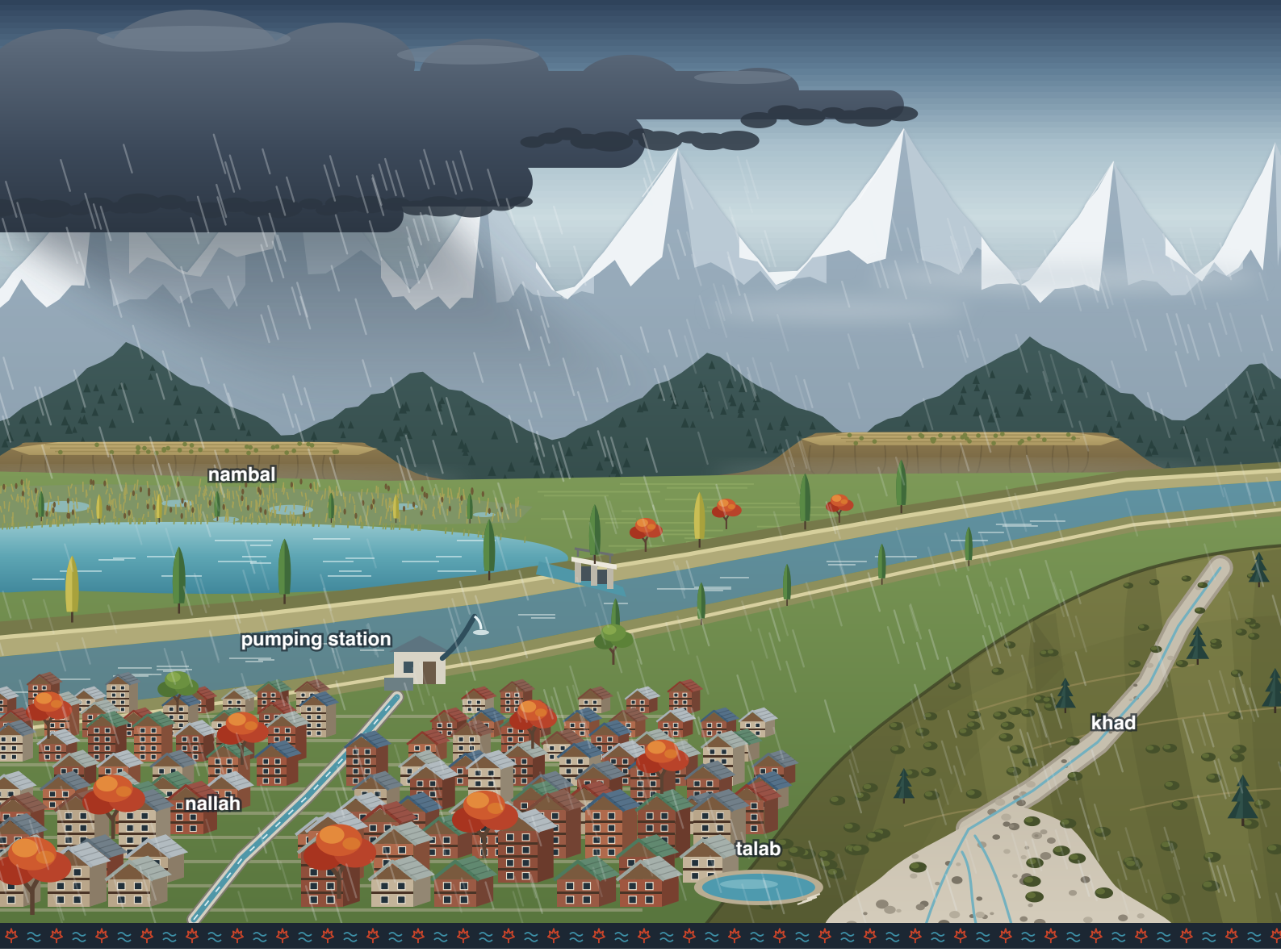
JAMMU AND KASHMIR

Stormwater Design Manual

Standards for the planning, design, construction, operation and maintenance of stormwater systems



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Prepared by

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About this draft

Status. This is Draft v1.0 of the *Jammu and Kashmir Stormwater Design Manual*. It was prepared by Neer as a proposed stormwater design standard for the Union Territory of Jammu and Kashmir.

Not adopted. This Manual has not been adopted, notified or endorsed by the Government of the Union Territory of Jammu and Kashmir, by its Lieutenant Governor, its Council of Ministers or its Legislative Assembly, or by any of its departments, local bodies or agencies. In particular, it has not been adopted, notified or endorsed by the Housing and Urban Development Department (H&UDD), the Jal Shakti Department or its Irrigation and Flood Control (I&FC) and Public Health Engineering (PHE) wings, the Srinagar Municipal Corporation (SMC), the Jammu Municipal Corporation (JMC) or any Municipal Council or Municipal Committee, the Srinagar Development Authority (SDA), the Jammu Development Authority (JDA), the Town Planning Organisations of Kashmir and Jammu (TPO), the Urban Environmental Engineering Department (UEED), the Lake Conservation and Management Authority (LCMA), the Wular Conservation and Management Authority (WUCMA), or any other agency. Nor has it been adopted, notified or endorsed by the Ministry of Home Affairs or any other ministry of the Union. Where it names a body, such as the Revenue Department, the Public Works (Roads and Buildings) Department (R&B), the Forest, Ecology and Environment Department, the Wildlife Department, the J&K Wetland Authority, the J&K Pollution Control Committee (JKPCC), the J&K State Disaster Management Authority (J&K SDMA), the Jammu & Kashmir Economic Reconstruction Agency (JKERA), a Smart City company, a Deputy Commissioner or a district administration, a dam operator such as the J&K State Power Development Corporation (JKSPDC) or NHPC, the High Court of Jammu & Kashmir and Ladakh, the National Green Tribunal (NGT), or a body of the Union, such as the Central Water Commission (CWC), the Central Ground Water Board (CGWB), the India Meteorological Department (IMD), the National Highways Authority of India (NHAI) or the Central Pollution Control Board (CPCB), it describes the role that body would have if the Manual were adopted. It does not say the body has agreed to that role.

No legal force. Until a competent authority adopts it, with or without changes, this Manual has no legal force. A competent authority (for example H&UDD for building approvals, or the Jal Shakti Department for river and flood-basin matters) could adopt it. Until then, the Jammu and Kashmir Unified Building Bye-Laws 2021 (UBBL-2021) as amended, the Srinagar Master Plan 2035 and the Jammu Master Plan 2032 and their regulations, the J&K Development Act, 1970, the J&K Municipal Corporation Act, 2000 and the J&K Municipal Act, 2000, the J&K Water Resources (Regulation and Management) Act, 2010, drainage schemes, orders of courts and tribunals and approval conditions in force continue to apply.

Jammu and Kashmir is a Union Territory. Jammu and Kashmir has been a Union Territory with a Legislative Assembly, not a State, since 31 October 2019, under the Jammu and Kashmir Reorganisation Act, 2019 (No. 34 of 2019). The chapters of this Manual are shared with the editions written for States, and they use the word "State" throughout. In this Manual, "State" means the Union Territory of Jammu and Kashmir, and "State Government" means the Government of the Union Territory of Jammu and Kashmir, consistent with section 3(58)(b) of the General Clauses Act, 1897, under which "State" includes a Union territory. The usage is one of convenience. It does not change who holds any power. Under section 32 of the Reorganisation Act the Legislative Assembly may make laws on any matter in the State List except public order and police, so land, local government, water, drainage, flood control and building regulation are within the Union Territory's own powers: the master plans and the building bye-laws are made by its own government, through H&UDD and the Development Authorities, and not by a body of the Union. The Council of Ministers aids and advises the Lieutenant Governor, except where the Act or a law requires the Lieutenant Governor to act in his discretion (section 53), and executive action of the Government is expressed to be taken in the name of the Lieutenant Governor (section 55). The Act continues the laws of the former State on which this Manual relies, among them the Development Act, the Municipal Corporation Act and the Municipal Act, the Water Resources Act, the Flood

Plain Zones Act, 2005 and the Land Revenue Act (Fifth Schedule, Table 4). Some of the bodies this Manual names are bodies of the Union rather than of the Union Territory: CWC, CGWB, IMD, NHAI and NHPC. Ladakh is a separate Union Territory and is not part of the State as this Manual defines it. Chapter 1 repeats the definition.

Supplements. The Manual carries one supplement, for a place that adjoins Jammu and Kashmir but lies outside the Union Territory's jurisdiction. Supplement S01 covers the Union Territory of Ladakh, a Union Territory without a legislature since 31 October 2019, administered by its Lieutenant Governor. Ladakh is a cold desert of the upper Indus and its tributaries, with the towns of Leh and Kargil; the creation of five new districts, seven in all, was approved in April 2026, as the Supplement explains. The supplement has not been adopted, notified or endorsed by the Administration of the Union Territory of Ladakh, the Lieutenant Governor, the Ladakh Autonomous Hill Development Councils of Leh and Kargil, the Municipal Committees of Leh and Kargil or any of its departments or agencies, nor by the Government of the Union Territory of Jammu and Kashmir. What this notice says of the Manual applies to the supplement.

Names. Some places, rivers and gauges have more than one name or spelling in statutes, sources and on IMD and CWC stations:

- the former State of Jammu and Kashmir was reorganised on 31 October 2019 into two Union Territories, Jammu and Kashmir and Ladakh. Statistics of the former State include Ladakh: its area of 101,387 km² and its extent of 72°31'–80°20'E are not those of the Union Territory, and this Manual does not use them for it. The district map has also changed, and the Union Territory now has 20 districts. The CWC flood estimation report for zone 7 (1994) uses the districts of its time: Kashmir (North), Kashmir (South), Reasi and Udhampur among them, and Mirpur and Muzaffarabad, beyond the Line of Control, whose stations, such as Kotli, are data points of 1994 only; it prints Sonemarg, now in Ganderbal district, under "Ladakh". IMD and CWC sources, and the rainfall data in this Manual, use the districts of their time, and a clause that names a district must be checked against the current list;
- **Jammu** is the city, the district and the division, and **Kashmir** the valley and the division; this Manual says which it means. **Kokernag** is also written Kukernag; **Qazigund** Quazigund; **Bhaderwah** Badarwah or Bhadarwah; **Sonamarg** Sonemarg, as the CWC report prints it; **Akhnoor** Akhnur; **Basohli** Basoli; **Chasoti** Chishoti; and **Ram Munshi Bagh**, the gauge on the Jhelum at Srinagar, Rammunshi Bagh. The **Wular** is also the Wullar; the **Doodhganga** the Dudhganga; **Hokersar** Hokarsar, and on the Ramsar list Hokera; **Nigeen** Nageen, as UBBL-2021 writes it; and **Shallabugh** Shalbug, as the Srinagar Master Plan writes it. The **Tsunth Kol** of Srinagar is listed by CPCB as the Chunt Kol. This Manual names the station each figure comes from;
- CWC's **zone 7** ("Western Himalayas", report No. WH/22/1994) is the hydrometeorological region of the CWC flood estimation reports that covers the whole Union Territory. Its boundary with **subzone 1(e)** ("Upper Indo-Ganga Plains") lies outside it, in Gurdaspur district of Punjab, so the Jammu plains, from Akhnoor and R.S. Pura to Kathua and Lakhanpur, are in zone 7 and no town of the Union Territory is in 1(e). One of the six gauged catchments on which the zone 7 report rests, that of the Sewa project in Kathua district, drains the Union Territory; the Jhelum, the Chenab, the Tawi and the Ujh are not among them. Zone 7 is not one of the four rainfall zones (JK-Z1 to JK-Z4) and five hydrologic sub-areas (JK-A, JK-B, JK-B1, JK-C and JK-D) that this Manual sets in Annex 2A, nor Zones 1 and 2 of a waterbody setback in Chapter 7, nor a "flood zone" under the Flood Plain Zones Act, 2005, which that Act defines by "the maximum probable floods", nor the three drainage zones of the Srinagar Master Plan;
- where a shared clause names the State's main city or its municipal corporation, this Manual names **Srinagar** and the **Srinagar Municipal Corporation (SMC)**, whose drainage is pumped and is served by the largest drainage organisation in the Union Territory. **Jammu** and the **Jammu Municipal Corporation (JMC)** are named with them wherever the Manual lists bodies. Srinagar and Jammu are the Union Territory's two largest cities, and each has a Development Authority under the J&K Development Act, 1970, **SDA** and **JDA**, which prepare and enforce its master plan. The other towns are governed by **Municipal Councils** and **Municipal Committees** under the J&K Municipal Act, 2000;

