Local Bend Losses and Water Superelevation in a Detention Drain

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Background reading

When water turns at a sump, we expect some head loss and a rise in water level against the outer wall. How much do these affect a detention drain? In this article we will use the model from *Detention Drain Design With Dynamic Routing* to examine the results from MiTS, using the outlet water-surface width for the local-rise calculations.

We have covered the theory in two earlier articles. *What a One-Dimensional Drainage Model Can Tell Us About Flow Turning in a Sump* explains the bend-loss coefficient K and the limits of a 1D routing model. *The Superelevation Equation for Flow Through Curved Conduits* derives the local water-level rise, explains how bend radius and water-surface width affect the rise, and sets out when we can use the estimate.

Conclusion first: the turning of pipes will introduce a bend loss, represented by K and this affects the node hydraulic grade line (HGL) and it doesn't depend on the chamber size. Superelevation, on the other hand, is affected by the chamber size and the connection between the pipes.

Notation used in the results

MiTS reports two outer-wall rises. \Delta h_{outlet} is the **outer-wall rise using outlet speed**. \Delta h_C is the **outer-wall rise using larger speed**, with the coefficient C selected from the outlet Froude number. R_{turn} is the assumed turning radius shared by both calculations. B_{outlet} is the outlet water-surface width, also used by both.

Every calculation uses outlet water-surface width, with \lambda=R_{turn}/B_{outlet} . Chamber clear width is not tested as an alternative hydraulic width. Only the comparison of both coefficients near

critical flow is a sensitivity check.

The outlet speed used for this estimate is $V_{outlet}=|V_o|$, whereas the larger speed is $V_{max}=\max(|V_i|,|V_o|)$. Here i and o identify the inlet and outlet. Both results describe extra height at the outer wall above the node HGL used as the assumed centreline level. Neither is a rise added at the centreline. Only Δh_C uses the velocity-head cap Δh_{cap} .

The model and how we modified it

We use the detention drain with orifice control calibrated in the earlier article. We keep its pipes, storms and routing settings, including the calibration of discharge, velocity and depth at the outfall.

In the MiTS report, a node identifies a sump or junction and a link identifies a connected drain. A path is the selected inlet-to-outlet connection. The pipe alignment turns at four junctions. MiTS calculates their deflection angles from the drawn geometry, as listed in Table 1:

Table 1. Pipe paths and deflection angles at the four junctions

Node	Pipe path	Deflection angle
A02	L01 → L02	47.3°
A03	L02 → L03	76.9°
S01	L03 → L05	78.3°
B03	L07 → L08	7.9°

S01 is the project’s discharge control sump, a 1400mm chamber ahead of the orifice and outfall. We keep this chamber as built and change the dimensions at A02, A03 and B03, which are ordinary bends along the pipe run.

Use 900mm × 900mm rectangular chambers at A02, A03 and B03, connected to their 450mm pipes. Keep S01 at 1400mm. Run Sump Bend Effects for the 5-, 50- and 100-year ARIs, with eight rainfall durations each. The examples in 100-year ARI, 10-minute storm and Same node, a milder storm: 5-year ARI, 70-minute use this 900mm configuration.

The rainfall duration identifies the storm input. The reported time t is elapsed time from the start of hydraulic routing, which can continue after rainfall ends. Each saved result sample is one reported timestep. A **governing time** is the sample at which the particular reported maximum or minimum occurs; different quantities can govern at different times.

Bend loss and the node HGL

MiTS obtains the bend-loss coefficient K from the HEC-22 angle-only table described in the first background article [1, table 9.4]. MSMA 3 writes a junction loss in the same form, K times the outlet velocity head, but reads the coefficient from the Missouri or Mills pit-loss charts, which need the junction's discharges, pipe sizes and geometry [2, sec. 6.2.3.7.3]. Its bend coefficient, K_b=0.0033 times the deflection angle in degrees, is for a bend in the pipe itself [2, sec. 6.2.3.7.4, eq. 6.9]. The HEC-22 table gives an access-hole coefficient from the deflection angle alone, which MiTS can calculate at every junction from the drawn geometry. Switching on Sump Bend Effects applies it at all four nodes, with the results in Table 2:

Table 2. Applied bend-loss coefficients and head losses

Node	Deflection	Applied K	Head loss
A02	47.3°	0.765	0.099 m
A03	76.9°	0.935	0.055 m
S01	78.3°	0.942	0.022 m
B03	7.9°	0.256	0.002 m

Table 3 compares the peak node HGL with and without Sump Bend Effects. These are the 5-year ARI results; the 50- and 100-year runs follow the same pattern.

