Problem 1

Since a given highway has 6 lanes, we establish $N = 3$
$U_p = 65 \text{ mph}$

Side obstructions are 6 ft & 4 ft wide respectively for two sides $P_r = 10\% = 0.1$; since no recreational vehicles are present, $P_r = 0$

PHF = 0.9

From Table 7.7, $E_p = 1.00$; From Table 7.2 $f_0 = 0.94$ (average number)
From Table 7.3, $E_r = 3.0$
From Table 7.1 $C_j = 2300 \text{ pcphpl}$, $(V/C)_j = 0.673$, $MSF_i = 1548 \text{ pcphpl}$

$HV = \frac{1}{1 + P_r (E_r - 1) + P_r (E_r - 1)} = \frac{1}{1 + 0.1 (3.0 - 1) + 0} = 0.83$

$SF_i = C_j (V/C) \cdot N \cdot f_0 \cdot f_{HV} \cdot f_p = 3636 \frac{\text{veh}}{\text{hr}}$

Peak hour volume $V_{ph} = SF_i \cdot PHF = 3636 \times 0.9 = 3272 \frac{\text{veh}}{\text{hr}}$

Since the peak hour volume makes up 20% of the daily traffic volume, then $V_d = V_{ph} \times 5 = 3272 \times 5 = 16360 \text{ veh}$

Problem 2

Reconsidering problem 1:

$4\%$ grade; $V_h = 3500 \text{ veh/hr}$; $SF = \frac{V}{PHF} = \frac{3500}{0.9} = 3889 \frac{\text{veh}}{\text{hr}}$

$HV = \frac{1}{1 + P_r (E_r - 1) + P_r (E_r - 1)}$; $SF = C_j (V/C) \cdot N \cdot f_0 \cdot f_{HV} \cdot f_p$

$HV = \frac{SF}{C_j (V/C) \cdot f_0 \cdot f_p \cdot N} = 0.6 \Rightarrow 0.6 = \frac{1}{1 + 0.1 (E_r - 1)} \Rightarrow E_r = 7.67$

According to table 7.4, $E_r = 7.67$ gives us continuous grade length of longer than 1 mile.
Problem 3

\[ N = 2; \quad U_t = 70 \text{ mph}; \quad P_R = \emptyset; \quad \text{from Table 7.3, } E_T = 3.0 \]

\[ F_{uv} = \frac{1}{1 + P_t (E_T - 1) + P_R (E_R - 1)}; \quad PHF = \frac{V}{N_t (60/t)} \]

\[ SF = N_t \left( \frac{60}{t} \right) = 700 \times 4 = 2800 \text{ veh/hr} \]

From Table 7.2, \( f_w = 1.00; \) from Table 7.7, \( f_p = 1.00 \)

\[ f_{uv} = \frac{SF}{C_j \cdot \left( \frac{N_t}{E_T} \right) \cdot f_w \cdot f_p \cdot N} = \frac{2800}{2200 \times 0.447 \times 1 \times 1 \times 1} = 0.852 \]

\[ 0.852 = \frac{1}{1 + P_t (3-1) + \emptyset} = f_{uv} \Rightarrow P_t = 4.8\% = 0.048 \]

\[ \nu_{p.h.} = 1800 \text{ vehicles (peak hour volume)} \]

\[ 1800 \times 0.048 = 159 \] - number of trucks and buses.

Problem 4.

\[ P_T = 10\%; \quad l = 4.5 \text{ miles; } 5\% \text{ downgrade; } E_T = 4 \text{ (Table 7.6)} \]

\[ f_{uv} = \frac{1}{1 + 0.1 (4-1) + \emptyset} = 0.77 \quad \text{ P_R = \emptyset} \]

\[ MSF = \frac{SF}{N \cdot f_w \cdot f_{uv} \cdot f_p} = \frac{2800}{2 \times 1 \times 0.77 \times 1} = 1820 \text{ pcp/hpl} \]

Since obtained MSF exceeds boundaries of LOS C, thus LOS D is considered.