella shape. Both dense and open forms can be lit from inside the canopy. However, with dense forms, light will not penetrate the leaves. For Palms, consider highlighting the trunk with a grazing technique. Some forms require additional lights for the fronds, due to the large expanse of the canopy.

Group four-weeping or branching to the ground tree. Weeping form. For dense trees, locate fixtures at the edge of the branching structure to highlight foliage, texture, and to provide depth around the tree. Consider additional fixture(s) for the trunk. For open trees, especially those with translucent leaves, locate fixtures inside the canopy. Branching to the ground form. For trees with dense branching locate fixtures outside the canopy. Either wash for shape or graze to bring out foliage detail. Consider combining the two techniques when both effects are desired. For short, dense evergreen and deciduous forms use downlighting.
This dwarf Japanese Maple (Acer palmatum) in the ‘Yatsubusa’ group may require many years to increase its size by a foot. Locate fixtures below grade to hide them, to increase the amount of lit canopy, and to reduce the chance of lamp heat burning leaves.

Flexibility becomes paramount for trees such as this Laceleaf Japanese Maple (Acer palmatum) ‘Dissectum Viridis’, which may quadruple in size or more from planting to maturity. Use stake-mounted fixtures with enough spare wire to move the fixtures away from the tree as it increases in size.

Immature specimen trees, such as this dense Weeping Copper Beech (Fagus sylvatica ‘Purpurea Pendula’), often increase significantly in size. A fixture placed close to the immature tree will soon be buried and its light lost in the dense leaf coverage; a fixture properly placed for the mature tree may not be able to light the young tree for some time. Evaluate the options and determine which works best for the project.
Trees that start foliage and branching a foot or more above ground level do not block the view of the luminaries lighting them. Aim uplights between vertical and 35° off vertical to avoid glare. Locating smaller plants between the fixtures and the tree blocks the view of the fixture, allowing a wider aiming angle between 45° and 60°.

When a plant will interfere with a fixture highlighting another plant and cannot be moved without upsetting the landscape composition, relocate the fixture. This may require using less wattage or a lamp with a wider beamspread when the fixture must move closer. Moving the fixture farther away might require a higher wattage or narrower beamspread.

When using a stake-mounted fixture, consider the plants surrounding the fixture. As these plants grow, they can block light from reaching the target plant. The fixture needs the ability to be moved away from such plants, raised to avoid becoming buried, or both.
Palms vary in size and shape, requiring differing lighting techniques as the following three examples show. The Queen Palm (*Arecastrum romanzoffianum*), with a straight, patterned trunk and rounded head of gracefully arching fronds, grows quickly to about 30 feet high. For trees situated in a lawn and viewed from all directions, locate a minimum of two lights under or outside the canopy for shape and a third to highlight the trunk.

The Mediterranean Fan Palm (*Chamaerops humilis*) produces a striking appearance with multiple trunks from 5 to 10 feet tall, forming a thick clump with foliage down to the ground. Vary the number of fixtures based on viewing direction. Always locate fixtures far enough away from the outside edge of the clump to avoid a situation in which the lower fronds restrict light from reaching the upper fronds.
The Sago Palm (Cycas revoluta), while not technically a Palm, closely resembles a Palm. It grows slowly to between 6 and 10 feet tall and creates a rounded form with arching fronds. Downlighting emphasizes form and detail.

Silhouette technique. This adds emphasis different from all other techniques. Consisting of backlighting, it shows only shape, eliminating texture, colour, and detail. Locate fixtures behind the plant, washing or grazing a surface beyond the plant. This technique works best on plants with a strong shape used as a primary or secondary focal point or as an element in the overall composition.

Crape Myrtle (Lagerstroemia indica) has an open form and produces leaves at branch ends. Locate fixtures at the outer edge or beyond the canopy to highlight flowers in bloom. Light penetrates the canopy due to the relatively translucent leaves.
Large, open-form trees require 5, 10, or more fixtures to cover the entire canopy area, as shown with this California Live Oak (Quercus agrifolia). Restrict aiming angles to between 0° and 35° off vertical, as smaller plants typically do not grow under this tree.