Table 3. Peak node HGL with and without Sump Bend Effects for the 5-year ARI

Node	Duration (min)	Peak HGL, without (m)	Peak HGL, with (m)	Change
A02	10	4.488	4.492	+4 mm
A02	20	4.485	4.493	+7 mm

Node	Duration (min)	Peak HGL, without (m)	Peak HGL, with (m)	Change
A02	50	4.703	4.703	0 mm
A03	10	3.798	3.830	+31 mm
A03	20	3.912	3.925	+13 mm
S01	10	3.776	3.774	−2 mm
S01	50	3.914	3.913	−1 mm
B03	20	3.936	3.919	−17 mm
B03	30	3.934	3.918	−16 mm

At A02 and A03, the peak level rises by a few millimetres to about 3cm, and generally more at the higher ARIs. However, S01 has the largest K (0.942) and its peak level changes by no more than ±2mm. The extra loss at S01 does not control the backwater there.

What about B03, where the peak level goes down? The added losses upstream change the timing and attenuation of flow through the network, so less water arrives at B03 at the same moment. Its own local loss is only 2mm. Thus, we need the routing results to assess the water level at each node; the size of K alone does not tell us how much it will change.

Chamber geometry and the outer-wall rise

The automatic HEC-22 lookup depends on the pipe deflection angle, not chamber width. Chamber geometry is used in the separate turning-radius construction for the outer-wall rise. Changing the radius can change that estimate even when the angle-only loss coefficient stays the same.

Case studies

The values calculated using the procedure in How to read the reported rise are the retained **outer-wall rise using larger speed**, denoted \Delta h_C . It uses V_{max} , the larger inlet or outlet speed. The separate **outer-wall rise using outlet speed**, \Delta h_{outlet} , uses the outlet section and is reported only where its numerical screens pass. These two rises have different inputs and

applicability; their maxima must stay separate. The velocity-head cap is not a proven physical upper bound.

Geometry used for the outer-wall rise

MiTS fits an assumed turning radius R_{turn} from the available inlet/outlet tangent distances. Chamber dimensions affect that radius, but they do not provide an alternative water-surface width. Both coefficients use the saved outlet water-surface width B_{outlet}. For A03's 900mm chamber and 450mm rectangular outlet, $R_{turn}=0.566\,\mathrm{m}$ and $B_{outlet}=0.450\,\mathrm{m}$, giving $R_{turn}/B_{outlet}=1.259$. The construction is shown in Figure 1.

How to read the reported rise

At each usable saved timestep, MiTS uses outlet water-surface width B_{outlet}, the assumed radius R_{turn} and the larger inlet/outlet speed $V_{max}=\max(|V_i|,|V_o|)$. The inlet can set the speed while the width comes from the outlet; this is an assumption, not a resolved chamber velocity distribution.

The outlet Froude number Fr_{outlet} compares outlet speed with the speed of a small surface wave. It uses the outlet hydraulic depth $D_{h,outlet}$ (wetted flow area divided by water-surface width), which generally differs from actual depth above the invert. Fr_{outlet} below 1 is subcritical, 1 is critical and above 1 is supercritical. It determines which **superelevation coefficient** C to evaluate. This coefficient is separate from the head-loss coefficient K. MSMA 3 gives $C=0.5$ for subcritical flow in its bend equation [3, sec. 5.10.2, eq. 5.52]; $C=1.0$ for supercritical flow comes from USACE [4, table 2-4]. Table 4 lists the selection rules:

Table 4. MiTS superelevation coefficient selection by outlet Froude number

Outlet Froude number	Coefficients evaluated
$Fr_{outlet}<0.8$	$C=0.5$
$0.8\le Fr_{outlet}\le1.2$	Both $C=0.5$ and $C=1.0$
$Fr_{outlet}>1.2$	$C=1.0$, flagged `CUnvalidated`

The procedure is:

1. Compute Fr_{outlet} from that timestep’s saved hydraulic results.
2. Select C=0.5 , C=1.0 , or both, using Table 4.
3. Use B_{outlet} for every selected C . There is no chamber-width comparison.
4. Repeat at each usable saved timestep and select the largest retained rise after the applicability screens described in How to read the reported rise and the depth check in Near-dry samples.

