Medway Council

Guidance Note Adaptive Lighting

June 2019

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1.0 Lighting Design Standards

1.1 Strategic Route and Main or Secondary Distributor Network

The selection process for M Class roads is covered by BS5489 which should be adhered to. However, once the lighting class has been determined the designer should visit site and provide evidence that a risk assessment based on the parameters indicated in BS5489 has been done. If as a result of the risk assessment it is felt that the lighting class should be changed, either up or down one class, the reasons should be stated on the Risk Assessment.

2.0 Executive Summary

2.1 Introduction

Medway Council have as an objective in the Highway Lighting Policy 2019, to "conserve energy and promote sustainability". There are a number of ways in which this can be promoted with street lighting.

Medway Council has an aspiration to convert all street lighting to LED light source which is significantly more energy efficient than the obsolete light sources that it replaces.

A benefit of moving to LED is the ability to promote Adaptive lighting which is the ability to vary the light levels to suit the ambient conditions such that lower light levels can be used throughout the night when the use of the highway is much lower.

Adaptive lighting is supported by the British Standard for Road Lighting BS5489-1 in clause 4.4.2 which states "Variable lighting. The road lighting standards classify the required lighting class based on usage".

This Adaptive Lighting Guidance Note provides the guidance and methodology for Adaptive (or Variable) lighting for any new or replacement LED schemes within the Authority.

The overall report demonstrates a practical and measured approach to proposing adaptive lighting throughout the street lighting network under the Authorities control. This approach is based on guidance from the Institution of Lighting Professionals (ILP) Professional Lighting Guide PLG08, Guidance on the Application of Adaptive Lighting within the Public Realm.

Whilst the report clearly demonstrates how adaptive lighting can be implemented, it is not in a position to fully quantify what energy or financial savings can be made as this will be design and equipment dependent.

This Guidance Note demonstrates that there are potentially significant savings to be made compared to keeping the lighting at the 100% level throughout the night.

In order to quantify the savings, the Unmetered Supply Charge Code for each solution needs to be notified to the Meter Administrator via the Asset Management System (or a Central Management system (CMS) if this is the control system in operation for the scheme).

Before the Authority considers these costs, the following key questions need to be answered.

- Can the lighting profiles proposed be implemented within the luminaire LED driver?
- Is there an Unmetered Charge Code for the profile?
- Can the Asset Management System report real-time on the energy consumption and use this for billing by the Energy Administrator?

3.0 Introduction

3.1 Medway Council

Medway Council as a highway authority has responsibility for all street lighting in the Authority, consisting of more than 26000 street lighting units. Medway has aspirations to convert all of its street lighting to Light Emitting Diode (LED) sources.

Medway Council has developed this Adaptive Lighting Guidance Note in order to apply adaptive lighting to new and where possible, existing installations throughout the Authority.

The objective of this guidance note is to optimise lighting levels and minimise energy consumption and to help provide an improved reduced cost lighting service to Medway residents.

3.2 Highway Lighting Policy 2019

Guidance notes for lighting are contained within the Medway Council – Highway Lighting Policy 2019.

The guidance note details the following principles and objectives: Principles:

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- Respecting and enhancing the local streetscape.
- Using a simple palette of quality materials.
- Maintaining consistently high standards of design.
- Reducing the amount of clutter on our streets.
- Making the street environment safer.
- Enabling equal and inclusive consideration for all road users.

Objectives: -

- Provide a safe and attractive road network for all road users.
- Help reduce crime and fear of crime.
- Provide a cost-effective public lighting service.
- Conserve energy and promote sustainability.
- Control light pollution.
- Promote a general feeling of well-being.
- Aid movement across the network.

The gradual move to LED sources is part of the strategy to reduce energy usage, thereby meeting the objective of conserving energy.

Under normal circumstances the street lighting in Medway will operate from dusk to dawn. There is currently no policy of part night lighting.