- the Union Territory has two rainfall regimes and four broad belts of ground. The **Jammu plains** below the outer hills are made of the **Kandi**, a belt of boulder-gravel fans at the foot of the hills, through which the khads run and where the water table lies 7–30 m below the ground, and the **Sirowal**, the finer plain beyond it, where the water table is 2–5 m deep, the ground is waterlogged in places and many wells flow at the surface. The **outer and middle hills** of the Siwalik and Murree rocks, of alternating sandstone and clay, carry Udhampur, Katra, Reasi, Rajouri, Poonch, Ramban and Banihal, and the inner hills of the Chenab carry Doda, Kishtwar and Bhaderwah. The **Kashmir valley** is a flat floor of alluvium, of Gurti clay and of Nambal peat, along the embanked Jhelum, where the water table lies within 0–2 m of the ground, with the **Karewas**, flat-topped tablelands of old lake deposits, raised above it on both sides. The **high mountains** of the Pir Panjal and the Great Himalaya, above Gulmarg, Pahalgam, Sonamarg and Gurez, are fed by snow. The names describe regions, not administrative units, except where a district bears the same name;
- the waters have their own names in Kashmiri, Urdu and Dogri, and this Manual explains them where they first appear. A **talab** (तालाब; تالاب; Kashmiri *talāv*, pond or tank) is a pond or tank, *talāv* "an artificial pond, a tank" in Grierson's Kashmiri dictionary (p. 1003) and *tālāb* "Pond, pool, tank, reservoir of water" in Platts (p. 306); UBBL-2021 writes "Talav" and "talab, village tanks", and the Jammu Master Plan "talabs", and this Manual uses it as its general term for ponds and tanks. In Kashmiri the word *talab* (طلب) also means "pay, wages" (Grierson, p. 1000), so this Manual always gives the script or the gloss. Natural waterbodies keep their own words: a **sar** (सर्) is a lake (Grierson, p. 928), as in Hokersar, Khushalsar, Gilsar, Mansar and Surinsar; a **nambal** (नंबल्) "a grass-grown lake, a lake choked by vegetation, a shallow lake, a marsh, swamp" (p. 637), as in Brari Nambal and Nambal Narkur; and a **nāg** (नाग्) a spring (p. 624), as in Kokernag and Verinag, though in Urdu (Platts, p. 1116) the word means only a snake. A **cashma** or **chashma** (چشمه) is also a spring (Grierson, p. 177; Platts, p. 434). This Manual never calls a detention basin a nāg or a nambal. A **kŏl** (क्वल्) is a stream, canal or irrigation channel (Grierson, p. 437), as in the Tsunth Kol; it is not Platts' *kūl*, a bank or pool, which is a different word. The **Dal** (*ḍal*, "a lake", Grierson, p. 210) is a name; Grierson records that its flood-gate, the *Ḍal-darwāza*, closes automatically when the Jhelum rises. A **nallah** (नाला; نالا; natural or artificial drainage channel) is *nāla* "an artificial watercourse, a channel, a canal" in Grierson (p. 633) and *nālā* "A watercourse; channel …, a ravine; a rivulet, brook, canal; a drain, gutter" in Platts (p. 1117), and UBBL-2021 writes "Nallas". A **khad** (खड्ड; seasonal hill torrent or ravine stream) is the boulder-laden torrent of the Jammu hills and the Kandi, which the Jammu Master Plan says are "transformed into gushing torrents" in the rains; in Grierson (*khŏḍ*, p. 392) and Platts (*khaḍḍā*, p. 873) the word means only a pit or hollow, so this Manual always glosses it. **Gair Mumkin Khad** is a revenue classification, land recorded as uncultivable stream-bed (khad), which the Jammu Master Plan proposes to reduce to the "true Khad"; this Manual uses it only as a revenue term. A **rakh** is a preserve, "for grass, or game" (Platts, p. 597), and the word survives in the names of reserved wetlands and grasslands, such as Rakh-e-Arth and Hygam Rakh, and in the "State Rakhs" of the Wildlife Department; this Manual uses it only in names and does not use it for marshes in general. A **kuhl** (कूहल) is a gravity irrigation channel; the Water Resources Act counts "zamindari khuls" among hydraulic works. No Dogri dictionary was consulted for this Manual, and the Dogri senses of *talab*, *khad* and *kuhl* are taken from the plan and statute usage only; and
- many levels and flows in the sources are not in metric, or not on a stated datum, and there are **two systems of river gauges that cannot be tied together**. I&FC reads its staff gauges on the Jhelum, the Chenab and the Tawi in **feet**, on zeros it does not publish, so that readings can go below zero: a flood is declared at 18 ft on its Ram Munshi Bagh gauge and the danger stage is 21 ft, as reported. CWC gives its levels in metres, as transcribed by SANDRP, for the same river at the same place: a warning level of 1,584.87 m, a danger level of 1,585.48 m and a highest flood level of 1,588.99 m (8 September 2014) at Ram Munshi Bagh, with other values in an earlier list, and no source read states their datum [TBC]. This Manual never converts an I&FC reading in feet to metres, and names the gauge and its datum with every level. Flows are given in **cusecs** (cubic feet a second; 1 cusec = 0.0283 m³/s), often in **lakh** (100,000): the Jhelum carried 72,585 cusecs at Ram Munshi Bagh in September 2014 and about 1,15,000 cusecs at Sangam.

This Manual uses the first form and keeps the others where a title, a source or a station uses them. Some names of bodies and laws need a word of explanation:

- the **Jammu and Kashmir Unified Building Bye-Laws, 2021** (**UBBL-2021**, the form H&UDD's notification of 2025 uses) are the Union Territory's building rules. They were adopted by each local body on a common text, as by the Doda Municipal Council on 21 October 2021, as listed, and were read in the copy published by JMC in the *J&K Official Gazette* (Extraordinary, Vol. 134, No. 39-4) of 24 December 2021; H&UDD's original notification was not found [TBC]. They were amended by JMC's notification in the Gazette of 9 March 2022 and by H&UDD's **S.O. 304 of 1 December 2025**, made under section 395(d) of the J&K Municipal Corporation Act, 2000 and section 202 of the J&K Municipal Act, 2000, which brought online scrutiny, deemed rejection after 15 days and online no-objection certificates; a further amendment, S.O. 58 of 26 February 2026, is known only from a listing, and draft amendments of 9 September 2026, reported to be made under section 397 of the Corporation Act, are known only from the press [TBC]. This Manual cites clauses as "UBBL-2021 (as amended), cl. 7.12";
- the **Srinagar Master Plan 2035** (**SMP**; Town Planning Organisation Kashmir, February 2019) covers a local planning area of 766 km², and the **Jammu Master Plan 2032** (**JMP**) the Jammu area; both are made under the J&K Development Act, 1970. The SROs that notified them (SRO 160 of 7 March 2019 and SRO 90 of 3 March 2017) and the amendments to the JMP of 2022 and 2024 are known only from listings and were not read; a revision of the JMP is reported to be pending [TBC];
- the **J&K Water Resources (Regulation and Management) Act, 2010** (**WRA**; Act XXI of 2010) gives I&FC control of the bed and banks of water sources, "city channels and flood spill channels", and lets the Government declare a "flood basin" after survey and notification (Part VI). It was read in a copy whose section numbers were stripped, and the numbers this Manual gives were assigned from a title index and must be confirmed against an official copy [TBC]. No flood basin has been found notified under it. The **J&K Flood Plain Zones (Regulation and Development) Act, 2005** (Act XVII of 2005) comes into force only on a date the Government appoints by notification; no such notification was found, and this Manual does not treat the Act as in force or any flood plain zone as notified;
- a **Municipal Corporation** (SMC and JMC) is constituted under the J&K Municipal Corporation Act, 2000, and a **Municipal Council** or **Municipal Committee** under the J&K Municipal Act, 2000; their sections on drains were not read for this Manual [TBC]. In Srinagar, **UEED** plans, designs and builds sewerage and drainage, with the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies, Kashmir (**DULBK**); in Jammu, UEED's Sewerage and Drainage Division (West) works within JMC's limits. **LCMA**, formerly the Lakes and Waterways Development Authority (LAWDA), manages the Dal and Nigeen and their catchment and issues no-objection certificates under S.O. 304, and **WUCMA** manages the Wular;
- the **Jal Shakti Department** has two wings that this Manual names: **I&FC**, which holds the rivers, nallahs, embankments, flood spill channels and city channels and their gauges, and **PHE**, which supplies water and registers bore wells; this Manual names the Jal Shakti Department as the State groundwater agency, and CGWB's regional office at Jammu keeps the observation wells. **R&B** keeps the Union Territory's roads and their drains and culverts, and NHAI the national highways;
- the **J&K Wetland Authority** was constituted on 25 November 2020; no wetland had been notified under Rule 4 of the Wetlands (Conservation and Management) Rules, 2017 by September 2024. Seven wetlands, among them Hokersar, Shallabugh and Hygam, are Wildlife Conservation Reserves of the Wildlife Department, first notified by an order of 17 July 1945;
- **J&K SDMA** is the Union Territory's disaster management authority. **JKERA** runs the World Bank's **Jhelum and Tawi Flood Recovery Project** (**JTFRP**), approved in 2015 after the floods of 2014, which has funded the rehabilitation of pumping stations in Srinagar and was extended to 31 August 2026, as reported;
- the **High Court of Jammu & Kashmir and Ladakh** has acted as "Custodia Legis of river Jhelum and other water bodies" in a public interest case on the floods of 2014 (PIL 8/2017 with PIL 2/2014 and PIL 18/2018), and has kept a 200 m no-construction zone around the Dal since 2002, as quoted; its judgment of 30 October 2025 in that case is reported to keep the 200 m ban but was not read. A 200 m zone around the Wular, ordered in November 2020, is known only from the press. This Manual cites them with their status and treats the lines they draw as binding where they apply; and

- a **tehsil** is the revenue subdivision of a district, under a Tehsildar. A district is headed by a **Deputy Commissioner** (DC).

Some abbreviations have more than one meaning:

- AMC is the antecedent moisture condition in Chapters 2 and 3; this Manual does not use it for any Municipal Council or Committee;
- SMC is the Srinagar Municipal Corporation and SMP the Srinagar Master Plan 2035. In other editions of this series and in some sources the same letters stand for other municipal bodies; in this Manual they mean only these;
- JDA is the Jammu Development Authority and SDA the Srinagar Development Authority. The J&K Development Act, 1970, under which both work, is written in full, and so is the Srinagar Smart City company;
- UBBL-2021 is the Jammu and Kashmir Unified Building Bye-Laws 2021, as amended. It is not the Model Building Bye-Laws 2016 of the Union or the unified bye-laws of any other State or Union Territory;
- J&K SDMA is the disaster management authority of the Union Territory of Jammu and Kashmir. The Ladakh Disaster Management Authority (LDMA) of Supplement S01 is a different body, and neither acts in the other's territory;
- HFL is the highest flood level recorded at a gauge, as CWC uses it. It is not a design level, and sources sometimes give different values for the same gauge. WL and DL are CWC's warning and danger levels, in metres; I&FC's "flood declaration" and "danger" stages are readings in feet on its own gauges and are not the same levels. The building rules and plans measure setbacks from three other lines: UBBL-2021 cl. 7.12 from the "edge" of the bank, cl. 5.2.5 from "the highest water level", and the Jammu Master Plan from the **Full Tank Level** (FTL); Chapter 7 says how each maps onto this Manual's design flood line;
- FRL (full reservoir level) is used for the reservoirs of the dams on the Chenab and the Ravi, and FSC for the flood spill channel of the Jhelum at Srinagar; and
- SWD is a storm water drain.

The sense is clear from the context. Kashmiri, Urdu and Dogri terms used in the text, such as *talab*, *sar*, *nambal*, *nāg*, *kŏl*, *nallah*, *khad*, *rakh* and *kuhl*, are explained where they first appear.

Use with care. Clauses and values may change after review. Designers remain responsible for their designs and for checking the data they use. Neer accepts no liability for decisions made on the basis of this draft.

Disclosure. Neer publishes the India Flood Atlas, a national map of modelled 1% AEP flood depth. Clause 6.11.3 names it as one example of a regional map that an Approving Authority may adopt for floor levels. The Manual does not require the Atlas; any map adopted under Clause 7.3.4 may be used.

Comments. Comments and corrections are welcome at info@neer.ai.

Preface

Jammu and Kashmir's towns flood, and fail, for three reasons. September 2014 showed the first, when the Jhelum, carried above the floor of the Kashmir valley between its embankments, broke out into Srinagar, 34% of the city's planning area went under water and the floods of that month killed 304 people across the then State, as the CAG counted; 26–27 August 2025 showed the second, when Jammu recorded 380 mm of rain and Udhampur 630 mm in 24 hours, as IMD reported, and the Tawi rose to the highest level recorded on it at Jammu, as reported; and the hill towns of Ramban and Doda showed the third, when the ground under Pernote cracked and slid in April 2024 and the Geological Survey of India found that "ingress of surface runoff through these cracks may have developed the pore pressure".

1. **A valley-floor city behind river embankments, which drains by pumps once the Jhelum rises.** Srinagar is built on the flat floor of the Kashmir valley, on alluvium, Gurti clay and Nambal peat, where CGWB found the water table within 0–2 m of the ground over the central valley in November 2014, wells flowing on both sides of the river, and "no scope for artificial recharge to ground water" in Srinagar. The Jhelum runs through the city above the land on either side, between embankments, and its channel at Ram Munshi Bagh carried about 27,000 cusecs, raised to about 32,000 by the first phase of the works that followed 2014, as reported. In September 2014 it carried 72,585 cusecs there and about 1,15,000 cusecs at Sangam upstream, as a study of the flood reports; the flood spill channel, built after the great flood of the early 1900s (the sources give 1902 and 1903) to take 17,000 cusecs past the city, could take only 4,000 by then, as the CAG found. The Srinagar Master Plan 2035 records that 34% of its planning area, 262 km², was flooded, and studies report water up to 16 ft deep that stood for up to 25 days. It was a river flood, not a city storm: Srinagar's own gauges recorded only about 140–152 mm over the four days, while Qazigund, at the head of the valley, recorded 599.8 mm. Once the river reaches flood-declaration stage on I&FC's gauge, the city's gravity outfalls are shut and its drains empty only through pumps: the Master Plan counted 89 drainage pumping stations in 2019, and H&UDD told the Legislative Assembly on 12 February 2026 of 104 permanent dewatering stations of about 2,300 cusecs and 281 mobile units, as reported. Those pumps, spread over the city's drainage area of about 767 km², lift the equivalent of about 0.3 mm of rain an hour, by this Manual's reckoning, so the city holds what it cannot lift; and even an ordinary storm floods it, as the 26.4 mm of 1 August 2019 did the city centre, as reported. The marshes that once held the river's floods have shrunk: Hokersar from 18.75 km² in 1969 to about 13 km² in 2008, when it had "lost nearly half of its flood storage capacity", and the Wular from 157.74 km² in 1911 to 86.71 km² in 2007, as reported, while the flood basins west of the city were built over after 1971, as the Master Plan records.
2. **An outer-hill front whose storms outrun the design maps, and khads narrowed by building and land release.** Where the monsoon meets the first ranges above the Jammu plains it brings the Union Territory's heaviest rain, 2,151.1 mm a year at Katra, and the records exceed the national maps. IMD's press release of 27 August 2025 gave 38 cm at Jammu and 63 cm at Udhampur's air force station in the 24 hours to 08:30 that day; Jammu's highest day in IMD's own tables, kept since 1910, had been 299.2 mm on 31 July 1961. The CWC map for zone 7 gives Jammu a 50-year day of about 240–280 mm, and 380 mm exceeds even its 100-year value; Udhampur's 630 mm is about 2.3 times the map's 100-year value there, though the period of record of that gauge was not found in any IMD table read [TBC]. The front has done this before: Batote recorded 316.2 mm and Katra 292.4 mm on 25 September 1988, and in September 2014 Katra recorded 698.6 mm in 72 hours. Through Jammu the khads, which the Jammu Master Plan says are "transformed into gushing torrents" in the rains, run as the city's storm drains; the plan finds that only 20% of the roads have side drains, covering about 40% of the city, that the drains carry "considerable quantities of raw and untreated effluents", and that land recorded as Gair Mumkin Khad is more than 30% of JDA's land, which it proposes to reduce to the "true Khad" fixed with I&FC. Its buffers along the khads are 15 m, or 5 m along the smaller ones, from the Full Tank Level.
3. **Hill towns where water put into the ground moves the ground, and cloudbursts that no gauge measures.** The Murree and Siwalik hills on which Ramban, Udhampur, Rajouri and Poonch are built are made of "alternating layers of permeable sandstone and weak impermeable clay", as the Geological Survey of India described the slope at Pernote in Ramban district, where about 35 houses were damaged in April 2024; it recommended

