

# ANNEXURE A

## Measurement and Verification Protocol

This annexure describes the Measurement and Verification Protocol that should be used for the determination of Energy Savings produced by the implementation of the energy efficiency measures. Unless specified, all measurement and verification activities should be performed by the Energy Management Firm and the cost for such activities should have been included in the proposed project cost.

### 1.0 Determination of Energy Savings

#### 1.1 Approach for the determination of Energy Savings

The energy savings will be evaluated by comparing actual energy usage after implementation of the Improvements over a specific period of time to the energy usage derived from the Baseline Energy Consumption and Demand;

- (i) the evaluation for the street lighting savings will be based on short term measurement before and after the implementation of the measure (after the commencement date). This initial measurement will be used to invoice the energy savings for the first year of the Project. A short-term measurement campaign will be done at the beginning of each subsequent year in the Payback Period to determine a revised saving level for the year.
- (ii) the evaluation of pumping energy savings will be based on a short-term measurement of the system efficiency before and after the implementation of the measure. This initial measurement will be used to invoice the energy savings for the first year of the Project. A short-term measurement campaign will be done at the beginning of each subsequent year in the Payback Period to determine a revised saving level for the year. The improvement will be measured as a percentage improvement in the energy efficiency index of the pumping system. The energy efficiency index is the water flow pumped by the system divided by the input energy to the pump.
- (iii) For the pumping system, all of the units will be monitored individually.
- (iv) For the street lighting, a sampling of some switching points and distribution circuits will be measured before the energy efficiency measure implementation to determine the baseline of energy consumption. A similar test will be performed to determine the energy usage after implementation of the energy efficiency measures. The sample test results will be extrapolated to cover the complete system that will be part of the scope of work for the Project.
- (v) The calculation for the Baseline Energy Consumption and Demand and the Measurement and Verification of energy consumption after the implementation of the energy efficiency measures will be performed on electronic spreadsheet that would be made available to the City for analysis. All electronics files from data loggers in support of the Baseline or post-measure implementation energy usage will be made available to the City.
- (vi) This Protocol is based on International Performance Measurement and Verification Protocol option B.

- 1.2 If no extension had been requested by the City, within \_\_\_\_ ( ) working days of the City's receipt of the Energy Management Firm's calculations (referred to paragraph 1.1(b) of this Appendix, the Energy Management Firm does not receive notice from the City that it objects thereto, the City shall be deemed to have approved the calculations.

## **2.0 Energy Savings and Escalation Factors**

- 2.1 Energy Savings are determined by multiplying the energy saved (kilowatthours/month) by the greater of (a) the actual energy rates or (b) the energy rate that prevailed at the date of signature of this Contract.
- 2.2 The unit costs of energy demand and consumption will include any applicable taxes, levies and surcharges and will be the actual average utility costs charged by the supplier.

