Case Study: Assigning Students to Schools

The Springfield school board has made the decision to close one of its middle schools (sixth, seventh, and eighth grades) at the end of this school year and reassign all of next year's middle school students to the three remaining middle schools. The school district provides bussing for all middle school students who must travel more than approximately a mile, so the school board wants a plan for reassigning the students that will minimize the total bussing cost. The annual cost per student of bussing from each of the six residential areas of the city to each of the schools is shown in the following table (along with other basic data for next year), where 0 indicates that bussing is not needed and a dash indicates an infeasible assignment.

		Percentage	Percentage	Percentage			
	Number of	in 6th	in 7th	in 8th	Bussing Cost ($/Student)		
Area	Students	Grade	Grade	Grade	School 1	School 2	School 3
1	450	32%	38%	30%	$300	$0	$700
2	600	37%	28%	35%	-	$400	$500
3	550	30%	32%	38%	$600	$300	$200
4	350	28%	40%	32%	$200	$500	$0
5	500	39%	34%	27%	$0	-	$400
6	450	34%	28%	38%	$500	$300	$0
				School Capacity:	900	1100	1000

The school board also has imposed the restriction that each grade must constitute between 30 and 36 percent of each school's population. The above table shows the percentage of each area's middle school population for next year that falls into each of the three grades. The school attendance zone boundaries can be drawn so as to split any given area among more than one school, but assume that the percentages shown in the table will continue to hold for any partial assignment of an area to a school. You have been hired as an operations research consultant to assist the school board in determining how many students in each area should be assigned to each school.

(a) Formulate and solve a linear programming model for this problem. What is your resulting recommendation to the school board?

The school board is considering eliminating some bussing to reduce costs. Option 1 is to eliminate bussing only for students traveling 1 to 1.5 miles, where the cost per student is given in the table as $200. Option 2 is also eliminating bussing for students traveling 1.5 to 2 miles, where the estimated cost per student is $300.

(b) Revise your model to fit option 1, and solve. How much would be saved?

(c) Revise your model to fit option 2, and solve. How much would be saved (from (b))?

The school board is concerned about the splitting of residential areas among multiple schools.

(d) (continuing from (c)), adjust your model to enable each area to be assigned just one school. How much does this increase the total bussing cost?

Note: Solver will not find a solution—but you must bring some suggestions back to the school board. In order to do this, you will have to modify the constraints. But which constraints are flexible and which are inflexible? Decide, or ask, and try again!

(e) After all your work on (d), the school board has decided that option (d) is too expensive but asks if it would help to add a portable classroom to increase the capacity of one or more of the middle schools. Each portable classroom holds 25 students and has a leasing cost of $25,000 per year. Determine which schools (if any) should use these portable classrooms to reduce the bussing costs. [I expect educated guess and check here—don't overthink it!]

Prepare a final write up to the school board influencing them to make the best decision.