"diverting the surface runoff away" from the slope, that "Drains present in the affected slope should be lined/trained", and "No new construction". At Thathri Nai Basti in Doda district in 2023 the Survey reportedly named "poor drainage" among the causes, and a committee of the NGT found "unplanned PVC pipes for the purpose of sewerage disposal to the road side drainage downslope", as reported. JKPCC lists Budgam district and Duksar in Ramban among the places prone to land sinking. Above the towns, the worst storms are not measured at all. The Ministry of Earth Sciences defines a cloudburst as "10 cm/ hour or more" over about 20–30 km², and no gauge in Jammu and Kashmir has recorded that in any primary source read; the automatic weather station at the Amarnath cave recorded 25 mm in the hour of 8 July 2022, which "does not satisfy the criteria for cloud burst", although 16 people died there, as reported; and no gauge recorded the cloudburst at Chasoti in Kishtwar district on 14 August 2025, in which more than 60 people were killed, as reported. Like the debris flows they bring, such events set where towns may build, not how their drains are sized.

Behind all three lie sewage in the drains, the lakes, marshes, springs and talabs that set the level at the outfall, and the dams upstream. In April 2024 Srinagar generated 193.34 MLD of sewage and could treat 62.01 MLD, 32.07%, as JKPCC told the NGT, which also found that "Untreated sewage gets entry into the Dal Lake from areas like Telbal, Lalbazar"; in October 2025 CPCB listed seven polluted river stretches in the Union Territory, among them the Chunt Kol in Srinagar, the Jhelum from its confluence with the Vishav to Baramulla, and the Tawi from Tawi Bridge to the Balol Nallah. The Wular (18,900 ha), Hokersar (1,375 ha), Surinsar–Mansar (350 ha), Hygam (802 ha) and Shallabugh (1,675 ha) are Ramsar sites, and the Dal, with a catchment of about 314 km², drains through the lock and weir at Dal Gate and through the Nallah Amir Khan to the Nigeen and the Anchar, but no wetland in the Union Territory has been notified under the Wetlands Rules, no rule or buffer protects a spring, and most of Jammu's talabs survive only as place names. The Chenab is held by the Dul Hasti, Baglihar and Salal dams, whose gate and flushing operations may now be unannounced, as reported, and the Tawi by a new barrage at Jammu, whose pool level was not found [TBC]. Two laws allow the river's floodplain to be zoned, the Flood Plain Zones Act, 2005 and Part VI of the Water Resources Act, 2010, but no zone or flood basin has been notified under either, and the Srinagar Master Plan's proposal to protect the 25-year floodplain between Lelhar and Lasjan as a "Protected Natural Flood Absorption Basin" is a plan proposal only. And no document of any agency in the Union Territory states a design storm for a drain.

Design for Jammu and Kashmir therefore has to cover two rainfall regimes, divided by the Pir Panjal. The Jammu division follows the south-west monsoon: Jammu receives 1,401.9 mm a year, 77% of it from June to September, with its wettest month in July, and Katra 2,151.1 mm, with its wettest in August; the monsoon reaches Jammu about 28 June and withdraws about 21 September under IMD's new normals, and leaves most of Jammu and Kashmir by 1 October. The Kashmir valley does not: Srinagar receives 697.5 mm a year, only 30% of it from June to September, and its wettest month is March; as the CWC report puts it, Srinagar receives "only 28% of the annual rainfall during south west monsoon season as against over 55% in the months of December - April in association with western disturbances", and Banihal, Batote and Bhaderwah are wettest in February. Storms large enough to design for have come in every season: Srinagar's highest day, 147.8 mm, on 31 January 1930; Gulmarg's 293.4 mm on 20 February 1967; Katra's 261.9 mm on 13 March 2007; and Jammu's 160.0 mm and Basohli's 229 mm in October 1955. The largest floods of both divisions came in September, in 1988, 1992 and 2014, when monsoon moisture met a western trough over the mountains, and the Jammu division's largest days in late August. After the winter's snow, CGWB finds the valley's water levels shallowest in May. Underground, the Union Territory draws 22.28% of its extractable groundwater, and all 149 of its assessed units were safe in 2024; Jammu, Samba and Kathua have been safe in every assessment since 2017, and Srinagar's urban unit, semi-critical in 2022, was safe in 2024.

National guidance sizes public drains but does not control the runoff that new building adds. This Manual makes stormwater a condition of development approval. Every development above a modest size must:

- hold frequent rainfall on site, in the ground where the ground can take it and in tanks where a high water table or a slope means it cannot;
- release the large storms no faster than the undeveloped land did, or slower where catchments already flood; and
- show that its outfall still works when the receiving river, khad, nallah, lake, nambal or talab is high, when the river has shut the outfall's gate, when a dam upstream is releasing, or when a drain is choked with debris.

The Manual also sets how public drains, pumping stations, hill roads and their drains, nallahs, khads, rivers, lakes, nambals, talabs, springs and kuhls, outfalls and basin-wide master plans are designed, and how drains in steep catchments are protected against debris and sediment, so that private sites and public works aim at the same standard.

The Manual draws on leading stormwater standards from India and abroad. Each is adapted to Jammu and Kashmir's two regimes: the south-west monsoon from late June to late September in the Jammu division, with its storms against the outer hills, and the western disturbances from December to April, with the snowmelt of spring, in the Kashmir valley and on the Pir Panjal, and to the late-August and September storms in which the two meet; to the Jhelum, embanked through the valley floor, with its flood spill channel, its gates and pumps, the Dal and the Anchar, and the Wular and the marshes of Hokersar, Narkara and Shallabugh that store its floods; to the Chenab under the Dul Hasti, Baglihar and Salal dams; to the Tawi with its barrage at Jammu, the Ujh, the Basantar and the Devak, and the Ravi below the Ranjit Sagar dam; to the khads of the Kandi and the outer hills; to the boulder fans of the Kandi, the Sirowal, the sandstone and clay of the Siwalik and Murree hills, the Karewa tablelands, the alluvium, Gurti clay and Nambal peat of the valley floor, and the moraine and snow-fed slopes of the high mountains; to the sars, nambals, nāgs, talabs and kuhls; and to towns built below river embankments and on slopes across the natural lines of drainage.

1. **National base.** The CPHEEO *Manual on Storm Water Drainage Systems* (2019). This Manual builds on it and sets higher standards where it allows a State to do so. IRC road-drainage codes, including IRC:SP:42-2014 on hill roads, and the NDMA urban flood guidelines are also used. The drainage chapter of the IRC's hill road manual, IRC:SP:48, was not read for this Manual.
2. **Overall structure.** Kansas City Metro APWA Section 5600 (Version 2025.01), the most recent comprehensive regional standard. It supplies the preserve, retain, detain, convey and maintain sequence and the required retention volume.
3. **Design rainfall.** The CWC *Flood Estimation Report* for zone 7, Western Himalayas (1994), as the interim source for the whole Union Territory. It rests on only six gauged catchments, of which one, the Sewa in Kathua district, drains the Union Territory; it warns against using its relations without checking them, and does not apply them to snow-fed catchments, which this Manual leaves to site-specific study with a screening for glacial lake outbursts, landslide lakes, debris flows and avalanches. Its ratios of the short-duration to the 24-hour rain, 0.425 for one hour, are used across the Jammu plains, the hills and the Kashmir valley: the hours they give at Srinagar and Gulmarg lie above or around the largest hours recorded there (32–40 mm and 62 mm), and the lower ratios of the long storm of 2014 do not justify lowering them. Inside the closed low that the maps draw over Srinagar, this Manual takes the enclosing contour, never a lower value. It checks the design day against the largest reliable days recorded nearby, and the 380 mm recorded at Jammu in August 2025, which IMD's own tables allow to be checked, raises the 100-year day within 25 km of the Jammu gauge to that value. IMD's national set of rainfall intensity curves (Das et al., 2022) has panels for Srinagar and Jammu, but both repeat the curve printed for many other cities, and the 100-year day that the Srinagar panel implies, about 360 mm, is more than twice the largest day recorded there in over a century; they are not used. The gridded rainfall of NIH-DHAARA is used only to cross-check the 24-hour depth in the Jammu plains, never for the hour, because its ratios of the hour to the day are implausibly low.
4. **Monsoon practice.** The PUB Singapore *Code of Practice on Surface Water Drainage* (7th ed., 2025), for the fixed-coefficient route for small sites and drainage reserves. Malaysia's MSMA 2 (2012), for monsoon design storms and simplified on-site detention.
5. **Runoff reduction and treatment.** The Georgia Stormwater Management Manual (2016), for runoff reduction and downstream analysis. CIRIA C753 *The SuDS Manual* (2015), for the treatment train. The Mile High Flood District criteria manual, for outlet and storage design.
6. **Local rules.** UBBL-2021 as amended by JMC's notification of 9 March 2022 and by S.O. 304 of 1 December 2025; the Srinagar Master Plan 2035 and the Jammu Master Plan 2032 and their regulations, under the J&K Development Act, 1970; the J&K Water Resources (Regulation and Management) Act, 2010; the J&K Flood Plain Zones (Regulation and Development) Act, 2005, which is not in force; the J&K Municipal Corporation Act, 2000 and the J&K Municipal Act, 2000; the Jammu and Kashmir Reorganisation Act, 2019; the Wetlands (Conservation and Management) Rules, 2017 and the constitution of the J&K Wetland Authority in 2020; and the orders of the High Court of Jammu & Kashmir and Ladakh on the Jhelum and the Dal, and of the NGT on the Dal, the wetlands,

the polluted stretches of the Jhelum and the Chenab, and land sinking at Pernote and Thathri. This Manual follows them or, where disclosed, makes them stricter. The statutory orders that notified the master plans, the later amendments to UBBL-2021, the Municipal Acts' sections on drains, an official copy of the Water Resources Act with its section numbers, and the Dal judgment of 30 October 2025 were not read. Every rule cited must be checked against the current text.

Why this Manual is needed

India has no uniform stormwater design standard. The CPHEEO *Manual on Storm Water Drainage Systems* (2019) is the country's first manual dedicated to storm water drainage, but it is advisory. The Ministry of Housing and Urban Affairs lists it among advisory guidelines and treats urban flooding as a matter for State Governments and urban local bodies. None of the national rules or State building rules reviewed for this Manual makes runoff control a condition of building approval, and neither does the Model Building Bye-Laws 2016.

The national documents leave key values open, or give different answers.

- **Return periods.** CPHEEO recommends 5 years for drains in Class I cities and 2 years elsewhere, and lets a State committee adopt higher values. A 2023 CPHEEO presentation shows a different table. IRC:SP:50-2013 suggests 1–2 years for urban road drains; IRC:SP:42-2014 suggests 5–25 years for road drains and 10–50 years for culverts, by class of road and size of culvert. An engineer designing a drain in Jammu and Kashmir can cite 1, 2, 5, 10 or 25 years, depending on the code chosen.
- **Detention.** CPHEEO describes limiting peak outflow to pre-development rates as general practice. It uses no "shall" and names no storm frequencies.
- **Climate.** The NDMA Urban Flooding Guidelines (2010) call for detention and retention facilities and for rainfall curves adjusted for climate change, but give no sizing rule or return period. The State Action Plan on Climate Change of the former State (2012–13) expects the intensity of rainfall to rise by 1–2 mm a day and annual rainfall by 5–13% by the 2030s, but gives no factor for design, and the observed trends at the valley's stations are mixed.
- **Design rainfall.** No national document gives design rainfall that a designer can apply directly to a given town. Each project chooses its own source. IMD's 2022 national set of rainfall intensity curves has panels for Srinagar and Jammu, but both repeat a curve printed for many other cities: the Srinagar panel gives about 109 mm in the 100-year hour, where the largest hours recorded at Srinagar are 32–40 mm, and implies about 360 mm in the 100-year day, where the largest day recorded since 1901 is 147.8 mm. The one CWC report that covers the Union Territory dates from 1994 (zone 7); its maps give Srinagar a 50-year day of less than 120 mm and Jammu one of about 240–280 mm, but Jammu recorded 380 mm in a day in 2025, and the hour it implies for Jammu, about 102–119 mm for 50 years, has never been tested against an hour recorded at a Jammu gauge, because no such record has been published. The only published curve for a town of the Union Territory, for Kupwara, does not reproduce its own tabulated intensities.

