**CE 3500: Group Assignment 3** (30 points)
Due Monday, April 25

As spring approaches, your design firm has been tasked with designing a two-lane highway in rural Wyoming. The highway descends a hill, crosses a river, and must shift to a parallel alignment on level terrain. You must design the vertical alignment, horizontal alignment, and the flexible pavement. Top-view and profile diagrams are on the next page, and more details are as follows:

- The river crossing must occur where indicated in the diagram. For right-of-way reasons, the horizontal alignment must be straight until station 140+00, and the transition to the new alignment must be completed within 3000 ft (measured along the original alignment, as shown in the figure on the next page.)

- The natural terrain is level at elevation 7100 ft until station 100+00. Between station 100+00 and 120+00, the elevation of the terrain bears a striking resemblance to the curve $7050 + 50\cos(\pi x/2000)$, where $x$ is the distance past station 100+00 in feet. From station 120+00 onward, the terrain is level at 7000 ft.

- If you can, design the alignment to be safe when traveled at 65 mph; however, you may lower the design speed for short sections if necessary. If you do so, this must be indicated in your report.

- If you use superelevation on your horizontal curves, there must be a straight transition section between the curves of 60 feet per 0.01 change in superelevation. (For instance, if one horizontal curve has $e = 0.03$ and the other has $e = 0.02$, you need 300 feet of transition (because the two curves are banked in the opposite direction).

- The average daily volume is 23,000 vehicles in each direction, with 90% of them passenger vehicles and 10% semi-tractor trailers. This volume is expected to grow by 2% per year.

- Currently there is an average of 12 injury accidents each year on a nearby section of this road which has already been constructed and is operational (with the same volume and typical roadway characteristics).

- When this road is opened, the expected average injury crash frequency should be no higher than 9 per year.

- Assume that passenger vehicles on average weigh 2000 pounds per axle, and that the semi-tractor trailers each have two tandem axles with a 34,000 pound load, and a single axle with an 8,000 pound load.

- Design the pavement to last ten years with a reliability level of 95%, with initial and final serviceability indices 4 and 2.5, an overall standard deviation of 0.45.

- Water drains from the pavement within a week, and the pavement is saturated with moisture 1% of the time.

- The resilient moduli of the asphalt concrete, base course, subbase, and subgrade materials are 300,000 psi; 21,000 psi; 11,000 psi; and 8,000 psi, respectively.

Each team must turn in a short report, containing at a minimum:

- A brief written summary of the alignment, including the presence of any straight sections in between vertical or horizontal curves, the superelevation (if any) on the horizontal curves, and any locations where the design speed must be reduced.

- For each vertical curve, the elevation of the PVC, PVT, and each whole station in between.

- For each horizontal curve, the deflection and chord lengths for PC, PT, and each whole station in between.

- The combination of safety improvements you propose to meet the injury crash rate goal, as well as discussion of why your group feels this combination is appropriate for this facility, and your confidence in your ability to achieve the goal with these improvements.

Bonus point will be awarded to the team which minimizes the total cut and fill requirements for the vertical alignment. For simplicity, assume that you cannot move soil within the site, so I will measure the total cut and fill by taking the integral of the absolute value of the difference between the natural terrain and your proposed alignment. The usual tiebreakers apply. (correct analysis and professional presentation). Your vertical curves must be parabolic, and you can use at most two vertical curves (possibly with a straight section in between).

100+00

120+00

River

140+00

3000 ft

1000 ft

$x$

7100 ft

7050 + 50 cos ($\pi x$/2000)

7000 ft

100+00

120+00