## **3.0 Street Lighting Measurement and Verification Procedure**

### **3.1 Baseline Energy Consumption and Demand**

- (a) A table of each switching point and the precise number of fixtures categorized by types for each switching point will be prepared by a physical count.
- (b) A sample of 20% of the switching points will be drawn at random for the purpose of selecting a representative number of points for a measurement campaign. The selected point will have only a single type of lamp (fluorescent or HPS) on the supply network.
- (c) A physical inspection of the switching points and the distribution line will be performed before the test to see if there is illegal connection to the network or if there are burn-out or non-operating fixtures. Correction should be applied before starting the measurement.
- (d) A seven-day measurement campaign will be held for each switching point selected in the sample.
- (e) The measurement will include the instantaneous measurement of kW demand, a continuous measurement of amperes on each distribution wire with 20 seconds between sampling, a continuous measurement of the voltage level at 20 seconds logging interval and a lighting (lux) level measurement below fixtures and at 5 meters distance in all directions from a point directly under the fixture (see section 4). The voltage measurement should allow to precisely see the variation of voltage during a typical day and more precisely the possible increase in voltage during the night when the electrical network becomes unloaded. The lux level should be measured in area where there is no additional lighting that could affect the result and preferably by night with minimum moonlight.
- (f) The City reserves the right to participate in any or all of the field measurement activities and to crosscheck any measurement made by the Energy Management Firm with its own equipment for comparison purpose.
- (g) The results of the sample test will be used to determine an average consumption per type of fixture prior to the energy efficiency measure implementation. As the measurement is on the switching point, the unitary power per fixture will include the lamp, the ballast and the distribution wiring losses.
- (h) The result from the sample test will be used to determine the energy consumption for the Baseline by multiplying the unitary power per lamp by the number of lamps of each type included in the scope of work of the Project.
- (i) A correction factor for the hours of operation will be agreed between the City and the Energy Management Firm. For instance, if the Baseline is established on a month where the lighting system operates only 11 hours a day while the annual average is 12 hours, then the Baseline determined by the protocol will be readjusted by a ratio of 12/11.
- (j) All these measurements, calculations and reporting will be made by the Energy Management Firm and be submitted to the City for approval.

### 3.2 Energy Consumption and Demand Measurement after the Implementation of Measures

This procedure will be applied immediately after the commencement date of the Payback Period and will be repeated once per year at the anniversary of the beginning of the Payback Period. The Energy Consumption and Demand will be used to determine the savings that will be applied for the year following the measurement.

- (a) The table of switching points and the precise number of fixtures categorized by types defined in 3.1(a) will be reused for the test.
- (b) The same sample of 20% defined in 3.1(i) will be used for the measurement.
- (c) A physical inspection of the samples will be performed to insure that no additional fixtures had been added or removed and that all fixtures are working properly. Any defective or burnt unit should be reported to the City to be replaced before the test. The City will participate in this field examination of system prior to the test.
- (d) A physical inspection of the switching points and the distribution line will be performed before the test to see if there is illegal connection to the network. Any illegal connection should be reported and eliminated before the test.
- (e) A seven-day measurement campaign will be held on each switching point selected in the sample.
- (f) The measurement will include the instantaneous measurement of kW demand, a continuous measurement of amperes on each distribution wire with 20 seconds between sampling, a continuous measurement of the voltage level at 20 seconds logging interval and a lux level measurement below fixtures and at 5 meters distance in all directions from a point directly under the fixture. The voltage measurement should allow to precisely see the variation of voltage During a typical day and more precisely the possible increase in voltage during the night when the electrical network becomes unloaded. The lux level should be measured in area where there is no additional lighting that could affect the result and preferably by night with minimum moonlight.
- (g) The City reserves the right to participate in any or all of the field measurement activity and to crosscheck any measurement made by the Energy Management Firm with its own equipment.
- (h) The results of the sample test will be used to determine an average consumption per type of fixture prior to the energy efficiency measure implementation. As the measurement is on the switching point, the unitary power per fixture will include the lamp, the ballast and the distribution wiring losses.
- (i) The result from the sample test will be used to determine the Energy Consumption after the measure implementation by multiplying the unitary power per lamp by the number of lamps of each type included in the scope of work of the Project.
- (j) A correction factor for the hours of operation will be agreed between the City and the Energy Management Firm. For instance, if the measurement after measure implementation is established on a month where the lighting system operate only 11 hours a day while the annual average is 12 hours, then the measurement obtained from the protocol will be readjusted by a ratio of 12/11.
- (k) All these measurements, calculations and reporting will be made by the Energy Management Firm and be submitted to the City for approval.

### 3.3 Energy Savings Evaluation

- (a) The Energy Savings will be established by subtracting the Baseline Energy Consumption and Usage by the energy consumption and usage measured after the measure implementation.