3.3 What is Adaptive Lighting?

The term adaptive lighting is defined in PLG 08 and is used to define the operation of lighting at different lighting levels during periods of darkness. It includes the following options below:

- Trimming
- Adjusting lighting class based upon highway/area use or the tasks being undertaken
- Part night lighting
- Switch off

4.0 Guidance Note Adaptive Lighting

4.1 Introduction

The objective is to provide the most efficient lighting solution possible to further promote the concept of the “right light in the right place at the right time” and provide additional energy savings.

For this to be carried out, this guidance note considers the current Medway Council Highway Lighting policy requirements, British and European Standards and any other guidance or factors that might impact on the options available for the lighting levels that can be proposed.

The Medway Council Highway Lighting Policy – 2019 uses the term Adaptive Lighting to define the operation of lighting at different lighting levels during periods of darkness. There are 3 main ways of managing adaptive lighting within the policy:

4.2 Adaptive Lighting

Adaptive lighting in the context of this Guidance Note refers to the variation of light levels at different times of the night according to the level of usage of the area, the needs of the users and specific risks which may also vary at different times of the night.

Adaptive Lighting is to be incorporated into all new and replacement lighting installations according to the profiles and guidance defined in later chapters within this document.

The key aspect of this guidance note is that lighting is present throughout the night, however the light levels can reduce significantly when there is little usage of the area. This allows significant energy savings to be realised.

Adaptive lighting can otherwise be known as “variable” and “dimming”, however the term dimming can be misleading as the requirements of a particular area may require enhancing the lighting levels rather than dimming them.

Adaptive lighting may be controlled by one of the following: -

- A fixed regime which is factory set at the required times and levels.
- A Central Management System (CMS), which allows lights to be monitored remotely including setting on and off times or to reduce the lamp power, allowing for flexible regimes.

4.3 Trimming

Turning the lighting on later and off earlier to suit the local ambient lighting levels and performance requirements, thus ensuring the lighting is activated for the minimum amount of time necessary for safe operation.

Currently, trimming of lighting is undertaken by the use of photocells, however, CMS could be introduced in Medway in the future.

The photocell currently specified for Medway is a 35:18 lux photocell whereby lighting is switched on at an ambient illuminance of 35 lux and switched off at dusk when the ambient illuminance drops to 18 lux.

4.4 Constant Light Output (CLO)

All light sources naturally degrade over time. To ensure the optimum amount of light is emitted from a luminaire throughout its life, an automatic control mechanism (CLO) within LED drivers compensates for this by incrementally increasing the power over the design life of the luminaire. Throughout the life of the luminaire, the average energy consumed is lower than it would otherwise be if CLO were not present

CLO should be specified for all new luminaires.

4.5 Legal context

One of the most important things the Authority needs to consider with all lighting is the legal responsibilities and duties they have. Principally this is the Highways Act.

In addition to this the Local Authority should follow any guidance in the following order of priority.

- Act of Parliament and Regulations
- Approved codes of Practice
- European and British standards and codes of practice
- Industry Guidance notes
- Organisations own strategy or guidance

The primary guidance for this document follows BS 5489-1:2013 and the Institution of Lighting Professionals (ILP) Professional Lighting Guide PLG 08: Guidance on the Application of Adaptive Lighting within the Public Realm

All standards and guidance followed are detailed in the bibliography section of this document.

4.6 Environmental context

When considering the environmental impacts that adaptive lighting might have, it needs to be considered alongside the change from the conventional lighting to the LED light source. The LED light source has a much better control of light spill through the directional light sources. In addition, designing using the latest standards has reduced the amount of light output required. This will have a correlated effect on the amount of CO2 produced as the energy consumption is reduced. It is highly likely that through the implementation of any adaptive lighting, that these environmental contexts will be further enhanced with a greater reduction in light output and energy consumption.

In addition to this, there should be liaison with local environmental groups and the Local Authority's Ecological department to ensure lighting is also adapted to ensure is mitigates potential environmental impacts.

4.7 Economical context

Any proposed adaptive lighting has to be economically viable and affordable in order for it to be cost effective.

Typically, the costs that are normally considered with this are that of the incremental cost associated with specifying multi-step dimming control gear to accommodate the proposed adaptive lighting profiles, although many manufacturers now provide this as standard.
If a CMS system is implemented, this will be at a high capital cost and ongoing maintenance charge which will need to be considered against the improved flexibility, reporting and bespoke energy savings which can be achieved.