Jammu and Kashmir has no drainage design standard of its own. Research for this Manual found no standard, IDF relationship or circular of H&UDD, UEED, I&FC, SMC, JMC, SDA, JDA or any other body that fixes a return period, a runoff coefficient, a time of concentration, a minimum drain size or a freeboard for town storm drains. The drainage master plan and detailed project report prepared for about 767 km² of Srinagar in 2023 design the storm drains "separate from the sewage system", as reported, but publish none of these values; the Srinagar Master Plan sets "stormwater performance standards" of 100% coverage and no waterlogging, and calls for detention and retention "source controls", without a return period, a runoff coefficient or an intensity; the Jammu Master Plan says that a storm-water detailed project report is "to be prepared immediately after the approval" of the plan, and none was found; and the roads rebuilt after 2014 under JTFRP follow the IRC codes. These are plans and projects, not a standard. This Manual is offered as a

technical companion to UBBL-2021, the Srinagar and Jammu Master Plans, the Water Resources Act and the Flood Plain Zones Act: it supplies the design storm, detention, slope, water-level and buffer values that they leave open. It has not been adopted by H&UDD, the Jal Shakti Department or any other body. In particular:

- **UBBL-2021 requires rainwater harvesting, but not detention.** Chapter 10 requires every building on a plot of 100 m² or more to "mandatorily include the complete proposal" for rainwater harvesting, makes recharge mandatory above 500 m², requires public open spaces above 500 m² to capture storm water, asks group housing to use permeable paving for open parking, and sets up an inspection before completion; it describes a yield of "55,000 litres per 100 sq. m." a year but sets no storage volume. The Srinagar Master Plan makes storage mandatory only for plots of 1,000 m² or more and for group housing. No rule requires on-site detention, limits peak runoff, sets "zero runoff" or deals with basements that flood; and on the valley floor, where the water table is within 2 m of the ground, a recharge pit can only fill with groundwater;
- **The setbacks are the widest in this series, but they are measured from three different lines.** UBBL-2021 cl. 7.12(b) keeps building 50 m from the edge of the Chenab, the Jhelum, the Tawi, the Ravi, the Ujh "or any other river/khad", 30 m from the Mansar, Surinsar, Wular, Nageen, Manasbal and other lakes, and 20 m from rivulets and the Ranbir and Sindh canals, "or as per building regulation whichever is more", and cl. 5.2.5 keeps a green buffer "minimum 30 m from the highest water level" along nallahs and rivers. The Srinagar Master Plan sets buffers of 20–200 m around its lakes, marshes and nallahs, measured from their edges, and the Jammu Master Plan sets 50 m along the Tawi, the Devak and the Basantar (30 m in built-up areas), 15 m along the Balol, Thather and Bhalwal khads and 5 m along the others, measured from the Full Tank Level. The High Court has kept 200 m around the Dal. No rule says where the edge, the highest water level or the Full Tank Level lies on a khad or a nallah, or sizes a buffer by the flood it carries;
- **The flood-zoning laws have never been used.** UBBL-2021 cl. 7.12(a) leaves flood areas to I&FC "or the flood zonation maps notified by the department from time to time", and none was found; the Flood Plain Zones Act, 2005 has not been brought into force, and no flood basin has been declared under the Water Resources Act; the Srinagar Master Plan records I&FC's zonation of 125 km² of its area as undevelopable and 136.50 km² as vulnerable, and proposes the Lelhar–Lasjan basin, but nothing has been notified. This Manual offers a technical method for drawing a design flood line and corridors (Chapter 7); it does not replace any line that the State notifies, a master plan draws or a court orders, and where such a line binds and is wider, it governs;
- **The slope rules stop building, not infiltration.** UBBL-2021 asks for contours at 0.3 m where a site slopes more than 1 in 20, a plinth of at least 45 cm and sloping roofs in snowfall areas whose water may be piped to a drain, but no rule restricts soak pits, recharge pits or infiltration trenches on slopes, on the clay and sandstone of the hills or above a cut or retaining wall, and the rainwater rule applies on the slopes of Ramban and Doda as on the plains; and
- **No document sets the river, lake or khad level for which an outfall is designed.** Seven CWC sites in the Union Territory have levels, known from SANDRP's transcriptions, such as the danger level of 1,585.48 m and the highest flood level of 1,588.99 m (2014) for the Jhelum at Ram Munshi Bagh and the highest flood level of 321.1 m (2025) for the Tawi at Sidhra; I&FC reads the same rivers in feet on gauges whose zeros are not published; the khads and nallahs are ungauged; and the levels of the Dal, the Anchar and the Wular, and of the Tawi barrage, were not found on a stated datum, or only in the press. Danger levels and highest flood levels are flood-warning levels and records, not design levels.

So each agency and each local body interprets the central manual its own way. SMC and JMC, the Municipal Councils and Committees, SDA and JDA, UEED and the Town Drainage wings of SMC and DULBK, I&FC and PHE, R&B, NHAI, LCMA and WUCMA, the Smart City companies, JKERA, their consultants and funding agencies fill the gaps differently. No rule divides the drains between them: in Srinagar a drain may be designed by UEED, kept by SMC's or DULBK's Town Drainage, pass under a road of R&B, end at a pumping station on the embankment and discharge through a gate that I&FC controls on a river whose banks I&FC holds, and every outfall to a river, a flood spill channel or a city channel needs I&FC's consent; in Jammu the roadside drains of the roads are the storm drains, carry sewage, and end in khads that are partly recorded as Gair Mumkin Khad. The pumping stations of Srinagar are counted differently from year to year (about 56 in the World Bank project's papers of 2015, 89 in the Srinagar Master Plan of 2019 and 104 in 2026, as reported), and their capacities and sump levels were not found in any public list [TBC]. And a reviewer has no common basis against which to check a design.

What this Manual does about it. It turns those open choices into one standard for the Union Territory:

- one source and method for design rainfall across the Union Territory, in four rainfall zones and five hydrologic sub-areas, with a checked station analysis to govern where one exists, the zone 7 ratios throughout, the enclosing contour inside the closed low over Srinagar, a check of the design day against the largest reliable days recorded nearby, which raises the design day around Jammu to its record of 2025, two design cases for the Kashmir valley floor, a summer storm and a long western-disturbance or snowmelt event; and, in the snow-fed catchments of the high mountains, site-specific hydrology with a screening for glacial lake outbursts, landslide lakes, debris flows and avalanches (Chapter 2);
- named return periods for every drainage element (Chapters 2 and 6);
- a required pre- versus post-development rule for private sites (Chapter 4);
- a required tailwater check for outfalls to rivers, khads, nallahs, lakes, nambals, talabs and reservoirs, against a design river or lake level: CWC's levels where they exist, I&FC's stages in feet with their gauge named and never converted, the levels of the dam and barrage operators and the releases of the dams upstream, and, on the ungauged khads and nallahs, surveyed flood marks and a 1% AEP study that allows for debris; and, wherever the Jhelum can shut an outfall, a check with the outfall closed for the time the river stays high, with the drains, storage and pumps analysed together (Chapter 5);
- a design flood line, and corridors and setbacks along rivers, khads and nallahs and around lakes, nambals, talabs and springs, proposed by this Manual for use where nothing wider binds, with the 50, 30 and 20 m lines and the 30 m green buffer of UBBL-2021, the buffers of the master plans and the 200 m of the High Court wherever those are wider; the marshes that store the Jhelum's floods kept as storage; and land recorded as Gair Mumkin Khad released only after a hydraulic study of the functional khad (Chapter 7);
- recharge first on the Kandi fans, with protection for Jammu's groundwater supply, and none on the floor of the Kashmir valley or where the water table rises within 2 m of the ground, where rainwater is stored for use; no deliberate infiltration on slopes steeper than 10°, on the clay and sandstone of the Siwalik and Murree hills, in areas of land sinking such as Pernote and Thathri, on slide debris, or above a cut slope or retaining wall, unless a geotechnical certificate allows it; roof runoff to the storage UBBL-2021 already requires, with its overflow to lined drains; sewage kept out of roadside drains on slopes; protection of springs, talabs and kuhls; and treatment where drains carry sewage (Chapter 8);
- debris racks and traps, allowances for sediment and blockage, energy dissipation in steep drains, flap gates and pumping stations with standby power on the valley floor, and hill-road drainage that never discharges onto an unprotected slope (Chapters 6 and 9), with drains cleared across the Union Territory by 31 May, a post-winter clearance and a test of every pump in the Kashmir valley by 15 March and a second clearance there by 15 August, standby kept to 31 October for the late storms, and inlets kept clear of snow and ice in winter (Chapter 10); and
- basin-wide master plans, so that the agencies that share a basin plan together (Chapter 11).

It uses the route the CPHEEO manual itself provides: a State may adopt standards higher than the national values (CPHEEO 2019, Table 4.1, Note 2). A Municipal Corporation, a Development Authority in a master plan, or H&UDD can still adopt a stricter standard (Chapter 1).

Sources: CPHEEO (2019) Part A §4.4–4.5 and Table 4.1; CPHEEO presentation to CSE (August 2023); IRC:SP:50-2013 §6; IRC:SP:42-2014 cl. 7.1.4 and 8.5.1; NDMA (2010) Urban Flooding Guidelines, para 6.6.2; MoHUA Model Building Bye-Laws (2016); Jammu and Kashmir Reorganisation Act, 2019 (No. 34 of 2019), ss. 13, 32, 53 and 55 and Fifth Schedule, Table 4; J&K Unified Building Bye-Laws, 2021, J&K Official Gazette (Extraordinary) Vol. 134 No. 39-4 of 24 December 2021 (JMC), cl. 2.6, 2.18, 5.2.5, 6.1, 6.20 and 7.12 and ch. 10, the JMC notification of 9 March 2022, and H&UDD S.O. 304 of 1 December 2025; Srinagar Master Plan 2035 (Town Planning Organisation Kashmir, February 2019), §§4.2, 8.2.3, 13.3 and 14.4.4.2 and Tables 8-2 and 8-3; Jammu Master Plan 2032, §§2.4, 5.1.3, 7.3.3, 11.1.3 and 12.2.3; J&K Water Resources (Regulation and Management) Act, 2010 (Act XXI of 2010); J&K Flood Plain Zones (Regulation and Development) Act, 2005 (Act XVII of 2005), ss. 1–4; MoEFCC, list of Ramsar sites of India (31 January 2024); High Court of Jammu & Kashmir and Ladakh, PIL 8/2017 with PIL 2/2014 and PIL 18/2018, order of 29 May 2024, and PIL 159/2002 (as quoted and reported); NGT O.A. 504/2024 (JKPCC report of 14 August 2024), O.A. 239/2024 (Forest, Ecology and Environment Department report of 9 September 2024), O.A. 413/2025 (JKPCC report of March 2026, with

CPCB, Polluted River Stretches, October 2025) and O.A. 642/2024 (JKPCC report of 13 September 2024, with the GSI note on Pernote); CAG Report No. 4 of 2016 (Disaster Management, Jammu and Kashmir) and CAG audit of the Prime Minister's Development Package (2021); CWC, Flood Estimation Report for Western Himalayas – Zone 7 (WH/22/1994), Annexes 3.1, 4.3 and 4.4 and Plates 8–10, read by eye; CWC levels as transcribed by SANDRP (2018 and 2022); IMD, Extremes of Rainfall and Temperature (up to 2012), climatological normals 1991–2020, monsoon onset and withdrawal normals (2020), Meteorological Centre Srinagar station pages, and press release of 27 August 2025; MoES reply in the Lok Sabha (27 July 2022); Das et al. (2022), MAUSAM 73(4); NIH-DHAARA; Ray et al. (2015) on the floods of September 2014; Malik (2021), Natural Hazards 110(3); Grierson, A Dictionary of the Kashmiri Language (1916–1932), and Platts, A Dictionary of Urdū, Classical Hindī, and English (1884); CGWB, Dynamic Ground Water Resources of Jammu and Kashmir 2017–2024, NAQUIM reports for the Kashmir valley and the Jammu plains, and district booklets; Government of Jammu and Kashmir, State Action Plan on Climate Change (2012–13); World Bank, Jhelum and Tawi Flood Recovery Project (P154990); reports of the floods of 2014, 2022 and 2025, of the Srinagar drainage master plan, of the pumping stations and of the river gauges (press and secondary sources).

How to use this Manual

Clauses and commentary. Numbered clauses (for example 4.5.2) are the requirements of this Manual and use "shall". Paragraphs headed **Commentary** explain the reason for a clause and cite its precedent. They are guidance, not requirements. Where a value has no direct precedent elsewhere, the commentary says so and explains why this Manual sets it.

Return periods. Storms are described both by annual exceedance probability (AEP) and by return period. For example, "1% AEP (100-yr)" means a storm with a 1-in-100 chance of being equalled or exceeded in any year.

Illustrative values. Worked examples and figures marked "Illustrative — not design values" show method and scale only. Design values come from the sources set in Chapter 2.

Annexes and forms. Each chapter lists the annexes and forms it relies on. They follow the chapters, grouped by chapter, and hold the forms to submit, worked examples, templates, model text and standard drawings. Annexes that need data not yet collected are marked *To be prepared*. They say what they will contain, and the clause that depends on them states the rule that applies in the meantime.

Supplements. The supplement follows the annexes. It applies the Manual to the Union Territory of Ladakh and states where its rules differ.

Figures. All figures are original drawings prepared for this Manual. Where a figure follows a published concept, its caption credits the source.

Where to start.