Wash technique. Locate fixtures away from the surface to be lit to provide even lighting over a surface. It can be a bright or soft effect to fit its purpose in the overall composition. Lighting Group One trees requires washing the tree canopy from outside. When the tree will be viewed primarily from one direction, utilize at least two lights located 30° to 45° off centre.
Hedges often form boundaries of gardens. Softly washing a hedge provides a visual link with other elements in the composition as well as depth to the scene. Wash hedges that have little texture using the spacing ratio shown to ensure an even wash.

Small dense trees, including Canadian Hemlock (Tsuga Canadensis) from Group Four, look best downlit. Locate the fixture(s) in front of the tree, aimed away from the viewer. This creates a natural appearance.

Lombardy Poplar (Populus nigra ‘Italica’), a dense, columnar tree from Group Two, looks best uplit using the grazing technique. This accentuates its texture while defining its shape. When lighting a row of immature trees, place a fixture in front of each tree. For mature trees, place fixtures farther away from foliage and between two trees, thus minimizing the quantity of fixtures.
When a low wall sits in front of a hedge, recess a linear light source, such as fluorescent, into the wall, creating a grazing effect along the length of the hedge.

For trees with interesting trunk texture, locate fixtures in front of the trunk, using either up or downlighting to accentuate pattern.

Mounting fixtures to the side creates a strong effect on a limited portion of the trunk. This works well with other trunk lighting techniques or alone. When used alone, it ties the tree to the ground and shows texture, but another aspect of the tree becomes visually more important.

Texture technique. An even appearance represents the main difference between grazing and texturing. Grazing strives for an even appearance, while texturing affects a portion of a surface. Placing a fixture in front and to the side of a hedge with a narrow aiming angle emphasizes texture.
Shadows technique. Uplighting a tree from the side produces shadows on the adjacent vertical surface. Use this as a simple way to add interest on large, plain walls.

Glow technique. A. Fixtures located under canopies of trees with an open branching form and translucent leaves create a glowing canopy effect. Recess the fixtures below grade for trees branching close to or on the ground. Use stake-mounted fixtures when branches start higher off the ground. B. Hedges with an open form and translucent leaves can utilize this technique. This diagram shows Xylosma congestum with fixtures using compact fluorescent lamps located between plants.
**Halo technique.** Lighting a trunk from slightly behind and to one side creates a sharp halo effect.

**Dappled light technique.** Mount fixtures high in a large tree, aiming them down through foliage and branches to create patterns on the ground below. Use this technique as fill light on lawns or for path lighting on driveways and walkways. However, directing light through foliage can easily create hot spots of light on foliage. Consider uplighting into the canopy to balance this brightness.

**Sculptures**

**Uplighting Versus Downlighting**

Downlighting maintains the natural appearance of the sculpture more easily than does uplighting (once again due to the familiarity of sunlight on objects). Mimicking daylight, downlighting creates shadows on the underside of textural details. Be careful, though, as shadows introduced onto human faces or animal figures from directly above can alter the sculpture’s appearance, transforming friendly faces into frightening, unfriendly, or ugly forms.

**Effect of light from the front or sides on a human face (left) versus light from above (right).**

Lighting human faces requires understanding the way the face is modelled in three dimensions. The eye sockets sit recessed into the skull, while the nose, cheeks, and lips protrude.
Lighting a face from above can create shadows that distort the face and remove the viewer’s ability to read the informative expressions that people wear on their faces. Locate fixtures to shine light onto the face from the side or far enough away to minimize shadows from facial features. The key to success is fixture location, which determines aiming angle – wide angles perform better.

**One Viewing Direction**

The appropriate technique to select depends on the artistic impression desired and characteristics of the sculpture. With enough space to move away from the sculpture, one fixture centered on the sculpture with a flood distribution lamp washes the entire sculpture. This minimizes the quantity of fixtures, and therefore the cost, but does not emphasize specific parts or features. It shows detail but not texture or three dimensions. The distance depends on the size of the sculpture and the beamspread of the lamp (see Figure A below).