The Authority will also need to consider the impact that the lighting profile changes may have on its energy tariffs and also its Carbon Reduction Commitment (CRC) credits.

At this time, all energy savings are assumed to be reported through the Asset Management System and authorised by the Meter Administrator. If a CMS is implemented in future, this would be a function of the CMS.

5.0 Design Process

5.1 Adaptive lighting profile

The lighting profile will fundamentally be based upon the usage of the roads such that when road usage reduces during the hours of darkness, the risk of reducing the light levels also reduces and without unduly compromising safety. This works for a typical street, however the guidance note should be considered on a street by street basis to ensure that all potential criteria have been taken into consideration.

The typical variations in usage occur within discrete bands based upon activities such as commuting to and from work and schools etc which represent periods of high usage.

The "typical" profiles have been adapted from research undertaken in the preparation of the ILP PLG 08 guidance and are representative of the typical situation in Medway. They are represented in the following table:

Time	Usage	Characterisation
Dusk to 20:00	High	**Evening "rush-hour"**
20:00 to 22:30	Moderate	**Evening activities**
22:30 to Midnight	Low	**Head home from evening activities**
Midnight to 05:00	Very Low	**Little activity**
05:00 to Dawn	**High**	**Morning commuter "rush-hour"**

Table 1: Time and street usage profiles

Where the usage varies in line with the typical profiles and where there are no special circumstances or risks, it is appropriate to consider a light level profile whereby the lighting levels reduce during periods where the street usage is moderate to very low.

It is also important that consideration be taken of other influencing factors that may mean lighting classes should not be reduced. The relevant factors are detailed below in clause 5.2 and need to be taken into account when adopting a risk assessment-based approach to ascertain where individual roads or assets could operate adaptive lighting.

5.2 Assessment Process

The lighting design of all the assets will be carried out in line with BS5489-1:2013 and following the requirements of the Medway Council Highway Lighting Policy.

BS5489-1:2013 adopts a common approach to the selection of lighting class. Initially the designer must determine whether the lighting class should be for Traffic Routes (M Class), Subsidiary Roads (P Class) or Town Centres / Conflict Areas (C Class).

The designer selects the relevant Environmental Zone (E1 to E4) based on the criteria from ILP guidance GN01, and following consultation with the Authority.

In Medway there are a range of Environmental Zones from E1 (for instance at the AONB close to the Thames) up to E4 (for instance in Chatham town centre) and it is important that this selection is agreed.

Then the benchmark lighting class must be determined. The benchmark lighting class is that which is appropriate for the highest level of usage of that street, with the caveat that if there is a more appropriate lighting class in line with BS5489 then this could be proposed.

The Designer then follows the 5 step lighting class selection process from BS5489-1:2013, this is;

1. Select the Benchmark lighting class
2. Carry out a risk assessment to identify specific lighting needs
3. If necessary, adjust lighting class up or down based on the assessed risk
4. Adjust lighting level according to light source used (S/P Ratio) (only applicable to P Class roads)
5. Assess Lighting Requirements to judge whether different lighting classes are applicable at different times of night due to changes in traffic or use.

All designs should go through steps 1 - 4 above in order to determine the most appropriate lighting class. This policy provides the guidance for step 5.

For all designs, a “Lighting Reality” road or area calculation will be created and can demonstrate the achieved lighting levels of the proposed lanterns.

If for whatever reason, a compliant lighting design cannot be achieved, then this non-compliance must be taken into account prior to implementing adaptive lighting on that street.

The rationale behind the use of adaptive lighting and any possible profiles needs to be considered. This follows BS5489 but what it does not do is consider each road on and individual basis to see if there are local factors that might prevent adaptive lighting at certain periods of the night

5.3 Adaptive lighting levels

The risk assessed approach to considering where adaptive lighting can be implemented, will need to consider the following list. If any of the listed criteria are present within a scheme, then the lighting professional should review to specific site conditions to determine whether adaptive lighting should be applied.