#### **4.0 Waterworks Pumping Low Voltage Monitoring and Verification Procedure**

##### **4.1 Baseline Energy Consumption and Demand**

- (a) A table of each pumping system and their nameplate information will be prepared.
- (b) An instantaneous test (after stable operating conditions are reached) measurement campaign will be held on each pumping system.
- (c) The measurement will include the instantaneous measurement of kW demand and the flow rate of the pumping system. The voltage on the pump connection will also be recorded as well as the depth of the water table.
- (d) The flow rate measurement could be done using an ultrasonic flowmeter of good quality or by using an XY grid calibrated in laboratory for the appropriate pipe size.
- (e) The number of hours of pumping per year will be agreed between the Energy Management Firm and the City and stipulated in the calculation formula.
- (f) The energy efficiency index will be calculated by dividing the flowrate obtained by measurement by the kW input to the pump.
- (g) The Baseline Energy Usage will be established by multiplying the kW power measured by the stipulated number of hours for each pumping system considered. The cumulative energy usage will be calculated and will become the yearly Baseline Energy Usage.
- (h) All these measurements, calculations and reporting will be made by the Energy Management Firm and be submitted to the City for approval.

##### **4.2 Energy Consumption and Demand Measurement after the Implementation of Measures**

This procedure will be applied immediately after the commencement date of the Payback Period and will be repeated once per year at the anniversary of the beginning of the Payback Period. The Energy Consumption and Demand will be used to determine the savings that will be applied for the year following the measurement.

- (a) The table of pumping systems prepared in 4.1(a) will be used and the new installed equipment information will be recorded beside the old equipment.
- (b) An instantaneous test (after stable operating conditions are reached) measurement campaign will be held on each pumping system.
- (c) The measurement will include the instantaneous measurement of kW demand and the flow rate of the pumping system. The voltage on the pump connection will also be recorded as well as the depth of the water table.
- (d) The flow rate measurement could be done using an ultrasonic flowmeter of good quality or by using an XY grid calibrated in laboratory for the appropriate pipe size.
- (e) The number of hours of pumping per year will be agreed between the Energy Management Firm and the City and stipulated in the calculation formula.
- (f) The energy efficiency index will be calculated by dividing the flow rate obtained by measurement by the kW input to the pump.

#### 4.3 Energy Savings Evaluation

- (a) The percentage improvement for the pumping system will be determined by calculating the percentage improvement of the energy efficiency index prior and after implementation of the energy conservation measures.
- (b) The power saving will be established by multiplying the kW of power of the Baseline by the percentage improvement in the energy efficiency index.
- (c) The energy savings will be established by multiplying the demand saving by the stipulated number of hours for the pump systems considered. The total energy savings for all pumps will be cumulated.
- (d) All these measurements, calculations and reporting will be made by the Energy Management Firm and be submitted to the City for approval.

#### 5.0 Total Savings for the Project

The total savings for the Project will be calculated as the sum of the savings for the street lighting component (section 3.0 above) and the savings from the pump component (section 4.0 above).

#### 6.0 Detail of Lux Level Measurement for Street Lighting System

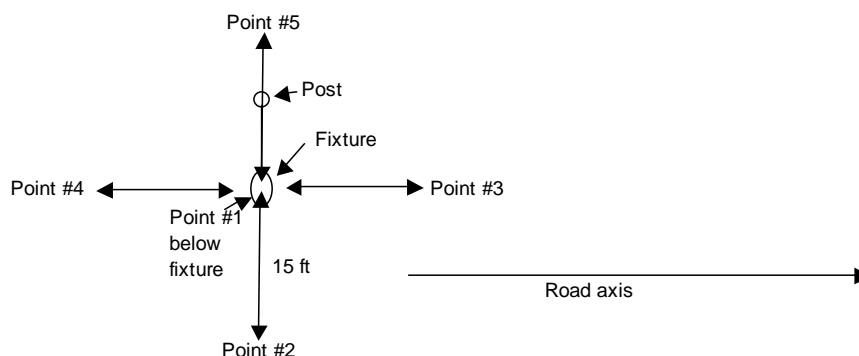
The test of lux level should be realized during the night and preferably when there is little or no moon lighting. Alternatively, it is possible to take a reading with the moon lighting but it requires making a separate measurement in a location where there is no artificial light to deduct the moon effect from the electric lighting.