Selecting a single coefficient from Fr_{outlet} is the normal calculation rule. Only testing both coefficients within 0.8\le Fr_{outlet}\le1.2 is a sensitivity comparison. This gives one calculation outside that band and two within it. Fr_{outlet} can change with flow, speed and hydraulic depth. Outlet water-surface width can change with shape and flow depth; it remains constant for a rectangular open section. Chamber dimensions stay fixed.

Sump Bend Calculation Details first substitutes the saved outlet values into the Froude formula and shows the numerical band inequality. For a value such as Fr_{outlet}=0.894 , 0.8 ≤ 0.894 ≤ 1.2 selects both C = 0.5 and C = 1.0. Separate working tables calculate each coefficient at that same time, using shared hydraulic inputs. Each working shows the uncapped rise, the velocity-head cap and the retained or excluded outcome. A final numerical selection line compares the retained rises and states their maximum; there is no duplicate comparison table. This is a comparison at the maximum-rise time, not a storm-wide count table.

For each selected C at each usable timestep, first calculate the uncapped rise and the velocity-head cap:

Δhuncapped=CVmax2gλ,Δhcap=Vmax22g,g=9.81 m/s2.\Delta h_{uncapped}=\frac{C V_{max}^{2}}{g\lambda},\qquad \Delta h_{cap}=\frac{V_{max}^{2}}{2g},\qquad g=9.81\,\mathrm{m/s^2}.

(1)

If \Delta h_{uncapped}/\Delta h_{cap} exceeds the configured Uncapped-Rise / Velocity-Head-Cap Limit, that C at that timestep is excluded from maximum-rise selection. The default limit is 1.5. Otherwise the retained value is \Delta h_C=\min(\Delta h_{uncapped},\Delta h_{cap}) . MiTS reports the largest retained value across the timesteps and all evaluated coefficients. Thus the largest uncapped value, or the larger coefficient alone, need not determine the reported maximum.

A missing outlet free surface, unavailable Fr_{outlet} or invalid radius/width geometry prevents the \Delta h_C calculation. Outlet depth below the configured minimum reliable depth also prevents it; that depth defaults to 0.05m. Flow reversal raises a timestep warning but is not automatically excluded from the \Delta h_C maximum; the separate \Delta h_{outlet} calculation does exclude reversed flow. The depth and ratio limits are software screening policies, not calibration of physical sump behaviour.

Read the selected \Delta h_C together with its status and caution codes in Table 5:

Table 5. Status of the outer-wall rise using larger speed

Status	Meaning	Typical condition
Not computed	The method is outside its applicability range.	No free surface, invalid chamber geometry, or near-dry outlet depth.
Withheld	A value was calculated but exceeds the Uncapped-Rise / Velocity-Head-Cap Limit.	\Delta h_{uncapped}/\Delta h_{cap} exceeds the configured limit (default 1.5).
Reported with caution	A value is shown together with the reason it needs engineering judgement.	Low R_{turn}/B_{outlet} , flow in the near-critical coefficient band, or a rise limited by the velocity-head cap.
Reported	No applicability or caution condition applies.	Normal free-surface conditions.

The report lists K , maximum bend head loss, maximum Fr_{outlet} , node HGL elevation, rim clearance above HGL, the outer-wall rise using outlet speed and the outer-wall rise using larger speed, together with the caution codes. The result identifies outlet width and the selected coefficient, `C=0.5` or `C=1.0`. MiTS evaluates both coefficients within the near-critical coefficient band; outside it, one coefficient is used.

Near-dry samples

A saved outlet depth of 24mm is below the default 50mm minimum reliable depth, even if the reported speed is high. MiTS does not calculate a usable local-rise case for that sample. A blank result

therefore does not mean zero rise.

A03 in the 900 × 900mm configuration

We now calculate the rise at A03 for a 100-year storm and a 5-year storm, using the 900 × 900mm chamber in both cases.

100-year ARI, 10-minute storm

Table 6. A03 report summary for the 100-year ARI, 10-minute storm

Quantity	Value
Deflection angle \delta	76.93° (L02 → L03)
Chamber	900 × 900mm rectangular
Applied K	0.935 (HEC-22 angle-only table)
Max bend head loss	0.080 m
Max Fr_{outlet} (separate timestep)	1.11
Max node HGL elevation	3.935 m
Min rim clearance above HGL	0.065 m
Max outer-wall rise using larger speed	0.136 m
Selected C	Outlet width (C = 0.5)
Cautions	`LowRatio`, `NearCritical`, `NonpositiveContainmentMargin`

The maximum outer-wall rise using larger speed occurs at t = 600 min. We use the hydraulic results at this timestep for the calculations below.