If you are…	Read first
A developer or architect	Chapter 1 (does it apply?), Chapter 4 (what to provide), Chapter 10 (what to submit)
A design engineer	Chapters 2–6, then 8 and 9
A local body or approving authority	Chapters 1, 10 and 11
A planner or waterbody manager	Chapters 7 and 11

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2	Design Rainfall and Design Storms	Annexes 2
3	Hydrologic Methods	Annexes 3
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Supplements

No.	Title	Status
S01	Ladakh (Union Territory)	Not adopted by the Administration of the Union Territory of Ladakh

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Abbreviations

Abbreviation	Meaning
AEP	Annual exceedance probability
AMC	Antecedent moisture condition
APWA	American Public Works Association
ARF	Areal reduction factor
AWS	Automatic weather station
BOD	Biochemical oxygen demand
BPIA	Building Permit Issuing Authority (UBBL-2021)
BSMP	Basin Stormwater Master Plan

Abbreviation	Meaning
CAG	Comptroller and Auditor General of India
CGWA	Central Ground Water Authority
CGWB	Central Ground Water Board
CN	Curve number (SCS/NRCS method)
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSE	Centre for Science and Environment
CWC	Central Water Commission
DC	Deputy Commissioner
DDMP	District Disaster Management Plan
DL / WL	Danger level / warning level (CWC)
DPR	Detailed project report
DULBK	Directorate of Urban Local Bodies, Kashmir
DWF	Dry-weather flow
EIA	Environmental impact assessment
ESC	Erosion and sediment control
FAR	Floor area ratio
FER	Flood Estimation Report (CWC)
FRL / MWL	Full reservoir level / maximum water level
FSC	Flood spill channel (of the Jhelum at Srinagar)
FSTP	Faecal sludge treatment plant (Supplement S01)
FTL	Full Tank Level (the line from which the Jammu Master Plan 2032 measures its buffers)
GLOF	Glacial lake outburst flood
GSI	Geological Survey of India
GWRA	Ground water resource assessment (CGWB)
H&UDD	Housing and Urban Development Department, Jammu and Kashmir
HAT / MHWS	Highest astronomical tide / mean high water springs (coastal terms; not applicable in Jammu and Kashmir)
HFL	High flood level (the highest level recorded at a gauge)
HGL	Hydraulic grade line
HSG	Hydrologic soil group
I&FC	Irrigation and Flood Control, a wing of the Jal Shakti Department
IAF	Indian Air Force (the IAF station at Udhampur, an IMD rain gauge)
IDF	Intensity–duration–frequency
IMD	India Meteorological Department

Abbreviation	Meaning
IMDAA	Indian Monsoon Data Assimilation and Analysis (a regional reanalysis)
IRC	Indian Roads Congress
J&K SDMA	Jammu and Kashmir State Disaster Management Authority
JDA	Jammu Development Authority
JKERA	Jammu & Kashmir Economic Reconstruction Agency
JKPCC	Jammu and Kashmir Pollution Control Committee
JKSPDC	Jammu and Kashmir State Power Development Corporation
JMC	Jammu Municipal Corporation
JMP	Jammu Master Plan 2032
JTFRP	Jhelum and Tawi Flood Recovery Project (World Bank)
KLD	Kilolitres a day
LAWDA	Lakes and Waterways Development Authority (now LCMA)
LCMA	Lake Conservation and Management Authority (formerly LAWDA)
LDMA	Ladakh Disaster Management Authority (Supplement S01)
LG	Lieutenant Governor
LPCC	Ladakh Pollution Control Committee (Supplement S01)
MLD	Million litres a day
MoEF&CC	Ministry of Environment, Forest and Climate Change
MoES	Ministry of Earth Sciences
MoHUA	Ministry of Housing and Urban Affairs
NAQUIM	National Aquifer Mapping (CGWB)
NCMRWF	National Centre for Medium Range Weather Forecasting
NDMA	National Disaster Management Authority
NGT	National Green Tribunal
NHAI	National Highways Authority of India
NHIDCL	National Highways and Infrastructure Development Corporation Limited (Supplement S01)
NHPC	NHPC Limited (operator of the Salal and Dul Hasti dams)
NIH	National Institute of Hydrology, Roorkee
NOC	No-objection certificate
OA	Original application (before the NGT)
OBPS	Online Building Permission System
PHE	Public Health Engineering, a wing of the Jal Shakti Department
PIL	Public interest litigation
PMDP	Prime Minister's Development Package

Abbreviation	Meaning
PSD	Permissible site discharge
R&B	Public Works (Roads and Buildings) Department
RRV	Required retention volume
RTP	Registered Technical Person (UBBL-2021)
RWH	Rainwater harvesting
S.O. / SRO	Statutory order / statutory rules and orders (notifications in the Gazette)
SANDRP	South Asia Network on Dams, Rivers and People
SAPCC	State Action Plan on Climate Change
SDA	Srinagar Development Authority
SLA	Sea-level allowance (coastal term; not applicable in Jammu and Kashmir)
SMC	Srinagar Municipal Corporation
SMP	Srinagar Master Plan 2035
SoI	Survey of India
SPV	Special purpose vehicle (a Smart City company)
SRRG	Self-recording rain gauge
STP	Sewage treatment plant
SUH	Synthetic unit hydrograph (CWC)
SW monsoon / JJAS	South-west monsoon, June–September
SWD	Storm water drain
TPO	Town Planning Organisation (Kashmir; Jammu), of H&UDD
UBBL-2021	The Jammu and Kashmir Unified Building Bye-Laws 2021, as amended
UEED	Urban Environmental Engineering Department
ULB	Urban local body (a Municipal Corporation, Municipal Council or Municipal Committee)
UTM	Universal Transverse Mercator
WD	Western disturbance
WQv	Water quality volume
WRA	The J&K Water Resources (Regulation and Management) Act, 2010
WSUD	Water-sensitive urban design
WUCMA	Wular Conservation and Management Authority

CHAPTER 1

Policy, Applicability and Adoption

1.1 Purpose and objectives

1.1.1 This Manual sets the minimum standards for the planning, design, construction, operation and maintenance of stormwater systems in Jammu and Kashmir. It applies to private development and to public works, as set out in Clause 1.5.

1.1.2 The Manual has the following objectives:

- (a) to make stormwater management a **condition of development approval**, so that new development and redevelopment do not increase flood peaks or runoff volumes downstream;
- (b) to retain frequent rainfall on site, so that groundwater recharge is sustained and pollutant loads are reduced;
- (c) to size storage for the long-duration storms of the south-west monsoon in the Jammu division, often joined by a western trough, as in September 1988, 1992 and 2014 and August 2025, and the multi-day western-disturbance storms and snowmelt of the Kashmir valley from December to May, which fall on soils, springs and water tables already wet, on lakes and marshes held at their outlets and on rivers already in flood, as well as for short-duration intensities;
- (d) to design outfalls for the stage of the Jhelum, held above Srinagar and the valley towns by its embankments, which shuts their gravity outfalls at its flood-declaration stage and leaves Srinagar to drain by pumps; the Tawi, the Chenab, the Ujh, the Basantar and the khads of the Jammu plains and hills, which rise within hours and carry boulders and debris; the levels of the Dal, Nigeen, Anchar and Wular and of the marshes at their gated or silted outlets; and the levels of Salal, Baglihar, Ranjit Sagar and the Tawi barrage, held and released by their operators, including the case where the outfall is closed;
- (e) to protect tanks (talabs), marshes, rivers, supply channels and surplus courses as part of the drainage system;
- (f) to give every element of the drainage network a safe overland path for the 1% AEP (100-yr) storm;
- (g) to make design inputs, approvals and facility records public, so that designs can be checked and repeated; and
- (h) to make sure that facilities, once built, are maintained and remain effective.

1.1.3 This Manual does not replace the rainwater harvesting (RWH) mandate, the building bye-laws notified under the Jammu and Kashmir Municipal Corporation Act, 2000 and the Jammu and Kashmir Municipal Act, 2000 (the Jammu and Kashmir Unified Building Bye-Laws 2021), or the statutes on waterbodies. It adds runoff control requirements to them (Clause 1.8).

> **Commentary.** Jammu and Kashmir's floods come from four sources, and the two divisions of the Union Territory meet them differently. The first is the Jhelum in the Kashmir valley, held above Srinagar and the valley towns by its embankments. In September 2014, when monsoon moisture met a western trough, Qazigund received 599.8 mm in four days and Katra 698.6 mm in three, while Srinagar's own gauges recorded only about 140–152 mm over 3–6 September (Ray et al., 2015): the city flooded from the river, through breaches of the embankments, not from its own rain. The Jhelum reached its highest levels at Sangam and Ram Munshi Bagh (1,588.99 m on 8 September 2014 at Ram Munshi Bagh in one CWC list and 1,589.65 m in another; CWC data as transcribed by SANDRP), and almost 34% of the Srinagar planning area, 262 km², was under water (Srinagar Master Plan 2035,

§4.2), in places up to 16 feet deep and for up to 25 days (Malik, 2021). The record of that flood is in conflict: the Comptroller and Auditor General counted 304 deaths (217 in the Jammu division and 87 in Kashmir) and 2,40,004 houses damaged (CAG, Report No. 4 of 2016), a study counts 277 deaths (Malik, 2021) and the press 284 (as reported), and the Government told the Assembly in 2026 of more than 1.6 lakh structures damaged (as reported); the breach locations have not been found [TBC]. The Comptroller and Auditor General found that the flood spill channel built after the great flood of 1902 or 1903 (the sources differ) for 17,000 cusecs could carry only 4,000, and that the floods "may have been mitigated" had two flood schemes been carried out as approved (CAG, 2016). The Jhelum has flooded the valley before: in 1893, in 1902 or 1903, and in 1957 and July 1959, when it was reported to have stood at "30.25 feet" on a gauge that is not named (as reported). The second is the storm of the outer hills of the Jammu division. In the 24 hours to 08:30 on 27 August 2025 IMD recorded 38 cm at Jammu and 63 cm at Udhampur IAF (IMD, press release of 27 August 2025); the Tawi at Sidhra rose to 321.1 m, 2.25 m above its highest level of 2014 (CWC data as transcribed by SANDRP); and more than 110 people died in the Union Territory in two weeks (as reported). Earlier storms on the same front, in September 1988 (Batote 316.2 mm and Katra 292.4 mm in a day), August 1996 and 1997, and September 1992, when the Chenab at Akhnoor rose to 61 ft on the gauge of I&FC and to its highest level of 324.29 m (CWC data as transcribed by SANDRP; as reported), show that it is not new (IMD). The third, as in the other mountain editions of the series, is the cloudburst, the debris flow and unstable ground: on 8 July 2022 a flood at the Amarnath cave killed 16 people although the gauge 50 m below the cave recorded 25 mm in the hour, which "does not satisfy the criteria for cloud burst" (MoES; as reported); on 14 August 2025 a cloudburst at Chasoti in Kishtwar killed more than 60 pilgrims on the Machail route, and on 26 August 2025 a landslide on the Vaishno Devi route above Katra killed 30 to 35, by differing counts; no gauge measured the burst at Chasoti (as reported); and at Thathri in Doda (2023) and Pernote in Ramban (2024) houses cracked where water from the surface entered the slope (GSI, 2024; as reported). The fourth is the town drainage that fails in a fall that is not extreme: on 1 August 2019, 26.4 mm of rain left Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar under water (as reported), Jammu's colonies from Gangyal to Trikuta Nagar and Nanak Nagar flooded in 2025 and 2026 (as reported), and in both cities the drains carry sewage: Srinagar could treat 32% of its sewage in 2024 (JKPCC, 2024), and the Jammu Master Plan 2032 records that its "Storm water drains carry considerable quantities of raw and untreated effluents".

Missing design makes all four worse. No design storm, return period or drain standard was found for the drains of any town in the Union Territory, and Srinagar's drains end at pumping stations, 89 counted in 2019 (Srinagar Master Plan 2035) and 104 permanent dewatering stations of about 2,300 cusecs reported in 2026 (as reported), which together could empty the 767 km² of the city's drainage plan at only about 0.3 mm of rain an hour once the river closes the gravity outfalls (NEER reading). The UBBL-2021 control setbacks, plinths and rainwater harvesting, not runoff. Objectives (b) to (e) address the storage, outfall and building-level failures, which a drain-sizing manual alone cannot fix; the first source is answered by the outfall-closed rules of Chapter 5 and the floodplain rules of Chapter 7, and the third by the siting, screening and debris rules of Chapters 2, 6 and 7, because no drain is sized to carry a debris flow or a river that has left its embankments.

No national instrument requires on-site detention. CPHEEO (2019) is advisory and describes peak control only as typical practice. NDMA (2010) says detention and retention "will" be included but gives no sizing rule. MBBL 2016 and the Jammu and Kashmir Unified Building Bye-Laws 2021 mandate RWH only. Objective (a) is therefore the main new step this Manual takes.

1.2 Stormwater management hierarchy

1.2.1 Every development to which Chapter 4 applies shall consider stormwater measures in the following order. A designer shall not use a lower measure in place of a higher one that is practicable on the site.

1. **Preserve** — keep or restore natural drainage features, tanks, wetlands, permeable soils, trees and overland flow paths (Chapter 7).

2. **Retain** — hold the runoff from the retention depth of Annex 2E on site, by infiltration, reuse or evapotranspiration (Chapters 4 and 8).
3. **Detain** — store larger storms temporarily and release them at or below the rates in Chapter 4, checked against downstream and tailwater conditions (Chapters 4 and 5).
4. **Convey** — carry the remaining flow safely in the minor system, and the 1% AEP flow in the major system (Chapters 6 and 9).

1.2.2 **Maintenance** underlies all four measures. A measure that cannot be maintained by its owner under Chapter 10 shall not be credited.

1.2.3 Credits from higher measures reduce the requirements of lower ones. Preserved areas and retained volume reduce detention storage as set out in Chapter 4.

