24.3 Examples

24.3.1 Example 24.1

Sketch and label type of water surface profiles in the Channel shown in Figure 25.1. All the channels are long.

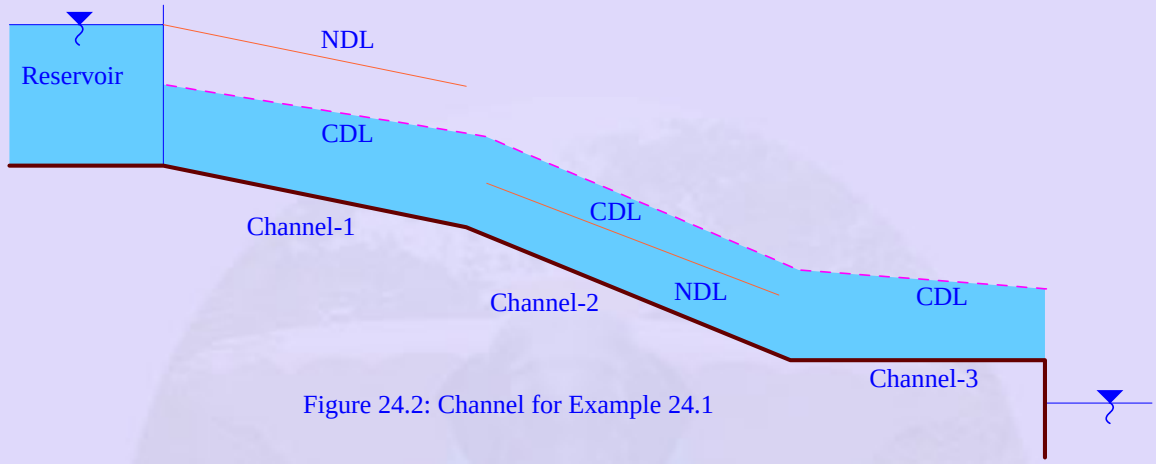

Figure 24.2: Channel for Example 24.1

Solution

- Channel-1 is a MILD channel since NDL is above CDL.
- Channel-2 is a STEEP channel since NDL is below CDL.
- Channel-3 is a HORIZONTAL channel since NDL does not exist.
- Critical flow conditions occur at the downstream end of Channel-3 since it is not a steep channel and there is a free overfall.
- Critical flow conditions occur at the junction of Channel-1 and Channel- 2 since the uniform flow in Channel-1 is sub critical while uniform flow in Channel-2 is supercritical.
- Flow is uniform in both Channel-1 and Channel-2 far away from the junction point, since the channels are long. Thus flow depths in Channel-1 and Channel-2 fall between NDL and CDL. Therefore, flow profile in Channel-1 is M2 type, while flow profile in channel-2 is S2 type
- In Channel-3, downstream portion would have sub critical flow conditions (critical depth occurs at the downstream end), while in the entrance region, flow would be

supercritical as it enters from the steep Channel-2. Therefore, a hydraulic jump should occur in Channel-3. The composite profile is shown in Figure 24.3.

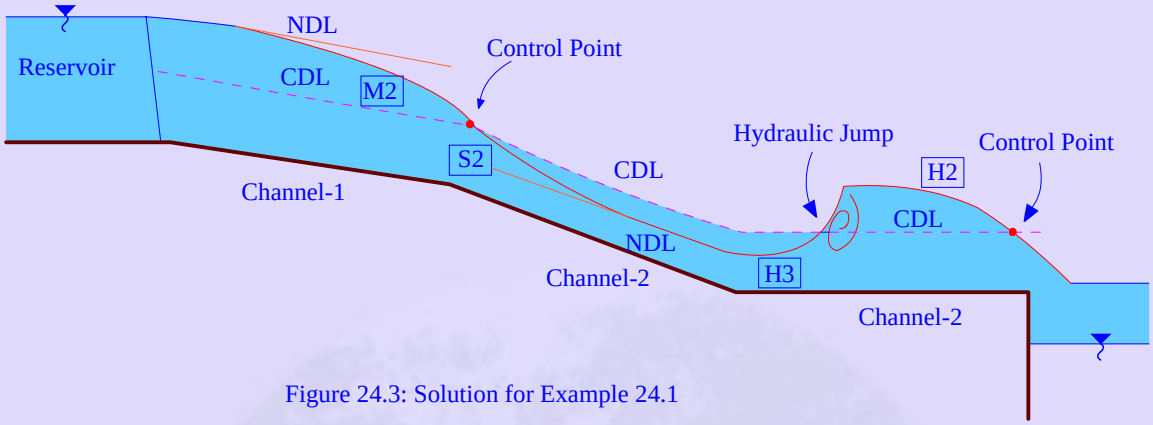

Figure 24.3: Solution for Example 24.1

24.3.2 Example 24.2

Sketch and label the types of water surface profiles in the Channel shown in Figure 24.4. All Channels are long.