Hydraulic depth and Froude number

At t = 600 min the outlet reports Q_o = 0.0819 m³/s, |V_o| = 1.292 m/s and top width B_{outlet} = 0.450 m, so

- flow area A_{outlet} = |Q_o/V_o| = 0.0819 / 1.292 = 0.0634 m²

- hydraulic depth $D_{h,outlet} = A_{outlet}/B_{outlet} = 0.0634 / 0.450 = 0.141$ m
- $Fr_{outlet} = |V_o|/\sqrt{g D_{h,outlet}} = 1.292 / \sqrt{(9.81 \times 0.141)} = 1.292 / 1.176 =$ **1.10**

Thus, $Fr_{outlet}=1.10$ is physically supercritical and is also within the software's near-critical coefficient band, $0.8\le Fr_{outlet}\le1.2$. The maximum Fr_{outlet} of 1.11 in Table 6 occurs at another timestep. The reported maxima for HGL, Fr_{outlet} and outer-wall rise need not occur together.

Choosing the coefficient C

For timesteps in the near-critical coefficient band, MiTS evaluates both C = 0.5 and C = 1.0 and keeps the largest retained Δh_C over the time series. At A03, the reported result uses **C = 0.5**. We need to compare the Δh_C values that pass the applicability checks and the Uncapped-Rise / Velocity-Head-Cap Limit; choosing C = 1.0 simply because it is larger would miss these checks.

Curvature ratio R_{turn}/B_{outlet}

For A03, $T_{in} = 0.462$ m and $T_{out} = 0.450$ m. We use the smaller distance, 0.450 m, to calculate R_{turn} :

$$Rturn=0.450\tan(76.93\circ/2)=0.4500.795=0.566 \text{ m}$$
$$R_{turn}=\frac{0.450}{\tan(76.93^\circ/2)}=\frac{0.450}{0.795}=0.566\ \text{m}$$
(2)

Use the outlet water-surface width for both coefficients:

$$Boutlet=0.450 \text{ m},\lambda=0.566/0.450=1.259.B_{outlet}=0.450\,\mathrm m,\qquad \lambda=0.566/0.450=1.259.$$
(3)

The curvature ratio in Equation (3) is below the smooth-bend recommendation of 3 and triggers LowRatio. The chamber clear span of 0.900m is not substituted as a second flow width.

The red arc in Figure 1 has radius R_{turn} and is tangent to both pipe centrelines. At the outlet, the chamber span is 0.900m and the pipe top width is 0.450m; the calculation uses the latter. We draw both pipes at their 450mm width, but the chamber walls are schematic, positioned from the

calculated dimensions rather than traced from the CAD footprint.

Figure 1. A03 assumed turning-radius construction, 100-year/10-minute storm

The outer-wall rise using larger speed

The uncapped rise is $\Delta h_{uncapped} = C\,V_{max}^2/(g\lambda)$. The retained rise is $\Delta h_C=\min(\Delta h_{uncapped},\Delta h_{cap})$, using the velocity-head cap $\Delta h_{cap}=V_{max}^2/(2g)$, with V_{max} the larger of the inlet and outlet speeds:

- V_{max} = max(1.832, 1.292) = 1.832 m/s
- $\Delta h_{uncapped}$ = 0.5 × 1.832² / (9.81 × 1.259) = 1.678 / 12.35 = **0.136 m**
- Δh_{cap} = 1.832² / (2 × 9.81) = 3.356 / 19.62 = **0.171 m**, so no cap applies and Δh_C = **0.136 m**, matching the report
- outer-wall level using larger speed = $H_{node}+\Delta h_C$ = 3.875 + 0.136 = **4.011 m** (3.875m is the node HGL at this timestep; the 3.935m in Table 6 is the storm maximum at another timestep)
- outer-wall clearance using larger speed = rim elevation − outer-wall level using larger speed = 4.000 − 4.011 = **−0.011 m**

Table 7 compares the two coefficients at this same timestep:

Table 7. Coefficient comparison at the A03 maximum-rise timestep

C	Uncapped rise (m)	Velocity-head cap (m)	Uncapped / cap	Outcome
0.5	0.136	0.171	0.795	Retain 0.136 m
1.0	0.272	0.171	1.59	Exclude: ratio exceeds 1.5

Both rows evaluate Equation (1) using the same outlet width, the radius from Equation (2) and the same speed. C = 1.0 gives the larger uncapped rise but exceeds the limit, so it does not govern the reported result.