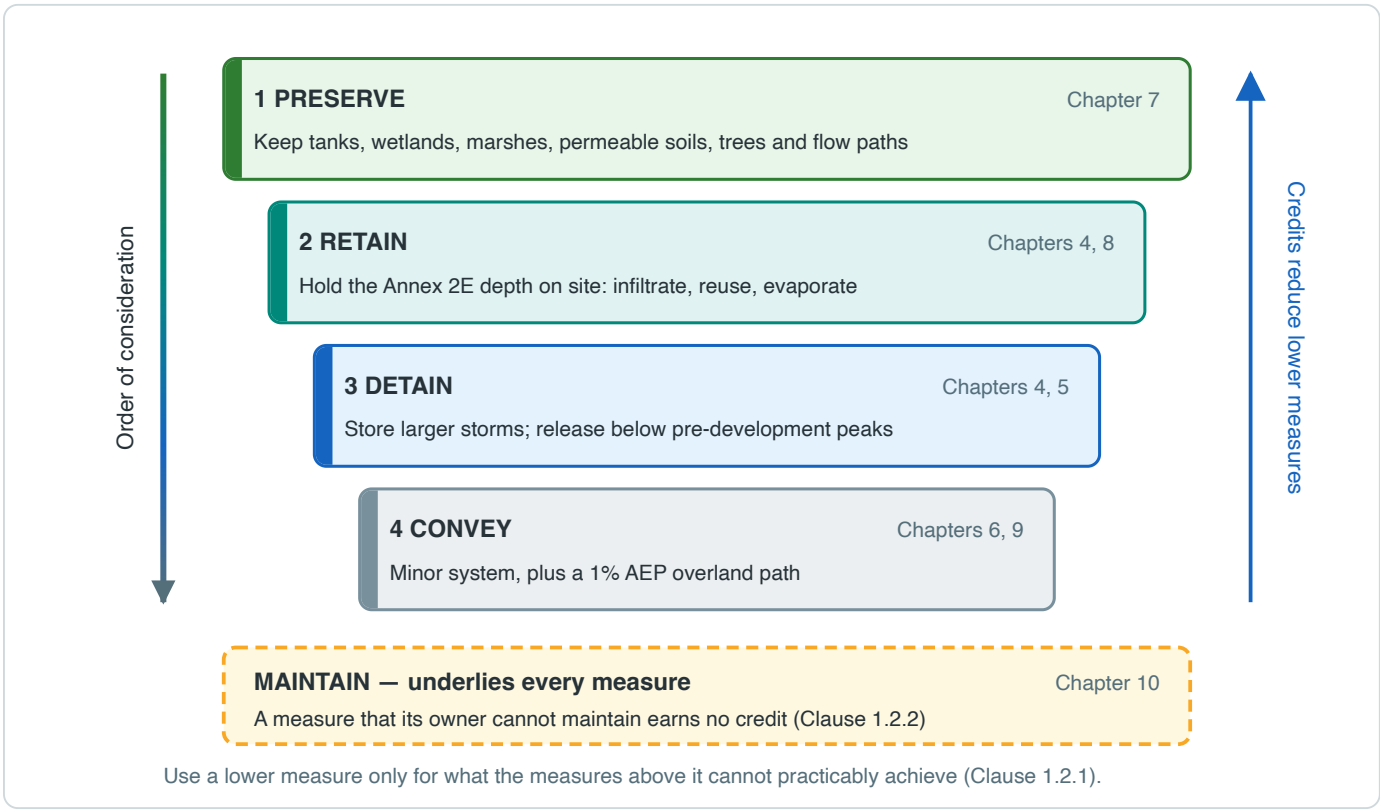

Figure 1.1 — Stormwater management hierarchy: preserve, retain, detain, convey, with maintenance underlying each measure. Original drawing for this Manual, adapted from Mid-America Regional Council / Kansas City Metro Chapter APWA, "Layers of Stormwater Management", APWA 5600 Manual Factsheet, 2025 (concept).

Commentary. The order follows the "layers" of Kansas City Metro APWA Section 5600, Version 2025.01: preserve or restore, retain, detain, convey, maintain (MARC factsheet, 2025). The same logic is behind Georgia's runoff-reduction standard and CSE's "attenuate and infiltrate first" principle (CSE, 2023). For Jammu and Kashmir, the top two layers have a particular meaning, and it differs between the Union Territory's three kinds of ground. Much of its natural storage lies in the lakes and marshes of the Kashmir valley: the Dal (20.37 km²) and Nigeen, which drain through the Dal Gate and the Nallah Amir Khan to Gilsar, Khushalsar and Anchar; the marshes (nambal (नंबल्; a grass-grown, shallow lake or marsh)) of Hokersar, Narkara, Shallabugh and the Rakh-e-Arth flood basin on the west and north of Srinagar, which the Srinagar Master Plan 2035 says "have been acting as flood retention basins"; and Wular, the valley's flood basin. Five of them are Ramsar sites: Wular (18,900 ha, 1990), Surinsar–Mansar (350 ha) and Hokera (Hokersar) (1,375 ha), both of 2005, and Hygam (802 ha) and Shallabugh (1,675 ha), both of 2022 (MoEFCC, list of Ramsar sites). Much has been lost: Hokersar has shrunk from 18.75 km² to about 13 km² and is reported to have "lost nearly half of its flood storage", Wular from 157.74 km² to 86.71 km², and 37% of Narkara has been built over (as reported). In the Jammu division the storage lies in the Kandi, the boulder-

gravel fans below the Siwaliks that the Central Ground Water Board calls "a very good medium for the recharge", in its 365 Kandi ponds (249 in Jammu district and 116 in Kathua), in the khads (खड्ड; seasonal hill torrents or ravine streams) that cross it, and in the old talabs of Jammu (Rani Talab, Talab Tillo), most of which survive only as names; and across the Union Territory in its springs (nāg (नाग्; spring), as at Kokernag, Verinag and Achabal). The law protects some of this. The UBBL-2021 keep development 50 m from the major rivers and khads, 30 m from the listed lakes and 20 m from rivulets and canals, measured from the edge of the bank (cl. 7.12(b)), and 30 m from the highest water level along nallahs and rivers (cl. 5.2.5); the master plans add buffers of up to 200 m round Anchar and Hokersar; the High Court keeps construction 200 m from the Dal; the Water Resources (Regulation and Management) Act, 2010 places the bed and banks of every water source under I&FC; and seven wetlands have been reserves since 1945. The statutory flood-zoning routes, flood basins under that Act and flood plain zones under the Flood Plain Zones Act, 2005, have not been used. The second layer changes with the ground, and this Manual flags three regimes. On the valley floor, where the water table stands 0–2 m below the surface and wells flow on both sides of the Jhelum, retention is storage and reuse, not infiltration, and no infiltration is credited (CGWB: in Srinagar "there is no scope for artificial recharge to ground water"). In the Kandi, infiltration is the preferred measure, with pre-treatment and protection of Jammu's groundwater supply. In the hills, water put into the slope moves the slope, as at Pernote in Ramban in 2024 and Thathri in Doda in 2023, so this Manual bars deliberate infiltration on natural slopes of more than 10°, on the clay–sandstone sequences of the Murree and Siwalik hills and in mapped subsidence or sliding zones, unless a geotechnical certificate allows it (Clause 4.11, set by this Manual). Losing the marshes and the Kandi cannot be offset by pipes, and on the valley floor the pumps can only empty what the marshes once held.

1.3 Legal basis and status

1.3.1 **Notification.** This Manual shall be given statutory effect by the Government of Jammu and Kashmir through:

- (a) an amendment to the Jammu and Kashmir Unified Building Bye-Laws 2021 that makes compliance with this Manual a condition of planning permission, building permit, layout approval and completion certificate, for development to which Clause 1.5 applies; and
- (b) bye-laws or standing orders of each urban local body (ULB), adopting the Manual for works executed or approved by that ULB, including the ULB's own drains and roads.

1.3.2 **Higher State standards.** The design return periods and performance criteria of this Manual exceed the national advisory minimums of the CPHEEO Manual on Storm Water Drainage Systems (2019). The State shall constitute, by notification, a high-powered committee (the **State Stormwater Technical Committee**, Clause 1.9) to adopt these higher standards. This is the route that CPHEEO (2019) provides for higher return periods.

1.3.3 **Precedence.** Within its scope, this Manual governs where it is stricter than CPHEEO (2019), IRC:SP:42-2014, IRC:SP:50-2013 or any departmental standard. Where a statute or statutory rule sets a stricter requirement (for example a waterbody setback), the statute governs.

1.3.4 **Design-practice standard for public works.** Departments and ULBs that procure drainage, road or waterbody works shall require compliance with this Manual in detailed project reports (DPRs) and contracts, from the dates in Clause 1.11.

Commentary. In Jammu and Kashmir the building rules are the Jammu and Kashmir Unified Building Bye-Laws 2021 (UBBL-2021), one set of bye-laws for "all urban local bodies, urban development authorities and metropolitan regional development authorities" of the Union Territory (cl. 2.1), read with the master plan of the area (cl. 1.1, 2.2). This Manual read them as published in the *J&K Official Gazette*, Extraordinary, Vol. 134, No. 39-4, of 24 December 2021 (the copy of the Jammu Municipal Corporation). They appear to have been adopted body by body on a common text: the Doda Municipal Council adopted them on 21 October 2021 under section 204 of

the Jammu and Kashmir Municipal Act, 2000 (as quoted); the original notification of H&UDD was not found [TBC]. They were amended by the notification of JMC gazetted on 9 March 2022, by S.O. 304 of 1 December 2025, which H&UDD issued under section 395(d) of the Jammu and Kashmir Municipal Corporation Act, 2000 and section 202 of the Jammu and Kashmir Municipal Act, 2000, and by S.O. 58 of 26 February 2026 (listed; text not read [TBC]); a further draft of 9 September 2026, published under section 397 of the Corporation Act, was reported (as reported). The two sections cited for the same power, 395(d) and 397, are both stated here; which one the final amendments rest on is to be confirmed [TBC]. S.O. 304 moved approvals to online auto-scrutiny, which checks rainwater harvesting, with deemed rejection after 15 days and online no-objection certificates from, among others, Sewerage & Drainage, the Lake Conservation and Management Authority (LCMA), the Pollution Control Board and the Irrigation and Flood Control Department (I&FC), and a "WATERBODY USE_NEGATIVE LIST" that bars permanent structures in a waterbody use. The bye-laws ask for a site plan that shows "any water body, flood affected areas and contours at an interval of 0.3m" where the slope is more than 1:20 (cl. 2.6(b)(xi)), and a certificate of the registered technical person that the site is clear of drains and water bodies (cl. 2.18); bar development in "water body, pond and Talav" land; keep a green buffer along nallahs and rivers of "minimum 30 m from the highest water level … whichever is more" (cl. 5.2.5); leave building in flood areas to I&FC "or the flood zonation maps notified by the department from time to time" (cl. 7.12(a)), of which none was found; and keep development 50 m from the edge of the bank of the listed rivers, among them the Chenab, the Jhelum, the Tawi, the Ravi and the Ujh, "or any other river/khad", 30 m from the listed lakes, among them Mansar, Surinsar, Wular, Nigeen and Manasbal, and 20 m from unlisted rivulets and the Ranbir and Sindh canals, "or as per building regulation whichever is more" (cl. 7.12(b)). They require sloping roofs in snowfall areas and let the Authority require roof water to be piped to a drain (cl. 6.20), and set a plinth of not less than 45 cm (cl. 6.1) and a ground-floor finish 300 mm above the centre line of the road (Table 5-9); the research for this Manual read each provision in a different part of the text, so both are cited, and the 1% AEP level plus 0.5 m of Clause 1.5.4(b) is stricter than either. Chapter 10 makes a rainwater harvesting proposal mandatory on plots of 100 m² or more. The bye-laws set no design storm, return period, release rate, detention volume or storage volume, no "zero runoff" rule, no basement flood rule and no rule on infiltration on slopes. The route of Clause 1.3.1(a) therefore runs through an amendment of the UBBL-2021 notified by H&UDD, and through the regulations of the master plans under the Jammu and Kashmir Development Act, 1970. This Manual is a draft; neither the Government nor any authority has adopted it. MoHUA told Parliament in July 2026 that urban flooding "falls under the purview of the State Governments and the ULBs" and listed the CPHEEO manual among "advisory guidelines" (Lok Sabha AU1847). The State therefore needs no central approval to adopt higher standards. CPHEEO's Note 2 to Table 4.1 (§4.4.1.4) allows "a high powered committee constituted by State/UT Government through a notification" to adopt higher return periods. Clause 1.3.2 uses that route so that higher standards are on record for centrally funded schemes.

1.4 Definitions

1.4.1 The following terms apply throughout this Manual. Chapter-specific terms are defined in each chapter (for example Clause 2.2).

Term	Meaning in this Manual
Approving Authority (the Authority)	The body that grants planning permission, building permit or layout approval for a development, or that sanctions a public work: the Building Permit Issuing Authority under UBBL-2021 in whose area the site lies: the Srinagar or Jammu Municipal Corporation, a Municipal Council or Municipal Committee, or a Development Authority under the Jammu and Kashmir Development Act, 1970, such as SDA or JDA, in its area, acting with the no-objection certificates routed through the online system of S.O. 304 of 2025, among them those of I&FC, Sewerage & Drainage and LCMA (the division of these powers between the bodies, and the bodies that grant permission outside urban areas, are to be confirmed [TBC]), or a department for its own works.
Applicant	The owner, developer or department that seeks approval, and its successors in title.

