CHAPTER 5

CONCLUSION

5.1 Introduction

Two techniques are used to forecast water demand. The comparison between their results is described in previous chapter. This chapter covers the summary of this study, the conclusion and the recommendation for further study.

5.2 Summary of the Study

1. Water demand forecasting is very important information for the Metropolitan Waterworks Authority. Its use for many managerial planning is described in Chapter 1. Since the traditional moving average usually gives inaccuracy, new forecasting technique may be introduced as the alternative. Artificial neural network is selected, as the new technique needed to be tested if it can provide more accuracy.

2. Basic knowledge on the artificial neural network is introduced in Chapter 2. A neural network will be trained so that it can recognize the pattern of input that generates specified output. Network development process from variables selection to the comparison of results is described in details. Related literature surveys on forecasting with artificial neural network show that it is a potential technique that can be used for forecasting.

3. Calculation on water demand forecasting with the accrual moving average is illustrated in Chapter 3. For the Fiscal Year 1999, 2000 and the first sixth months of the Fiscal Year 2001, when compared with actual demand, water demand forecast by accrual moving average technique has the percentages of error at 9.81, -3.20 and -3.55 respectively. These percentages of error are not at satisfactory level.

4. Several neural network models are developed in Chapter 4 to find the network that provides water demand forecast with minimum of error. The network used in this study is two-layer feed-forward backpropagation network. The learning algorithm of this network is batch gradient descent with momentum. Training with different learning rates, different number of neurons in the hidden layer and different sets of input are performed. For the Fiscal Year 1999, 2000 and the first sixth months of the Fiscal Year 2001, the best neural network in the study gives water demand forecast with percentages or error at -1.57, 1.17 and 0.22 respectively.

5.3 Conclusion

From the comparison between water demand forecast and actual demand, neural network provides less percentages of error than the accrual moving average. Neural network has proved that if the selection of input variables is appropriate, it will be a powerful technique that is able to provide high forecasting accuracy.

5.4 Recommendations for further study

Users must have a good study on theory and some experience related to artificial neural network so that they can develop appropriate network for their problems.

Variables selection should be considered in depth because it effects the reliability of the forecasting model. Improper variables selected as the input to the network will deviate the accuracy of the forecasting so unnecessary variables must not be included to the input. Independence of variables must be evaluated and no dependent variables should be selected as the input to the network.

For this study, a test of dependency between GDP, increased water tariffs and number of connections should be conducted so that the level of independence is known. Training with just one variable for each of the three

variables and training with two independent variables should be done. So the following tests should be done.

1. Training with GDP as the only one input
2. Training with increased water tariffs as the only one input
3. Training with number of connections as the only one input
4. Training with GDP and increased water tariffs
5. Training with GDP and number of connections
6. Training with increased water tariffs and number of connections

Users also have to pay more attention on the use of GDP because GDP stands for Gross Domestic Product that is calculated from summation of many factors. Using forecasted GDP as the variable input to forecast whatever factors might lead to low reliability of the result.

Further study may be done by extending the study to many options such as new experiments such as training with other neural network's algorithms. Using different variables or using different network architecture may be done in case that they might give better results.