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The effect of vegetation zones on adjacent clear channel flow

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Appendix D: Integrations of Velocity Distributions for Non-vegetated Zone Discharge

D.1: Method of Ikeda et al. (1991, 1994) and Tsujimoto and Kitamura (1994) for the Non-vegetated zone

The velocity for this method was given as:

$$V = V_{\inf} - \left(V_{\inf} - \sqrt{V_{\inf} \cdot V_{VegZone}}\right) e^{-Y/bm} \tag{28}$$

The non-vegetated zone discharge :

$$Q_c = \int_0^{bfo} V \cdot D \, dY = \int_0^{bfo} V_{\inf} \cdot D \, dY - \int_0^{bfo} \left(V_{\inf} - \sqrt{V_{\inf} \cdot V_{VegZone}}\right) e^{-Y/bm} \cdot D \, dY \tag{D1}$$

Noting that $\int e^{ax} \, dx = e^{ax}/a + c$

$$Q_c = \int_0^{bfo} V \cdot D \cdot [Y]_0^{bfo} - \left(V_{\inf} - \sqrt{V_{\inf} \cdot V_{VegZone}}\right) \cdot D \cdot \left[- Bm \cdot e^{-Y/Bm} \right]_0^{bfo} \tag{D2}$$

$$\therefore Qc = V_{\inf} \cdot D \cdot bfo + Bm \cdot D \cdot \left(V_{\inf} - \sqrt{V_{\inf} \cdot V_{VegZone}}\right)\left(e^{-bfo/Bm} - 1\right) \tag{D3}$$

$$\therefore Qc = V_{\inf} \cdot D \cdot bfo - Bm \cdot D \cdot V_{\inf} \left(\sqrt{V_{VegZone}/V_{\inf}} - 1\right)\left(e^{-bfo/Bm} - 1\right) \tag{D4}$$

$$\therefore Qc = V_{\inf} \cdot D \cdot \left[bfo - Bm \cdot V_{\inf} \left(\sqrt{V_{VegZone}/V_{\inf}} - 1\right)\left(e^{-bfo/Bm} - 1\right)\right] \tag{36}$$

D.2: Method of Ikeda et al. (1991, 1994) and Tsujimoto and Kitamura (1994) for the Vegetation zone

$$V = V_{VegZone} + \left(\sqrt{V_{\inf} \cdot V_{VegZone}} - V_{VegZone}\right) e^{Y/Bs} \tag{28}$$

The Vegetation zone discharge:

$$Qv = \int_{-Bv}^{0} V \cdot D \, dY = \int_{-Bv}^{0} V_{VegZone} \cdot D \, dY + \left(\sqrt{V_{\inf} \cdot V_{VegZone}} - V_{VegZone}\right) \cdot D \cdot \int_{-Bv}^{0} e^{Y/Bs} \, dY \tag{D5}$$

$$\therefore Qv = V_{VegZone} \cdot D \cdot [Y]_{-Bv}^{0} + \left(\sqrt{V_{\inf} \cdot V_{VegZone}} - V_{VegZone}\right) \cdot D \cdot \left[Bs \cdot e^{Y/Bs} \right]_{-Bv}^{0} \tag{D6}$$

$$\therefore Qv = V_{VegZone} \cdot D \cdot Bv + Bs \cdot D \cdot \left(\sqrt{V_{\inf} \cdot V_{VegZone}} - V_{VegZone}\right) \cdot \left(1 - e^{-Bv/Bs}\right) \tag{D7}$$

$$\therefore Qv = D \cdot Bv \left[V_{VegZone} + Bs/Bv \cdot \left(1 - e^{-Bv/Bs}\right) \cdot \left(\sqrt{V_{\inf} \cdot V_{VegZone}} - V_{VegZone}\right)\right] \tag{37}$$

D.3 Method of Nuding (1991, 1994) for Non-vegetated Zone limited to V_{max}

$$Qc = \int_{bm}^{bf} V \cdot D \, dy$$

$$= \int_{bm}^{TW} \frac{K \cdot u_v^*}{\log\left(V_{\max} / V_{VegZone}\right)} \cdot \sqrt{\frac{h_T}{R_v \cdot bm}} \cdot D \cdot y^{1/2} \, dy + \int_{TW}^{bf} V_{\max} \cdot D \, dy \qquad \text{(D8)}$$

$$= \frac{K \cdot u_v^* \cdot D}{\log\left(V_{\max} / V_{VegZone}\right)} \cdot \sqrt{\frac{h_T}{R_v \cdot bm}} \cdot \left[\frac{2}{3} y^{3/2}\right]_{bm}^{TW} + V_{\max} \cdot D \cdot [y]_{TW}^{bf}$$

$$Qc = V_{\max} \cdot D \cdot (bf - TW) + \frac{2 \cdot K \cdot u_v^* \cdot D \cdot \left[TW \cdot \sqrt{(TW/bm)} - bm\right]}{3 \cdot \log\left(V_{\max} / V_{VegZone}\right)} \cdot \sqrt{\frac{h_T}{R_v}} \qquad (20)$$