- Traffic Routes-Does the Area have a high or significant night time traffic record between 00:00 and 05:30. This will be defined as having high or very high traffic flows in line with BS5489 Tables A.2 and A.3 notes 3 and 2 respectively, that states
  - “High to Very High Traffic flow determined as either having ADT>40,000 or where the flow exceeds 65% of the lane maximum capacity for Dual or Multi lane carriageways or 45% of single lane carriageways.”
- Have the police identified the area as having high crime? In line with PLG08 this can be defined as >100 incidents per annum
- Town Centres where there is a night time economy such as pubs, restaurants and clubs.
- Dialogue with the Police to define areas as having an existing record of crime or having the potential for increased crime levels if the street lighting is changed.
- Defined areas with sheltered housing and other residences accommodating vulnerable people such as nursing homes or assisted living accommodation. This will be through liaison with Local Authority and private service providers.
- Areas with operational emergency services site such as major (A&E) hospitals.
- Formal pedestrian crossings such as zebra crossings or, subways and enclosed footpaths and alleyways.

- Where road safety measures or highway features are in place in the highway to facilitate a change in direction, reduction in speed or similar manoeuvre, such as roundabouts, chicanes, speed humps, etc.
- Roads that have local authority CCTV or Police surveillance equipment in that require monitoring through periods of darkness.

Note that if it is decided that a particular road or junction is not to have adaptive lighting, care must be taken with adjacent roads such that the light level on adjacent roads is never greater than two lighting classes.

5.4 Adaptive lighting process and profiles

Following the procedure in BS5489-1 2013 for Selection of lighting class Appendix 1, the final step in the 5-step process detailed above in clause 5.2 would involve selecting lighting classes from the table below if it was deemed appropriate following a risk assessment.

The proposed classes are a stepped reduction from the benchmark lighting class as the night time traffic volume reduces with a step back up in the last period to the benchmark lighting class for the morning rush hour.

The lighting areas can be broken down into three categories:

- Subsidiary Roads and Footpaths
- Traffic Routes
- Town centres and conflict areas

5.5 Subsidiary roads and footpaths

The adaptive levels should always continue to meet a class and should never fall lower than the lowest class in the Table, i.e. P6.

Time	**Dusk - 20:00**	**20:00 - 22:30**	**22:30 - midnight**	**midnight – 05:00**	**5:00 – Sunrise**
Traffic Usage	**High**	**Moderate**	**Low**	**Very Low**	**High**
Benchmark Lighting Class					
P2	P2	P3	P4	P5	P2
P3	P3	P4	P5	P6	P3
P4	P4	P5	P6	P6	P4
P5	P5	P6	P6	P6	P5
P6	P6	P6	P6	P6	P6

Table 2 Adaptive Lighting Profiles for Subsidiary Roads

The reduction in energy consumption when adapting from one lighting class to the adjacent lighting class is shown in the table below:

Subsidiary Roads and Footpaths

Class	Levels Eave (lux)	Leave Emin (lux)	Percentage reduction in light level from higher class
P2	10.0	2.0	N/A
P3	7.5	1.5	25%
P4	5	1	33.3 %
P5	3	0.6	40%
P6	2	0.4	33.3 %

Subsidiary Roads and Footpaths

Class	Levels Eave (lux)	Levels Emin (lux)	Percentage reduction in light level from higher class
P2	10.0	2.0	N/A
P3	7.5	1.5	25%
P4	5	1	33.3 %
P5	3	0.6	40%
P6	2	0.4	33.3 %

Table 3 % reduction in light output between adjacent lighting classes

5.6 Traffic routes

Traffic routes will typically be an M3 or M4 lighting class based on traffic speeds. The adaptive levels should always continue to meet a class. As M6 is the lowest defined lighting class in BS5489-1, lighting should not be adapted lower than this level.

Time	**Dusk20:00**	**20:00 – 22:30**	**22:30– Midnight**	**Midnight– 05:00**	**5:00 – Sunrise**
Traffic Usage	**High**	**Moderate**	**Low**	**Very Low**	**High**
Benchmark Lighting Class					
M2	M2	M3	M4	M5	M2
M3	M3	M4	M5	M6	M3
M4	M4	M5	M6	M6	M4
M5	M5	M6	M6	M6	M5
M6	M6	M6	M6	M6	M6

Table 4 Adaptive Lighting Profiles for Traffic Routes

For traffic routes the lighting levels are as per the following table which also details the % reduction in light levels between adjacent lighting classes.