One fixture located to the side shining across the sculpture emphasizes texture and highlights the closest side (see Figure B below). Two fixtures spaced equally to the side from the centre and aiming directly at the sculpture render a human or animal figure most naturally. This technique works with most sculptures. A variation of this technique would be to use a higher wattage lamp or narrower beamspread on one side for additional emphasis or increased three-dimensionality (see Figure C below).

Combining a side graze with a front wash emphasizes one side of the sculpture. The side light brings out texture on that side, while the wash fills in the rest of the form (see Figure D below). Adding light on the background with any of these techniques shows depth and provides a visual backdrop for the sculpture (see Figure E below).

![Sculpture lighting techniques for a single viewing direction.](image-url)
Multiple Viewing Directions

Lighting becomes more difficult with multiple viewing directions because people either move around the sculpture or look at it from varying locations. This makes fixture location, aiming angle, and lamp shielding critical to ensure that the viewer will not be distracted from enjoying the sculpture because of fixture glare.

The following figures show some basic techniques for full modelling of a sculpture. Accent uplights located at the front and back of a sculpture emphasize form and detail. Optional fill lights can be added at the remaining sides to soften brightness contrast and show overall shape (see Figure A). Shifting the location of the accent lights and the fill lights changes what will be emphasized. The shape, detailing, texture, and colour of the sculpture guide the placement of accent versus fill light fixtures (see Figure B). Four accent lights, evenly spaced around the sculpture, provide balanced highlighting. Emphasis can still be pr ovided to one or more sides of a sculpture using this technique by changing the lamp wattage from one fixture to another (see Figure C). Two accent fixtures placed close to the sculpture on opposite sides will emphasize shape or outline. These fixtures use either high wattage or a narrow beamspread for emphasis. The remaining two fixtures, located farther away, use lower wattage flood distribution lamps to wash the overall shape softly (see Figure D).

Walkways and Stairs

People feel comfortable walking along a dimly lit path as long as they are surrounded by or walking toward a higher light level.
Downlighting from eaves and trees highlights plant material edging the path to this residence. Spill light from wide-beam lamps (38° to 50°) softly washes the walk itself. The highest light level located at the front door draws the visitor through the garden. To welcome guests, the brick wall just inside the gate entry has the second level of brightness.
Lighting Plan
To produce even light along the path, the lamp beamspread must be known. Consider whether the fixture modifies the beamspread in any way. For example, does the fixture have a reflector that throws light forward or increases the lamp beamspread in more than one direction? The shape of the fixture can also limit the beam distribution of a lamp (see Figures below).

Plan fixture spacing to overlap the beamspread from adjacent fixtures. This combines the lower light output at the edge of two fixtures’ beamspreads to balance with the brighter light directly in front of the fixture (see Figure A). Generally, the eye detects a 4:1 ratio, so plan fixture placement to produce a light pattern within that range. This means that if there is 1.0 foot-lambert directly in front of a fixture, at the midpoint between two fixtures the level should not drop below 0.25 ft.

Fixtures placed on the same side of a pathway usually produce a more even spread of light than alternate fixtures on either side of the path. However, alternating sides of the path can work reasonably well when the lamp beamspread covers three-fourths of the width of the pathway and overlaps the next fixture’s beamspread (see Figure B).

Locate fixtures on both sides of the path for wide paths (approximately 8 feet or more) and paths with heavy traffic or cross traffic. Again, even light provides the most comfortable environment (see Figure C). Additionally, spacing needs to be realistic. Do not expect a small scale unobtrusive fixture with no optical control of the lamp to cover more than several feet of a pathway (see Figure D).