No separate containment level is defined for this project, so MiTS uses the rim elevation of 4.000m, also reported as A03's ground level in the Sump Schedule. MSMA 3 recommends a freeboard of 0.15m below the top of the lid at a junction structure [2, sec. 6.2.3.9, table 6-12]; here we compare with the rim itself. The outer-wall level using larger speed is 11mm above this level, triggering

`NonpositiveContainmentMargin`.

What the three cautions mean here

`LowRatio`: the outlet-width curvature ratio, 1.259, is below the USACE/USBR recommendation of $R_{turn}/B_{outlet} \ge 3$ for a smooth bend. A03's geometry falls outside that recommendation, so we need engineering judgement when using the rise estimate. See USACE EM 1110-2-1601 [4, sec. 2-5].

`NearCritical`: $Fr_{outlet}=1.10$ is physically supercritical and lies in the software's 0.8–1.2 near-critical coefficient band. MiTS evaluates both coefficients in this band; the code name does not redefine the physical boundary $Fr_{outlet}=1$. For comparison, MSMA 3 recommends keeping the Froude number below 0.6 under design conditions, because near-critical flow raises the risk of a hydraulic jump in the drain [3, sec. 2.6.9.3].

`NonpositiveContainmentMargin`: the outer-wall level using larger speed exceeds the containment elevation. The node HGL alone still gives a minimum rim clearance above HGL of +0.065m over this storm. However, once we add Δh_C to the HGL at its governing timestep, the outer-wall level reaches 4.011m, above the 4.000m rim. Checking only the node HGL would miss this local exceedance.

Same node, a milder storm: 5-year ARI, 70-minute

A03's outlet is a 450mm box culvert, so its free-surface top width stays constant with depth. Together with the fixed chamber geometry, this keeps R_{turn}, B_{outlet} and the outlet-width calculation's $\lambda = 1.259$ unchanged across all 24 duration/ARI combinations. The calculation uses outlet width in all 24 runs. The storms change the flow conditions, and therefore Fr_{outlet}, the coefficient choice and the outer-wall rise.

For the 5-year ARI, 70-minute storm, the governing timestep is t = 1440 min. The outlet velocity is $|V_o| = 0.546$ m/s, compared with 1.292 m/s in the 100-year example:

- $Fr_{outlet} = 0.546 / \sqrt{(9.81 \times 0.101)} =$ **0.548**, subcritical (below 1), below the near-critical coefficient band, and C = 0.5 applies directly with no two-coefficient evaluation
- $V_{max} = \max(1.504, 0.546) = 1.504$ m/s, still set by the inlet
- $\Delta h_{uncapped} = 0.5 \times 1.504^2 / (9.81 \times 1.259) = 1.132 / 12.35 =$ **0.092 m**

- \Delta h_{cap} = 1.504² / (2 × 9.81) = 2.264 / 19.62 = **0.115 m**, no cap
- outer-wall level using larger speed = 3.781 + 0.092 = **3.873 m**
- outer-wall clearance using larger speed = 4.000 − 3.873 = **+0.127 m**, against −0.011m for the 100-year storm

Only `LowRatio` applies to this result. At the governing timestep, the flow is subcritical and the outer-wall level using larger speed is 127mm below the rim. The storm does reach a peak Fr_{outlet} of 1.19 at t = 1080 min, but that is earlier than the maximum rise at t = 1440 min.

The outer-wall rise using outlet speed at this timestep

For this 5-year example, the outlet section is subcritical. Using the same printed, rounded values, $V_{outlet}=|V_o|=0.546\,\mathrm{m/s}$, $B_{outlet}=0.450\,\mathrm{m}$ and $R_{turn}=0.566\,\mathrm{m}$, Equation (1), evaluated with outlet speed and $C=0.5$, gives

$$\Delta h_{outlet}=\frac{0.546^2(0.450)}{2(9.81)(0.566)}\approx 0.012\ \mathrm{m}.$$

(4)

The rise in Equation (4) gives an outer-wall level using outlet speed of about 3.793m at this timestep, compared with 3.873m using larger speed in Same node, a milder storm: 5-year ARI, 70-minute. This is a substitution using printed inputs, not a newly measured full-storm maximum using outlet speed. At the timestep in 100-year ARI, 10-minute storm, Fr_{outlet}=1.10 excludes the outer-wall rise using outlet speed; other timesteps must be examined separately. The assumed turning arc and flow path still need engineering review.