The test should be preferably performed during a night without clouds to provide the indication of the minimum lux level achieved actually by the fixtures. Presence of clouds usually increases the road lighting level as there is some light reflected by the clouds.

The measurement should be taken vertically from the lamp position then at a distance of 5 meters in each direction. Two measurements are done in the street axis while the others two are made perpendicular to the road. If the fixture is affixed to a wall or other type of obstruction, then only one test perpendicular to the road is done.

The scheme below shows the location of the 5 metering points in relation with the road.

The test should be taken in typical street lighted with different types of lighting fixtures. For instance, a test should be made for the small road lit with one lamp fluorescent fixtures, for medium size road lit with 1 fluorescent tube fixtures and larger roads lit by high pressure sodium fixture of different power.



## ANNEXURE B

Note : Table from Annex “D” of the RFP should be reflected here.

### Annexure B.1 – Table of Project Cost, Energy Saving Estimate, Payback Period Duration and Contract term

#### D.1 - Table of Project Cost, Energy Savings and Payback Period Duration and Contract Term

**[MC to fill name] MUNICIPAL CORPORATION**

| <i>Item</i>                                   | <i>Project Cost Rs</i> | <i>Remarks</i>              |
|---|------------------------|-----------------------------|
| <b>Item Disbursed Before Payback Period</b>   |                        |                             |
| Feasibility Study and Final Design            |                        |                             |
| Engineering (Working Documents)               |                        |                             |
| Construction Cost (Street Lighting Component) |                        |                             |
| Construction Cost (Pumping Component)         |                        |                             |
| Project and Construction Management           |                        |                             |
| Training                                      |                        |                             |
| Monitoring and Verification (Baseline Only)   |                        |                             |
| Total Cost of Implementation (TCI) :          |                        | (TCI)                       |
| <b>Item Disbursed During Payback Period</b>   |                        |                             |
| Financing                                     |                        | (Calculated from Table D.2) |
| Monitoring and Verification of Savings        |                        |                             |
| Performance Premium                           |                        |                             |
| Maintenance                                   |                        |                             |
| <b>Total Project Cost</b>                     |                        |                             |

|   |  |
|---|--|
| <b>Annual Energy Savings (SL and Pumps)</b> |  |
|---|--|

|                             |  |        |
|-----------------------------|--|--------|
| <b>Payback Period Term:</b> |  | months |
|-----------------------------|--|--------|

|                       |  |        |
|-----------------------|--|--------|
| <b>Contract Term:</b> |  | months |
|-----------------------|--|--------|

## Annexure B.2 Calculation of Financing Charges for the Project

### D.2 Calculation of financing charges for the project : FOR [MC to fill name] MUNICIPAL CORPORATION

**Financing charges applied by the Energy Management Firm (to be specified)**  
 Financing is calculated on a \_\_\_\_\_ (monthly or quarterly) basis  
 based on the project balance of the previous period.

The interest rate applied is : \_\_\_\_\_ (I)