Term	Meaning in this Manual
Development	Any building, layout, sub-division, road, paving or land-use change that requires approval under the Jammu and Kashmir Unified Building Bye-Laws 2021 or that is executed as a public work.
Redevelopment	Development on a site where impervious cover already exists.
Land disturbance	Clearing, grading, excavation, filling or paving of land, measured in plan area over the whole of a common plan of development (Clause 1.5.5).
Impervious area	Roofs, paving, compacted gravel, decks and other surfaces that prevent infiltration. Permeable paving designed to Chapter 8 is counted as pervious only for the area it treats.
New or replaced impervious area	Impervious area created, or removed and rebuilt down to the subgrade, by the development. Resurfacing that leaves the base in place is not "replaced".
Retention	Permanent removal of runoff from the drainage system on site, by infiltration, reuse or evapotranspiration (Chapter 4).
Detention	Temporary storage of runoff with a controlled outlet, emptied after the storm (Chapter 4).
Rainwater harvesting (RWH)	Collection of rainfall for supply or recharge under the RWH mandate. RWH storage is not detention unless Chapter 4 allows it.
Minor system	Drains, pipes and inlets designed for the minor-system AEP of Chapter 6.
Major system	The overland and floodway path that carries the 1% AEP (100-yr) flow (Chapter 6).
Pre-development condition	Greenfield: open land in good condition for the mapped hydrologic soil group. Existing impervious cover is not counted (Chapter 3).
Flood-sensitive catchment	The catchments of Srinagar behind the Jhelum embankments, with the Dal–Nigeen catchment and the low land of the west-bank flood basins from Lelhar and Lasjan to Rakh-e-Arth, Narkara and Hokersar; the land of Anantnag, Bijbehara and Pampore that drains to the upper Jhelum; the land of Sopore, Baramulla, Sumbal and Bandipora that drains to the lower Jhelum, Wular and the flood spill channel; the land of Jammu that drains to the Tawi and to its khads; the land of Kathua and Hiranagar that drains to the Ujh and the Ravi, and of Samba that drains to the Basantar; the land of R.S. Pura, Bishnah and Arnia in the Sirowal; the land of Akhnoor that drains to the Chenab; the land of Udhampur that drains to the Tawi and the Devak, and of Katra; and the land of the hill towns of the Chenab valley, Ramban, Batote, Banihal, Doda, Thathri and Kishtwar, and any catchment the Authority notifies (Chapter 4; Annex 1B).
Waterbody	A river, stream, canal, tank (talab), lake, pond, marsh, supply channel or surplus course, whether perennial or seasonal (Chapter 7).
Regional facility	A detention, retention or tank storage facility serving more than one development, built or restored under a basin plan (Chapter 4).
Tier A / Tier B authority	An Approving Authority classed under Clause 1.6.
Policy supplement	The set of adoptable alternative clauses in Clause 1.7 and Annex 1C.
Drainage report	The preliminary or final report required by Chapter 10.
Registered professional	A person registered under the Jammu and Kashmir Unified Building Bye-Laws 2021 to prepare and sign the relevant plans, with any further qualification required by Clause 10.6.
Compliance calculator	The State-issued tool for computing and reporting compliance (Clause 10.5).
Maintenance declaration	The registered undertaking by an owner to maintain a stormwater facility (Clause 10.10).
Variance	Approval to depart from a numeric requirement, with equivalent performance shown (Clause 1.10).
Waiver	Approval that a requirement does not apply to a site, on the grounds in Clause 1.10.

Term	Meaning in this Manual
Notified	Published by the Government or the State Stormwater Technical Committee in the Jammu and Kashmir Official Gazette.
State	The Union Territory of Jammu and Kashmir. Jammu and Kashmir has been a Union territory with a Legislative Assembly since 31 October 2019 (Jammu and Kashmir Reorganisation Act, 2019; article 239A applies under section 13), not a State; "State" is used in this Manual as in section 3(58)(b) of the General Clauses Act, 1897, under which a State includes a Union territory. The usage is one of convenience and does not change who holds any power. The Legislative Assembly may make laws on any matter of the State List except public order and police (section 32), so land, local government, water, drainage and building regulation lie with the Union Territory. The Union Territory of Ladakh, a separate Union territory since 31 October 2019, is not part of the State in this Manual and is covered only by Supplement S01; figures published before that date for the former State include Ladakh and are not used for the Union Territory.
State Government, Government	The Government of the Union Territory of Jammu and Kashmir: the Lieutenant Governor acting on the aid and advice of the Council of Ministers, except where he acts in his discretion (section 53), with executive action expressed in his name (section 55(2)), and its departments, among them H&UDD and the Jal Shakti Department. Bodies of the Union that act in the Union Territory, among them CWC, CGWB, IMD, NHAI and NHPC, are named as such and are not part of the State Government.

> **Commentary.** "Replaced" impervious area is defined to the subgrade so that redevelopment of a fully paved site is captured, while routine resurfacing is not. This follows the approach of the APWA 5600 (2025.01) redevelopment triggers (MARC Supplement, 2025).

1.5 Applicability

1.5.1 **Who is covered.** This Manual applies to:

- (a) all development requiring planning permission, building permit or layout approval under the Jammu and Kashmir Unified Building Bye-Laws 2021;
- (b) all drainage, road, bridge, culvert, waterbody and flood-mitigation works executed by a ULB, a State department, a board, or a State undertaking; and
- (c) works executed by Central agencies or their contractors within Jammu and Kashmir, to the extent that the Authority's approval or no-objection is required.

1.5.2 **Retention and detention threshold.** Chapters 4 and 5 (retention, detention, downstream and tailwater analysis) apply to any development that, over the common plan of development, involves:

- (a) land disturbance of **0.1 ha or more**; **or**
- (b) new or replaced impervious area of **500 m² or more**.

1.5.3 **RWH.** The existing RWH mandate continues to apply under Chapter 10 of UBBL-2021 to every building on a plot of 100 m² or more, as a complete rainwater harvesting proposal with storage and recharge structures but no storage volume (cl. 10.1), with recharge mandatory for buildings and group housing on plots of more than 500 m² (cl. 10.5), the capture of storm water mandatory in public open spaces of more than 500 m² (cl. 10.4) and every structure inspected before the completion certificate or a service connection (cl. 10.6); the Srinagar Master Plan 2035 makes storage mandatory only for plots of 1,000 m² or more and group housing (reg. 1-7-13), and the stricter threshold of the bye-laws applies, as now. This Manual does not change it.

1.5.4 **Provisions that apply at every size.** The following apply to all development under Clause 1.5.1, whatever its size, unless exempted by Clause 1.5.8:

- (a) no sewage connection to a storm drain (Chapter 8);

- (b) lowest habitable floor and openings at or above the 1% AEP level plus 0.5 m, where a 1% AEP level is mapped or determinable (Chapter 6);
- (c) waterbody setbacks and the no-fill zone (Chapter 7); and
- (d) no obstruction of a natural drainage path or major-system flow path (Chapter 6).

1.5.5 **Common plan of development.** The thresholds of Clause 1.5.2 apply to the total area of a development, including all phases, plots and sub-divisions under one layout approval or one ownership at the date of application. A development shall not be divided to avoid the thresholds.

1.5.6 **Redevelopment.** For redevelopment, the thresholds apply to new plus replaced impervious area. Retention and detention apply to the whole of the new and replaced impervious area, and the pre-development condition is greenfield (Clause 1.4). Where greenfield control cannot be achieved on a constrained redevelopment site, the relief route of Clause 4.5.6 applies: a minimum on-site cut of 50% from existing peaks, with the shortfall paid as fee-in-lieu into basin storage.

1.5.7 **Linear public works.** For roads, widening and other linear works, the impervious area threshold applies to the added impervious area within each drainage catchment crossed. Retention and detention shall be provided within the right of way, or in a regional facility under Chapter 4, where the right of way cannot hold them.

1.5.8 **Exemptions.** The following are exempt from Chapters 4 and 5:

- (a) a single dwelling on its own plot, where the thresholds of Clause 1.5.2 are not met; and
- (b) linear road resurfacing that adds no impervious area.

Exempt development remains subject to the RWH mandate and to Clause 1.5.4.

1.5.9 **Applicability determination.** The Applicant shall record the applicability decision on **Form 1-1** (Applicability Determination) with the first submittal under Chapter 10. The Authority may confirm or correct it at the pre-application stage.

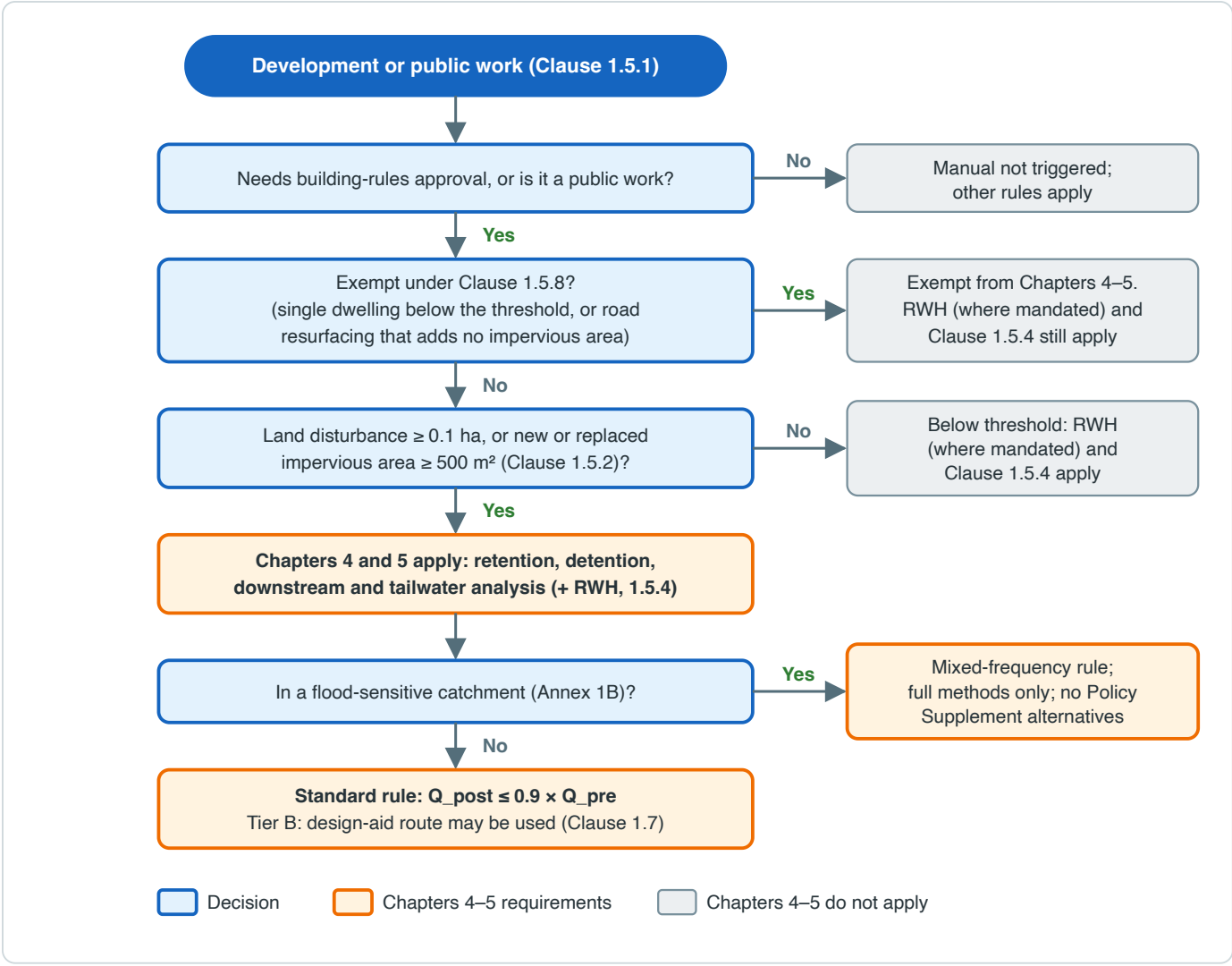

Figure 1.2 — Applicability decision flowchart for Clause 1.5. Original drawing for this Manual.

Commentary. The thresholds have no single direct precedent; they are set by this Manual. Precedents span a wide range:

- Singapore controls peak runoff from developments of 0.2 ha or more (PUB Code of Practice on Surface Water Drainage, 7th ed., cl. 7.1.5).
- Malaysia's 2008 DID checklist used on-site detention for sites up to 0.1 ha and community ponds above that.
- The APWA 5600 (2025.01) Policy Supplement offers alternative triggers of ¼ acre (about 0.1 ha) disturbed, or 1 acre (about 0.4 ha) with 10,000 sq ft (about 930 m²) impervious, and warns agencies not to exceed a 1-acre trigger.
- MBBL 2016 makes recharge mandatory for buildings over 500 m².

The 0.1 ha / 500 m² trigger sits at the strict end of these, because typical Jammu and Kashmir plots are small and the cumulative effect of many small plots is what fills Srinagar's drains. For small buildings in Jammu and Kashmir, Chapter 10 of the UBBL-2021 already reaches every plot of 100 m² or more: the plans must include "the complete proposal of rainwater harvesting" (cl. 10.1), and the structures are inspected before the completion certificate or a service connection (cl. 10.6). The bye-laws set no storage volume, and the only figure they give, that "55,000 litres per 100 sq. m. area per Year" can be harvested from rooftops, describes a yield, about 550 mm a year (NEER reading), not a tank. That is a supply measure, and none of it limits what leaves the plot in a design storm. The Srinagar Master Plan 2035 makes storage mandatory only for plots of 1,000 m² or more and group housing (reg. 1-7-13); the UBBL-2021, which are later and apply across the Union Territory, set the stricter

threshold of 100 m², and this Manual applies that one. Clause 1.5.4(b) applies to every building whatever its size, because no bye-law asks a small building to stand above the water: the UBBL-2021 set a plinth of 45 cm and a ground-floor finish 300 mm above the road, not a level above the flood. The same rainwater harvesting proposal does different things on the Union Territory's three kinds of ground, and an Authority may make the matching rule of this Manual a condition of every building permit in its area, whatever the size of the site (a recommendation of this Manual, not a requirement of Clause 1.5.4): on the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, where the water table is within 2 m of the surface and wells flow, it is storage and reuse, with no soakaway or recharge pit; in the Kandi of the Jammu plains it may be recharge, with the protections of Chapter 8; and on a hill slope, as at Thathri in Doda, where a committee before the NGT found no planned drainage on the subsiding slope and sewage piped to the roadside drains below it (as reported), it is storage with an overflow to a lined drain, never a soak pit (Clause 4.11).

Clause 1.5.4(b) has no direct precedent; this Manual sets it because floor levels are the cheapest protection a building can have, and it would be perverse to protect only large developments. Where no 1% AEP level is mapped, Chapter 6 gives the method for small sites.

1.6 Tiered adoption

1.6.1 **Tier A authorities.** The following are Tier A:

- (a) Srinagar Municipal Corporation (SMC) and the Jammu Municipal Corporation (JMC), constituted under the Jammu and Kashmir Municipal Corporation Act, 2000;
- (b) every Approving Authority within the Srinagar Local Planning Area, the local area of the Srinagar Master Plan 2035 notified under the Jammu and Kashmir Development Act, 1970 (SRO-429 of 21 October 2014), as that area is notified from time to time, including the Srinagar Development Authority (SDA), SMC and the Municipal Councils and Committees in that area; and
- (c) every Approving Authority within the Jammu Local Planning Area, the local area of the Jammu Master Plan 2032 notified under the Jammu and Kashmir Development Act, 1970, as that area is notified from time to time, including the Jammu Development Authority (JDA), JMC and the Municipal Councils and Committees in that area.

