

### Assignment 3: Linear Programming

Date Due: February 9, 2012

Instructor: Trani

#### Problem 1

Modify the water management pollution control problem described in the class notes and explained in class. New removal costs are presented in Table 1.

Table 1. Removal Costs and Pollution Values for Water Pollution Control Problem.

Source	Removal Cost (\$/kg)	Pollution to Lake (kg)
River A	146	27,500
River B	145	21,000
River C	149	24,500
City	215	13,200
Airport	203	18,900

Assume that under a new water mandate by EPA we would like to remove at least 58,000 kg. of the baseline pollution going into the lake. Moreover, airport and city managers want to participate in the pollution removal program by removing at least 60% of their baseline pollution allocations per year. The pollution processing plants at all three rivers need to remove at least a fifth of their pollutants as a minimum according to a new environmental law.

a) Formulate the problem as a linear programming problem. Solve the new problem using Excel Solver and state the optimal cost.

The airport manager would like to invest in a deicing fluid system able to recycle 60% of the pollutants produced by the airport. The new plant is expected to cost \$20,000,000 and last for at least 15 years.

b) Using principles of engineering economics and Excel, calculate the yearly payments from the airport authority to a bank to buy the recycling system and pay it off at the end of 15 years. Assume the bank charges 5% yearly over the loan period.

c) I assume that airport operations increase at a rate of 2% per year for the next 15 years. Is the investment in the recycling plant? Comment.

## Problem 2

You are in charge of a civil engineering construction company that makes concrete for various highway projects in the State of North Carolina. Your company has various sites across the state to take sand and gravel materials necessary to make a concrete mix. For a construction job near Greensboro there are two sites to extract sand and gravel raw materials: a) Sandy Ridge and b) Triad Park. Due to variations in the soil properties at each site, the raw material from Sandy Ridge produces 35% sand and 65% gravel. Triad Park produces 48% sand and 52% gravel.

The construction job in Greensboro requires a minimum of 36,500 cubic meters of sand and gravel mix. The pavement design engineer requires a minimum of 14,900 cubic meters of sand and no more than 19,000 cubic meters of gravel in making the concrete mix for this highway job. The unit delivery costs (includes the cost of raw materials and the hauling costs) are \$745 and \$820 per cubic meter from Sandy Ridge and Triad Park, respectively.

For each item below, use screen captures to show me how is that the analysis is done.

- a) Formulate this problem as a linear programming problem. Clearly state the objective function and the constraint equations of the problem.
- b) Solve the problem graphically. Plot the lines of constant values of the objective function and show the optimal solution in your plot.
- c) Setup and solve the problem using Excel solver.

### Problem 3

A colleague of yours started solving a linear programming. She created the following feasible region plot for this problem.

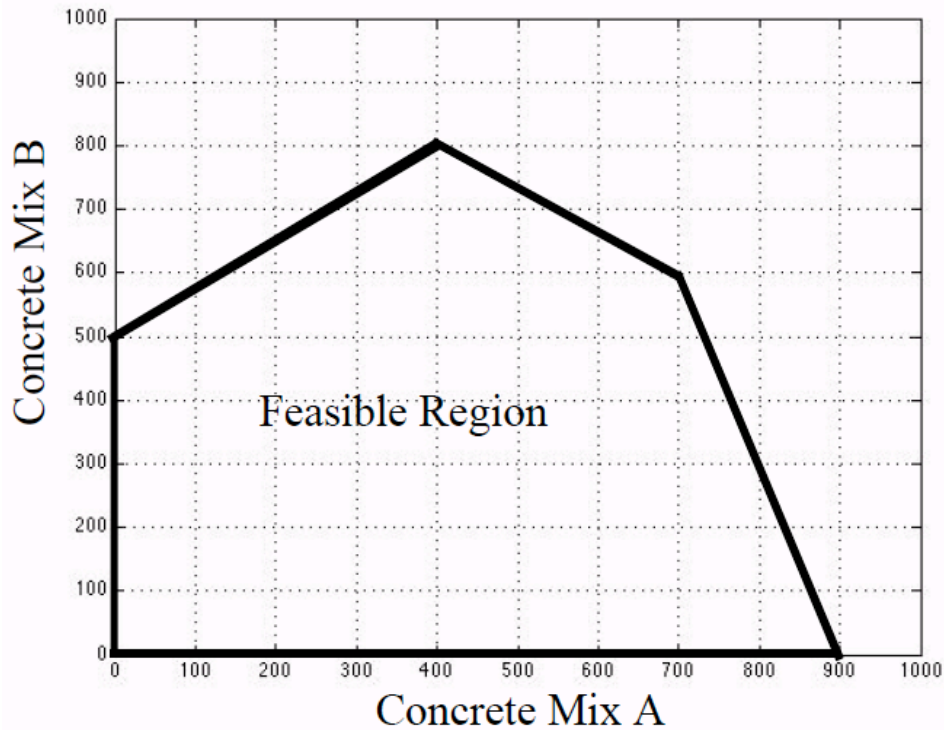


Figure 1. Revenue Production for ACME Concrete Company. Units of Axes are Metric Tons.

The ACME company makes \$1600 for every metric ton of concrete mix of type A delivered. The company makes \$1735 for every metric ton of concrete mix of type B delivered.

- Formulate this optimization problem to maximize the revenue for the ACME company. Write down the objective function and the constraints equations.
- Create the first three tables of the **Simplex method** to solve the problem.
- Find the optimal solution using Excel Solver.