| Payback<br>Period<br>Month                        | TCI<br>(A) | Financial<br>Support<br>(B) | Monitoring<br>(C) | Performance<br>Premium<br>(D) | Maintenance<br>(E) | Interest<br>(F) | Savings<br>(G) | Project<br>Balance<br>(H) |
|---|------------|-----------------------------|-------------------|-------------------------------|--------------------|-----------------|----------------|---------------------------|
| 0   |            |                             |                   |                               |                    |                 |                |                           |
| 1   |            |                             |                   |                               |                    |                 |                |                           |
| 2   |            |                             |                   |                               |                    |                 |                |                           |
| 3   |            |                             |                   |                               |                    |                 |                |                           |
| 4   |            |                             |                   |                               |                    |                 |                |                           |
| 5   |            |                             |                   |                               |                    |                 |                |                           |
| 6   |            |                             |                   |                               |                    |                 |                |                           |
| 7   |            |                             |                   |                               |                    |                 |                |                           |
| 8   |            |                             |                   |                               |                    |                 |                |                           |
| 9   |            |                             |                   |                               |                    |                 |                |                           |
| 10  |            |                             |                   |                               |                    |                 |                |                           |
| 11  |            |                             |                   |                               |                    |                 |                |                           |
| 12  |            |                             |                   |                               |                    |                 |                |                           |
| 13  |            |                             |                   |                               |                    |                 |                |                           |
| 14  |            |                             |                   |                               |                    |                 |                |                           |
| 15  |            |                             |                   |                               |                    |                 |                |                           |
| 16  |            |                             |                   |                               |                    |                 |                |                           |
| 17  |            |                             |                   |                               |                    |                 |                |                           |
| 18  |            |                             |                   |                               |                    |                 |                |                           |
| 19  |            |                             |                   |                               |                    |                 |                |                           |
| 20  |            |                             |                   |                               |                    |                 |                |                           |
| 21  |            |                             |                   |                               |                    |                 |                |                           |
| 22  |            |                             |                   |                               |                    |                 |                |                           |
| 23  |            |                             |                   |                               |                    |                 |                |                           |
| 24  |            |                             |                   |                               |                    |                 |                |                           |
| 25  |            |                             |                   |                               |                    |                 |                |                           |
| 26  |            |                             |                   |                               |                    |                 |                |                           |
| 27  |            |                             |                   |                               |                    |                 |                |                           |
| 28  |            |                             |                   |                               |                    |                 |                |                           |
| 29  |            |                             |                   |                               |                    |                 |                |                           |
| 30  |            |                             |                   |                               |                    |                 |                |                           |
| 31  |            |                             |                   |                               |                    |                 |                |                           |
| 32  |            |                             |                   |                               |                    |                 |                |                           |
| 33  |            |                             |                   |                               |                    |                 |                |                           |
| 34  |            |                             |                   |                               |                    |                 |                |                           |
| 35  |            |                             |                   |                               |                    |                 |                |                           |
| 36  |            |                             |                   |                               |                    |                 |                |                           |
| 37  |            |                             |                   |                               |                    |                 |                |                           |
| 38  |            |                             |                   |                               |                    |                 |                |                           |
| 39  |            |                             |                   |                               |                    |                 |                |                           |
| 40  |            |                             |                   |                               |                    |                 |                |                           |
| 41  |            |                             |                   |                               |                    |                 |                |                           |
| 42  |            |                             |                   |                               |                    |                 |                |                           |
| 43  |            |                             |                   |                               |                    |                 |                |                           |
| 44  |            |                             |                   |                               |                    |                 |                |                           |
| 45  |            |                             |                   |                               |                    |                 |                |                           |
| 46  |            |                             |                   |                               |                    |                 |                |                           |
| 47  |            |                             |                   |                               |                    |                 |                |                           |
| 48  |            |                             |                   |                               |                    |                 |                |                           |
| Can be extended<br>up to 72 months<br>if required |            |                             |                   |                               |                    |                 |                |                           |

- Notes :
- (A) The Total Cost of Implementation (TCI) should be applied on month zero (equivalent to the end of the last month preceding the Payback Period)
  - (C) The monitoring cost should apply once per year of the Payback Period
  - (D) Performance premium is a lumpsum amount
  - (E) Maintenance should be spread as expected monthly charge
  - (F) Interest is calculated monthly or quarterly with the indicated interest rate on the previous month project balance (H)
  - (G) Savings must be equal amount each month for bidding purpose. Real figures will be used during the project reimbursement.
  - (H) Project balance = (H previous month) + C + D + E + F - G





# ANNEXURE C

## ENERGY MANAGEMENT FIRM'S HOURLY RATES (Effective )

Project Team Members

Hourly Rates