*Fixture distribution determines spacing. A and C illustrate good coverage. B shows an effective use of alternating fixtures, while D illustrates the brightness imbalance problem normally encountered with alternating fixtures.*
Select the appropriate location and spacing of decorative fixtures to ensure that light reaches the path and to enhance the visual appearance along the path. Light from fixtures placed too far back from the path can be blocked, never reaching the path. Mounting a fixture behind a hedge causes a shadow on the path. Mounting the fixture in front of a hedge can light both the path and the hedge.

The height of decorative fixtures also needs to complement the overall landscape design – too tall a fixture looks gangly and out of place, while too short a fixture is ineffective. Fixtures mounted in a newly planted hedge can become buried over time unless the hedge is pruned to an appropriate height for the fixture or the fixture is selected for the eventual, mature height of the hedge.

The height of decorative fixtures affects the day-time appearance as well as night light distribution. Coordinate the height with the mature height of planting and the fixture’s visual appearance in the landscape.

*Examples of fixture height and placement to coordinate with planting.*
Mounting an adjustable fixture on a roof overhang provides light to the stair without making the fixture visible during the day. Success in this approach requires locating the fixture(s) to minimize shadows. The best results occur when the fixture is centered over the staircase. If that location is not possible, move down the staircase, not up. A fixture mounted too far up the staircase creates shadows on the treads. Shadows on any or all steps make them difficult to see. When mounting fixtures overhead, control the luminaire aiming angle to avoid creating glare and to shield the lamp.

A downlight can often cover a limited set of stairs. Locate the fixture in the middle or toward the bottom of the stairs, not toward the top.

The size of a fixture, along with the mounting height above the tread, affects the appearance of fixtures in the wall. Too small a fixture or a mounting height that is visually out of balance for the wall mass can cause fixtures to look awkward. A 2 to 3 inch diameter fixture looks best located between the centreline of the wall and two-thirds below the top on an 18 inch wall. A 4 inch diameter fixture works when located approximately one third from the top of the wall. An 18 inch fixture will always be too large for an 18 inch wall regardless of its location vertically on the wall. Always consider the size and location above grade when selecting fixtures to be mounted in a side wall.

Using one steplight recessed into the side of a stair requires considering a logical location for light distribution. The fixture at the right is too large and too close to the stair tread. While the fixture at the left would work, the location of the middle fixture is preferable.

Consider the mounting height above the tread and the position in relation to the tread in deciding where to place fixtures along a wall. The height of the wall determines how many treads each fixture can light without creating shadows, since it determines how high a fixture can be located above the tread. Fixtures centred on the tread normally provide useful light to
that tread only. Fixtures located at the intersection of tread and riser, but close to the riser, light
two treads. Fixtures located higher on the wall allow light to reach more treads.

Using more than one side recessed fixture for a flight of stairs. With limited mounting
space, using one fixture per stair creates a nice rhythm. Locating them at the
intersection of riser and tread works best. With enough height, a fixture can cover more
than one stair.

As with path lighting, avoid positioning fixtures on alternate sides of the staircase unless the
beamspreads overlap. Light patterns created by alternating fixtures can distract or confuse
pedestrians. Luminaries with little optical control work best when located along the same side
of a staircase to produce an even pattern of light showing the relationship of treads to risers.
Luminaries with optical control can throw light across the width of the stair, producing even light
along the staircase.

Options for fixture layout on wide
stairs. Opposite side placement
creates distracting light/dark
patterns. Locate fixtures on one side
of a staircase and use a forward-
throw distribution.

Whether fixtures will be required on both sides of the staircase depends on the overall width of
the staircase, fixture optics, and pedestrian use. For staircases over 4 feet in width consider
using fixtures on both sides. However, light traffic flow allows fixture placement on one side.
People simultaneously moving up and down the staircase or heavy traffic flow in one direction
requires positioning fixtures on both sides of the staircase. The addition of a railing along a
wide staircase offers an additional fixture location.

On a wide stair, reasonable coverage with
overlapping beamspread may be all that is
necessary. Wide stairs with two way traffic
require fixtures on both
sides of the stairs. With heavy traffic, adding lighting in the middle of the stairs may be
warranted.