Class	**Levels L_{av} (cd/m^2)**	**% reduction in light level from higher class**
M 2	1.5	n/a
M 3	1.0	33. 3%
M 4	0.75	25%
M 5	0.5	33. 3%
M 6	0.3	40%

Table 5 % reduction in light levels between adjacent lighting classes

5.7 Town centres and conflict areas

Conflict Areas are typically C2, C3 and C4 for traffic route junction points and C4 lighting class for town centres. The adaptive levels should always continue to meet a class. As C5 is the lowest defined lighting class in BS5489, lighting should not be adapted lower than this level.

Time	Dusk-20:00	20:00 – 22:30	22:30–Midnight	Midnight – 05:00	5:00 – Sunrise
Traffic Usage	**High**	**Moderate**	**Low**	**Very Low**	**High**
Benchmark Lighting Class					
C1	C1	C2	C3	C4	C1
C2	C2	C3	C4	C5	C2
C3	C3	C4	C5	C5	C3
C4	C4	C5	C5	C5	C4
C5	C5	C5	C5	C5	C5

Table 6 Adaptive Lighting Profiles for Town Centres and Conflict Areas

The reduction in energy consumption when adapting from one lighting class to the adjacent lighting class is shown in the table below:

Town Centres and Conflict Areas

Class	Levels Eave (lux)	Levels U_o (min)	% reduction in light level from higher class
C1	30	0.4	n/a
C2	20	0.4	33.3 %
C3	15	0.4	25%
C4	10	0.4	33.3 %
C5	7.5	0.4	25%

Table 7 % reduction in lighting levels between adjacent lighting classes

There may be bespoke locations where the road is not a standard geometric layout, such as turning heads, and the profile could be tailored to suit the situation and detailed on the risk assessment based on engineering judgement and supporting calculations.

6.0 Potential Savings

6.1 Introduction

Energy savings are a key benefit achieved when adopting adaptive lighting. The benefit will only be realised if it is reported through the relevant charge codes. Where reductions in lighting levels are implemented, consideration needs to be given to the effect this has on the power consumption.

It is important to remember that whilst there is typically a linear correlation between the reduction in energy consumed and the reduction in light levels, there are inefficiencies that mean that a 10% reduction in light output may not mean that the energy saving is as high as 10%. This would need to be verified on a product by product basis.

In order to calculate energy savings, the typical annual burning hours for a single lantern need to be considered. From information provided in the Meter Administrators monthly report average burning hours are between 18:30 and 05:00.

This can be mapped across to the proposed dimming profiles to understand the average time in each zone of a profile

- Dusk-20:00 = 1.5 hours operation
- 20:00 – 22:30 = 2.5 hrs operation
- 22:30 – Midnight = 1.5 hrs operation
- Midnight – 05:00 = 5 hrs operation
- 05:00 – Sunrise = 0 hrs operation

Profile Number	**Benchmark Lighting Class**	**High**	**Moderate**	**L o w**	**Very Low**	**High**
Profile 1	C1	C1 (0%)	C2 (33.3%)	C3 (50%)	C4 (66.7%)	C1 (0%)
Profile 2	C2	C2 (0%)	C3 (25%)	C4 (50%)	C5 (62.5%)	C2 (0%)
Profile 3	C3	C3 (0%)	C4 (33.3%)	C5 (50%)	C5 (50%)	C3 (0%)
Profile 4	C4	C4 (0%)	C5 (25%)	C5 (25%)	C5 (25%)	C4 (0%)
Profile 5	M2	M2 (0%)	M3 (33.3%)	M4 (50%)	M5 (66.7%)	M2 (0%)
Profile 6	M3	M3 (0%)	M4 (25%)	M5 (50%)	M6 (62.5%)	M3 (0)%)
Profile 7	M4	M4 (0%)	M5 (33.3%)	M6 (50%)	M6 (50%)	M4 (0%)
Profile 8	M5	M5 (0%)	M6 (40%)	M6 (40%)	M6 (40%)	M5 (0%)
Profile 9	P2	P2 (0%)	P3 (25%)	P4 (50%)	P5 (70%)	P2 (0%)
Profile 10	P3	P3 (0%)	P4 (33.3%)	P5 (60%)	P6 (73.3%)	P3 (0%)
Profile 11	P4	P4 (0%)	P5 (40%)	P6 (60%)	P6 (60%)	P4 (0%)
Profile 12	P5	P5 (0%)	P6 (33.3%)	P6 (33.3%)	P6 (33.3%)	5P (0%)