Reading the MiTS report

The report uses the notation defined above, with its terms explained in Table 8. Its HGL and outer-wall levels are **elevations** on the project datum; a datum is the common level zero for those levels. A rise is a **height difference** above the node HGL. Each outer-wall level is formed from node HGL plus the matching rise at the same sample.

Table 8. Meanings of the MiTS bend-effect report terms

Report term	Meaning
Outer-wall rise using outlet speed	Δh_{outlet} , calculated from the outlet section only where the outlet-flow checks pass
Outer-wall level using outlet speed	$H_{node}(t)+\Delta h_{outlet}(t)$ at the same reported time; its maximum is found independently of maximum rise
Outer-wall rise using larger speed	Δh_C , the value retained after the limit and the cap
Outer-wall level using larger speed	$H_{node}(t)+\Delta h_C(t)$ at the same reported time
Rim clearance above HGL	Rim elevation minus H_{node} ; its minimum over the reported samples excludes the outer-wall rise
Outer-wall clearance using outlet speed or larger speed	Rim elevation minus the matching outer-wall level; this project uses the rim as its containment elevation
Outlet-Speed Samples Used	Number of saved samples passing the outlet-flow checks out of the total for that sump and storm; each unused sample is assigned to its first failed check
Uncapped rise	$\Delta h_{uncapped}$ is the value before the velocity-head cap and the limit
Velocity-head cap	$\Delta h_{cap}=V_{max}^2/(2g)$, a software policy that limits Δh_C
Coefficient comparison	The final selection line compares retained rises at the stated time; excluded cases do not enter the maximum
Blank or dash	No available or applicable result; it does not mean a calculated zero

A positive clearance means the selected water level is below the stated limit; zero reaches it and a negative clearance exceeds it. Rim clearance above HGL and outer-wall clearance are therefore different checks. The largest rise above node HGL and the highest outer-wall water level are selected separately. A heading at 360 min for largest rise and one at 1080 min for highest water level need not conflict: HGL changes with time too. Each heading shows the maximum of its own quantity across applicable saved samples. Never add maximum HGL to maximum rise unless those values belong to the same sample.

In the formulas, min chooses the smaller value, max the larger, vertical bars indicate magnitude, √ is square root and tan is the trigonometric tangent. Deflection-angle substitutions marked in degrees use degrees. Hydraulic depth and Froude number have their physical definitions in the sump-flow article; the generic width B there is B_outlet when the outlet section is selected here.

The three cautions in the A03 example are explained in What the three cautions mean here. Table 9 lists other flags used in the detailed working:

Table 9. Additional caution flags in the detailed working

Flag	Meaning
`CUnvalidated`	Fr_{outlet} exceeds 1.2 and C = 1.0 is used; that curved-channel coefficient has not been validated for an abrupt sump
`MissingCurvatureRatio`	The assumed turning radius or required width is missing or invalid, preventing the ratio calculation
`RiseCapped`	\Delta h_{uncapped} exceeds the velocity-head cap; the retained value is limited by that policy
`UnstableLocalLevelEstimate`	\Delta h_{uncapped}/\Delta h_{cap} exceeds the Uncapped-Rise / Velocity-Head-Cap Limit, so that C at that timestep is excluded from the maximum retained \Delta h_C

Conclusion

For A03, the 100-year outer-wall level using larger speed reaches 11mm above the rim despite a positive rim clearance above HGL, so we would investigate the chamber flow and detailing. That exceedance is not a validated local-water-level prediction. The 5-year example has 127mm clearance with the same chamber geometry. Using the report terms in Reading the MiTS report, open Sump Bend Calculation Details when reviewing your own model and check the HGL, outer-wall rise and rim elevation at the governing timestep, together with the caution codes. Use the chamber dimensions intended for construction: they affect the superelevation estimate even when the routing results remain unchanged.

References

[1] Roger Kilgore, A. Tamim Atayee, George R. Herrmann. *Urban Drainage Design*. HEC-22; FHWA-HIF-24-006. 4th edition. 2024. Available: https://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif24006.pdf

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[2] Department of Irrigation and Drainage Malaysia. *Malaysia Stormwater Manual (MSMA 3), Part 2*. DFR2-Rev2. 2026.

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[3] Department of Irrigation and Drainage Malaysia. *Malaysia Stormwater Manual (MSMA 3), Part 1*. DFR2-Rev2. 2026.

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[4] U.S. Army Corps of Engineers. *Hydraulic Design of Flood Control Channels*. EM 1110-2-1601. Change 1. 1994. Available: https://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-1601.pdf

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Ngu Soon Hui

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You can also contact me at soonhui@mes100.com