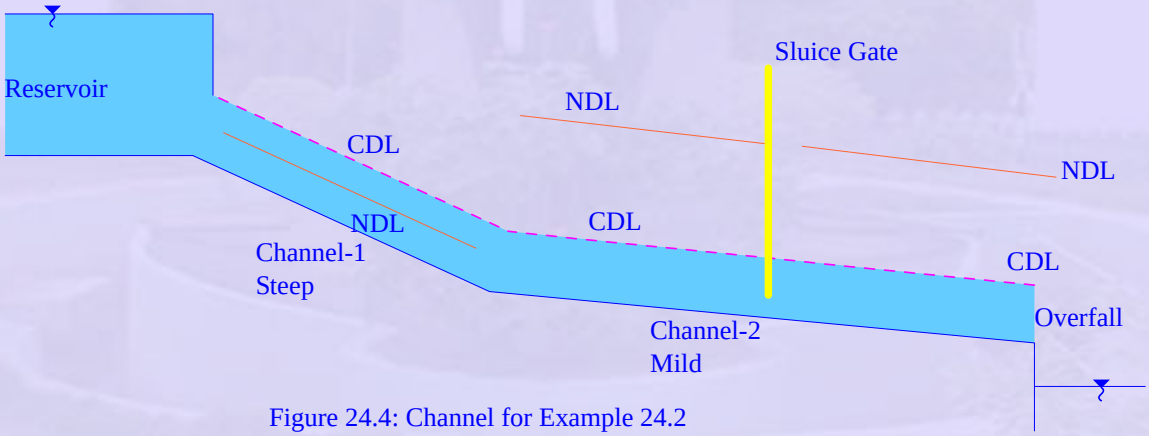

Figure 24.4: Channel for Example 24.2

Solution

- Critical flow conditions occur at the entrance to Channel-1 because Channel-1 is steep and the reservoir water level is above the CDL.
- Flow depth in the Channel-1 varies from critical depth at the entrance to the uniform flow depth far downstream. This is an S2 profile.

- At the entrance to Channel-2, flow depth is equal to the normal depth in Channel-1. This depth is below the CDL for Channel-2. Therefore, flow in the upper reaches of Channel-2 is supercritical. An M3 profile occurs in this region.
- The sluice gate in Channel-2 creates subcritical flow conditions on the upstream side and supercritical flow conditions on the downstream side. This acts as a control.
- On the upstream side of the sluice gate in Channel-2, flow has to change from supercritical because flow is supercritical in the upper reaches. Therefore, a hydraulic jump occurs at some distance on the upstream side of sluice gate in Channel-2.
- The sluice gate opening is such that the flow depth on the downstream side of the gate is below CDL. Therefore, flow is supercritical here.
- The Channel-2 is long on the downstream side of the gate also, and it is mild. Therefore, it cannot sustain supercritical flow conditions at distances far from the sluice gate. Flow changes from supercritical to subcritical at some distance downstream of the gate. This is accompanied by the formation of a hydraulic jump.
- There is a free over fall at the downstream end of the Channel-2. Therefore, critical depth occurs at this location. Note that the Channel-2 is mild and the flow is subcritical on the upstream side of the free over fall.
- All the channels are long. Therefore, uniform flow conditions are realized in all the channels far away from the control sections.
- Keeping in mind the above points, the composite water surface profile can be drawn as shown in Figure.24.5.

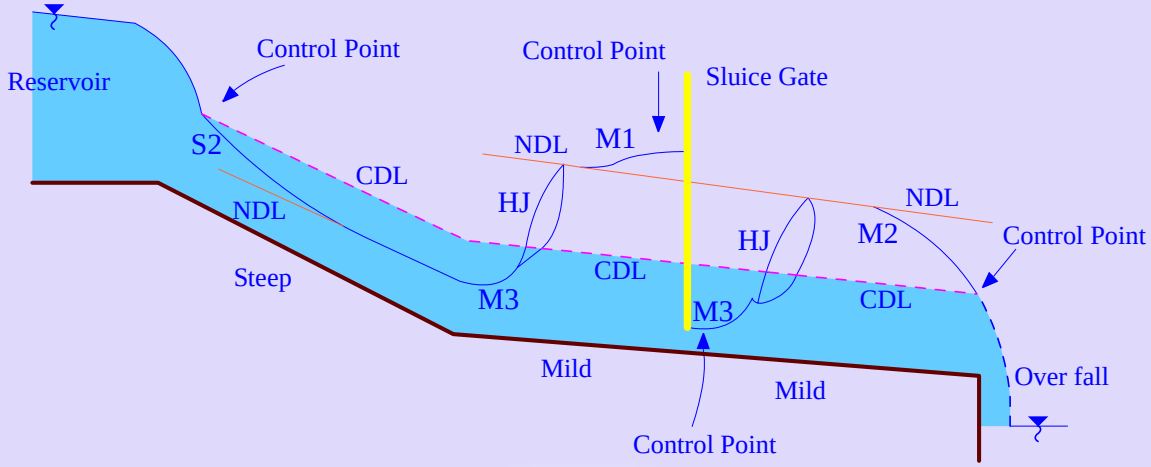

Figure 24.5: Solution for Example 24.2