Table 8 Cumulative Dimming for each Adaptive Profile

Note: the % dimmed values in the above table are cumulative values reduction from the Benchmark class.

Note when Benchmark class is C5, M6 or P6, no further dimming or adaption is allowed, so they are not shown in the above table.

6.2 Typical Energy Saving Examples

Using the table of adaptive lighting profiles (**Table 8**), typical energy savings can be established based on the Profile chosen.

Example 1 – Subsidiary Road lit to P3 benchmark lighting class

In this example the benchmark lighting class is P3 and the profile from Table 8 is Profile 10.

Time Period	Lighting Class	% Dimmed
Dusk to 20.00	P3	100%
20.00 o 22.00	P4	66.7%
22.00 to midnight	P5	40%
Midnight to 05.00	P6	26.7%
05.00 to Dawn	P3	100%

Table 9 Profile 10 adaptive lighting steps

By analysing the switch times throughout the year for Chatham, the equivalent burning hours can be derived as follows:

- Lighting hours for the undimmed regime = 4080 hours per annum
- Full level equivalent burning hours for the dimmed regime = 2134 hours per annum
- Energy Consumption = 2134/4080 = 52.3%
- Energy Saving = 47.7%

Example 2 – Traffic Route lit to M3 benchmark lighting class

In this example the benchmark lighting class is M3 and the profile from Table 8 is Profile 6.

