Combining the four equations above yields additional predictive relationships for concurrent increases or decreases in streamflow and/or sediment discharge:

$$Q_w^+ Q_s^+ \sim b^+, d^{+/-}, L^+, S^{+/-}, P^-$$

$$Q_w^- Q_s^- \sim b^-, d^{+/-}, L^-, S^{+/-}, P^+$$

$$Q_w^+ Q_s^- \sim b^{+/-}, d^+, L^{+/-}, S^-, P^+$$

$$Q_w^- Q_s^+ \sim b^{+/-}, d^-, L^{+/-}, S^+, P^-$$

Channel Slope

Channel slope, a stream's longitudinal profile, is measured as the difference in elevation between two points in the stream divided by the stream length between the two points. Slope is one of the most critical pieces of design information required when channel modifications are considered. Channel slope directly impacts flow velocity, stream competence, and stream power. Since these attributes drive the geomorphic processes of erosion, sediment transport, and sediment deposition, channel slope becomes a controlling factor in channel shape and pattern.

(See Figs. 1-27 and 1-28)

Most longitudinal profiles of streams are concave upstream. As described previously in the discussion of dynamic equilibrium, streams adjust their profile and pattern to try to minimize the time rate of expenditure of potential energy, or stream power, present in flowing water. The concave upward shape of a stream's profile appears to be due to adjustments a river makes to help minimize stream power in a downstream direction. Yang (1983) applied the theory of minimum stream power to explain why most longitudinal streambed profiles are concave upward. In order to satisfy the theory of minimum stream power, which is a special case of the general theory of minimum energy dissipation rate (Yang and Song 1979), the following equation must be satisfied:

$$\frac{dP}{dx} = \gamma Q \frac{dS}{dx} + S \frac{dQ}{dx} = 0$$

Where:

P = QS = Stream power

x = Longitudinal distance

Q = Water discharge

S = Water surface or energy slope

γ = Specific weight of water

Stream power has been defined as the product of discharge and slope. Since stream discharge typically increases in a downstream direction, slope must decrease in order to minimize stream power. The decrease in slope in a downstream direction results in the concave-up longitudinal profile.

Sinuosity is not a profile feature, but it does affect stream slope. Sinuosity is the stream length between two points on a stream divided by the valley length between the two points. For example, if a stream is 2,200 feet long from point A to point B, and if a valley length distance between those two points is 1,000 feet, that stream has a sinuosity of 2.2. A stream can increase its length by increasing its sinuosity, resulting in a decrease in slope. This impact of sinuosity on channel slope must always be considered if channel reconstruction is part of a proposed restoration.

Pools and Riffles

The longitudinal profile is seldom constant, even over a short reach. Differences in geology, vegetation patterns, or human disturbances can result in flatter and steeper reaches within an overall profile. Riffles occur