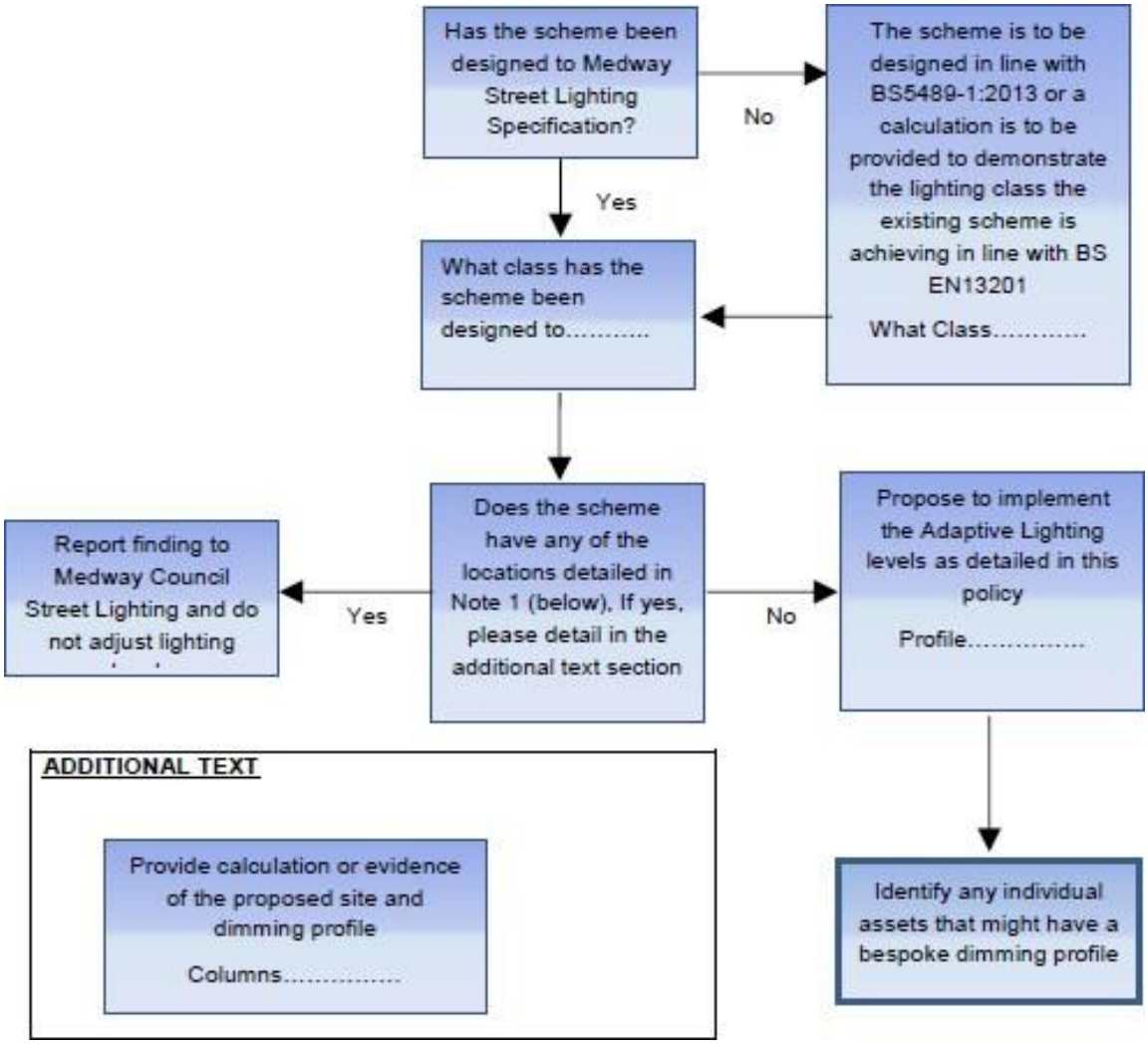
Time Period	Lighting Class	% Dimmed
Dusk to 20.00	M3	100%
20.00 to 22.00	M4	75%
2200 to midnight	M5	50%
Midnight to 0500	M6	37.5%
0500 to Dawn	M3	100%

Table 10 Adaptive Lighting Profile 6

By analysing the switch times throughout the year for Chatham, the equivalent burning hours can be derived as follows:

- Lighting hours for the undimmed regime = 4080 per annum
- Full level equivalent burning hours for the dimmed regime = 2449 per annum
- Energy Consumption = 2449/4080 = 60%
- Energy Saving = 40%

6.3 Design Process Flow Chart



Road	(insert)	**Created by**	(insert)	**Date**
URSN	(insert)	**Signed**	(insert)	(insert)
Ward	(insert)	**Approved by**	(insert)	**Date**
District	(insert)	**Signed**	(insert)	(insert)

Note 1

- Main routes with a significant night-time traffic record between 12.00 midnight and 05.00am.
- Town centres.
- Areas identified by the Police as having an existing record of crime or having the potential for increased crime levels if the street lighting is changed.
- Areas with sheltered housing and other residences accommodating vulnerable people.
- Areas with operational emergency services site including hospitals and nursing homes.
- Formal pedestrian crossings, subways and enclosed footpaths and alleyways where one end links to a road that is lit all night.
- Where road safety measures are in place in the highway, such as roundabouts, central carriageways islands, chicanes, speed humps, etc.
- Roads that have local authority CCTV or Police surveillance equipment.

- Sites with existing or with potential road safety concerns.

7.0 Bibliography

- BS 5489-1:2013 Code of practice for the design of road lighting Part 1: Lighting of roads and public amenity areas.
- BS EN 13201-2:2015 Road lighting - Part 2: Performance requirements.
- Institution of Lighting Professionals (ILP) Professional Lighting Guide PLG 08: Guidance on the Application of Adaptive Lighting within the Public Realm.
- Institution of Lighting Professionals (ILP) GN01 Guidance for the Reduction of Obtrusive Light:2011
- Medway Council Highway Lighting Policy 2019
- Medway Council Developers Guide & Equipment Specification 2019