1.6.2 **Tier B authorities.** All other Municipal Councils and Municipal Committees are Tier B.

1.6.3 **What differs between tiers.** All criteria of this Manual apply in both tiers. The tiers differ only in method and review:

Table 1.1 — Differences between Tier A and Tier B authorities

Item	Tier A	Tier B
Performance criteria (Chapters 2–9)	Apply in full	Apply in full
Hydrologic method for storage	Hydrograph method (Chapter 3)	Hydrograph method, or the design-aid route of Clause 1.7 where eligible
Compliance calculator (Clause 10.5)	Required as a summary	Required; may be the sole calculation on the design-aid route
Policy supplement alternatives (Clause 1.7)	Only with State Stormwater Technical Committee concurrence	May be adopted by council resolution
Technical review	By the Authority	By the Authority, with H&UDD regional support or an empanelled reviewer (Clause 10.7)
Flood-sensitive catchment rule	Applies	Applies

1.6.4 **Moving between tiers.** A Tier B authority may opt into Tier A by council resolution. The Government may notify a Tier B authority as Tier A when it becomes a Corporation, joins the local planning area of the Srinagar Master Plan 2035 or the Jammu Master Plan 2032 under the Jammu and Kashmir Development Act, 1970, or is found by a post-event review (Clause 10.16) to need the full methods.

1.6.5 **Flood-sensitive catchments override tier.** In a flood-sensitive catchment, whatever the tier, the alternatives of Clause 1.7 are available only as Table 1.2 allows: S-1 (the design-aid route) for sites of 0.5 ha or less (Clause 4.14.1), and S-5 fee-in-lieu where a basin plan has been notified (Clause 1.10.3(d)). S-2, S-3 and S-4 are not available.

> Commentary. Srinagar Municipal Corporation, with its Town Drainage wing, with UEED and the Town Drainage of the Directorate of Urban Local Bodies Kashmir beside it, about 119 km of primary and secondary storm drains and 89 drainage pumping stations counted in 2019 (Srinagar Master Plan 2035), and 104 permanent dewatering stations and 281 mobile units reported in 2026 (as reported), and a small hill Municipal Committee with one assistant engineer cannot be asked to review the same hydrograph models. The Kansas City solution was to keep one regional standard and publish adoptable alternatives for the most contested criteria, so that smaller agencies can "opt down" without leaving the standard (MARC Supplement, Nov 2025). The tiers here keep the performance criteria the same in both tiers and vary only the method, so that a building in a Tier B town is protected to the same level as one in Srinagar.

1.7 Policy supplement: adoptable alternatives

1.7.1 The Government shall publish, with this Manual, a **Policy Supplement** (Annex 1C) of alternative clauses. An Approving Authority may adopt one or more alternatives under the conditions in Clause 1.7.3.

1.7.2 The alternatives are:

Table 1.2 — Policy supplement: adoptable alternatives S-1 to S-5

No.	Main-text requirement	Adoptable alternative	Eligibility
S-1	Storage sized by hydrograph method (Chapter 3)	**Design-aid route:** retention and detention volumes taken from the unit-storage tables (m³ per ha, by rainfall zone, soil group and impervious fraction) in Annex 4 and the compliance calculator	Sites ≤ 2 ha outside flood-sensitive catchments; ≤ 0.5 ha within them (as Clause 4.14.1)
S-2	Release rate Q_post(T) ≤ 0.9 × Q_pre(T), computed for the site	**Permissible site discharge (PSD):** a tabulated unit-area release rate (m³/s/ha) by zone and AEP, derived from the 0.9 × Q_pre rule	Any site outside flood-sensitive catchments
S-3	Waterbody setback extended to the mapped 1% AEP flood extent plus margin (Chapter 7)	**Fixed-width setback table** by waterbody class, where no 1% AEP extent is mapped. Never less than the Zone 1 minimum of Clause 7.4.7	Waterbodies with no mapped 1% AEP extent
S-4	Downstream analysis by hydraulic model (Chapter 5)	**Screening checklist** of downstream capacity and known flooding, with a model only where the screen fails	Sites < 1 ha, outside flood-sensitive catchments, not discharging to a tidal outfall
S-5	On-site detention	**Fee-in-lieu** toward a regional facility or restored tank storage in a master-planned basin (Chapter 4)	Where a basin plan has been notified

1.7.3 **Conditions on adoption.**

- (a) An alternative shall not lower any criterion below the values of this Manual. S-1 and S-2 are simplified methods for meeting the same criterion. They are not lower criteria.

- (b) A Tier B authority adopts an alternative by council resolution, sent to the State Stormwater Technical Committee within 30 days. A Tier A authority needs the Committee's concurrence before adoption.
- (c) The adopted alternatives shall be published on the Authority's website and in the register of Clause 10.17.
- (d) Retention (Annex 2E depth) cannot be replaced by any alternative, except where fee-in-lieu under S-5 funds equivalent retention in the same basin.
- (e) The tables for S-1, S-2 and S-3 shall be issued by the State Stormwater Technical Committee, and reviewed with Chapter 2 (Clause 2.14).

> Commentary. The supplement follows the model of the APWA 5600 (2025.01) Policy Supplement, which gives alternatives for the four most contested criteria (applicability, Rational Method limits, stream setback trigger, and Zone 2 setback width). Two of those map onto S-3 and onto the applicability threshold of Clause 1.5.2. Alternative S-3 copies the APWA answer to the same problem: the 1% AEP extent is not mapped for small drainage areas, so a fixed-width table is offered. S-2 follows the Kansas City 2011 shift from "match existing" to fixed unit-area release rates. Local agencies preferred a set rate because existing conditions were hard to determine consistently (MARC Evolution deck). It also reflects the Sydney Water permissible site discharge (PSD) method. The 2 ha / 0.5 ha limits for S-1 (matching Clause 4.14.1) and the 1 ha limit for S-4 have no direct precedent; they are set by this Manual.

1.8 Relationship with other instruments

1.8.1 This Manual shall be applied together with the instruments below. Where they overlap, Clause 1.3.3 governs.

Table 1.3 — Relationship with other instruments

Instrument	Relationship
Jammu and Kashmir Reorganisation Act, 2019 (No. 34 of 2019): section 13 (article 239A applies), section 32 (legislative power), sections 53 and 55 (aid and advice; rules of business; executive action in the name of the Lieutenant Governor) and the Fifth Schedule, Table 4 (State Acts that remain in force); the Transaction of Business Rules as amended in 2024 (as reported)	Continue; they decide who could adopt this Manual. The Legislative Assembly may make laws on any matter of the State List "except … 'Public Order' and 'Police'" (s.32(1)), so land, local government, water, drainage and building regulation lie with the Government of the Union Territory, acting on the aid and advice of its Council of Ministers except where the Lieutenant Governor acts in his discretion (s.53); executive action is expressed in the Lieutenant Governor's name (s.55(2)). The amendment of the Business Rules reported in 2024 does not list any of the subjects of this Manual (as reported; NEER reading), and revised rules are reported to be pending (as reported, unverified). The Fifth Schedule continues the Development Act 1970, the Flood Plain Zones Act 2005, the Land Revenue Act Svt. 1996, the Municipal Act 2000, the Municipal Corporation Act 2000, the Town Planning Act 1963, the Water Resources Act 2010, the Common Lands Act 1956, the Control of Building Operations Act 1988, the Kahcharai Act Svt. 2011 and the Prevention of Ribbon Development Act Svt. 2007.

Instrument	Relationship
the Jammu and Kashmir Unified Building Bye-Laws 2021 (UBBL-2021), *J&K Official Gazette*, Extraordinary, Vol. 134, No. 39-4, 24 December 2021 (read), as amended by the JMC notification gazetted on 9 March 2022 (read), S.O. 304 of 1 December 2025 (read) and S.O. 58 of 26 February 2026 (listed; not read [TBC]); draft amendments of 9 September 2026 (as reported)	Continue. They keep development 50 m from the edge of the bank of the Chenab, the Jhelum, the Tawi, the Ravi, the Ujh "or any other river/khad", 30 m from Mansar, Surinsar, Wular, Nigeen, Manasbal "and other lakes" and 20 m from unlisted rivulets, tributaries and canals, among them the Ranbir and Sindh canals, "or as per building regulation whichever is more" (cl. 7.12(b)); keep a green buffer along nallahs and rivers of at least 30 m "from the highest water level" (cl. 5.2.5); leave the distance from a talab or village tank to the Authority (cl. 7.12(c)); leave flood areas to I&FC "or the flood zonation maps notified by the department from time to time" (cl. 7.12(a)), none of which was found; bar development in "water body, pond and Talav" land; require the site plan to show water bodies, flood-affected areas and 0.3 m contours on slopes steeper than 1:20 (cl. 2.6(b)(xi)); and route the no-objection certificates of I&FC, Sewerage & Drainage, LCMA and the Pollution Control Board through online scrutiny (S.O. 304). The list of major watercourses in cl. 7.12(b) also names a river that does not flow through the Union Territory; this Manual applies the clause to the rivers of the Union Territory it names and to "any other river/khad". The bye-laws set no design storm, release rate, detention volume, storage volume, basement flood rule or rule on infiltration on slopes. The design criteria of Chapters 2–6, the outfall-closed and infiltration rules of Chapters 4, 5 and 8, and the hydraulic corridor of Chapter 7, whose Zone 1 is at least 15 m and which applies only where no wider statutory line binds, are this Manual's proposals; they are not statutory values, and no authority has adopted them. Where the bye-laws, a master plan, a statute or a court order are stricter, they govern (Clause 1.3.3).
Rainwater harvesting: UBBL-2021, Chapter 10; Srinagar Master Plan 2035, regulation 1-7-13; Water Resources (Regulation and Management) Act, 2010, section 122 [section number to be confirmed]	Continue unchanged. Chapter 10 makes a complete rainwater harvesting proposal mandatory for every building on a plot of 100 m² or more (cl. 10.1), recharge mandatory for buildings and group housing on plots of more than 500 m² (cl. 10.5) and the capture of storm water mandatory in public open spaces of more than 500 m² (cl. 10.4), asks for permeable paving of the open parking of group housing (Table 10-1), bars contaminated water from recharge structures in industrial areas, and has every structure inspected before the completion certificate or a service connection, with an annual check of every building above 1,000 m² (cl. 10.6); it sets no storage volume. The master plan's regulation makes storage mandatory only for plots of 1,000 m² or more and group housing; both are cited, and the stricter 100 m² of the bye-laws applies. Section 122 of the Act of 2010 lets the regulatory authority advise the Government on areas where rooftop harvesting should be mandatory; it is advisory and not self-executing. This Manual counts the storage of Chapter 10 against its retention requirement only as reuse (Clause 4.4.3), never as detention, and on the Kashmir valley floor and on hill slopes only as storage, never as recharge (Clause 4.11).
Jammu and Kashmir Development Act, 1970 (Act XIX of 1970); the Srinagar Master Plan 2035 (SRO 160 of 7 March 2019, as quoted) and the Jammu Master Plan 2032 (SRO 90 of 3 March 2017, as quoted, amended by S.O. 243 of 2022 and S.O. 19 of 2024, as listed); the Development Authorities, LCMA (renamed from LAWDA on 3 November 2021, as reported) and WUCMA (2012)	Continue. The Srinagar plan records that 34% of its planning area, 262 km², was flooded in 2014, that I&FC's flood zonation puts 125 km² in undevelopable and 136.50 km² in flood-vulnerable categories (§4.2), and sets buffers round the Dal and Nigeen (50–100 m), Anchar (200 m on three sides, 30 m on the east), Hokersar (200 m south and west, 50 m east and north), Nambal Narkur (100 m), the Telbal and Sind nallahs (50 m) and the Doodhganga, the Nallah Amir Khan and other small water bodies (20 m), with 100 m round unlisted wetland reserves (Tables 8-2 and 8-3; §8.2.3); its §13.3 sets "stormwater performance standards" of full coverage and no waterlogging without a return period, and its §14.4.4.2 proposes, without having notified it, that the 25-year floodplain from Lelhar to Lasjan be a "Protected Natural Flood Absorption Basin". The Jammu plan sets buffers from the Full Tank Level of 50 m (30 m in built-up areas) on the Tawi, the Devak and the Basantar, 15 m on the Balol, Thather and Bhalwal khads and 5 m elsewhere (§7.3.3), and proposes that land recorded as "Gair Mumkin Khad", more than 30% of JDA's land, be reduced to the "true Khad" fixed with I&FC (§12.2.3). The buffers are measured from three different lines (the edge, the highest water level and the Full Tank Level); Chapter 7 maps each onto its design flood line, and the widest governs. This Manual requires any release of khad land to follow a hydraulic study of the functional khad at the AEP of Chapter 7 (set by this Manual). Master plans would show the flood-sensitive catchments, drainage reserves and regional facility sites of this Manual (Chapter 11).
Jammu and Kashmir Municipal Corporation Act, 2000 (Act XXI of 2000) and Jammu and Kashmir Municipal Act, 2000 (Act XX of 2000)	Continue. They are the parent Acts of the UBBL-2021: S.O. 304 cites section 395(d) of the Corporation Act and section 202 of the Municipal Act, the draft of September 2026 section 397 of the Corporation Act, and the Doda Municipal Council adopted the bye-laws under section 204 of the Municipal Act (as quoted); which sections govern is to be confirmed [TBC]. Their drainage sections, on the vesting of drains, connections and building over drains, were not read for this Manual [TBC].

Instrument	Relationship
Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010 (Act XXI of 2010) and its Rules of 2011 (section numbers were assigned from a title index and are to be confirmed against an official copy [TBC])	Continue, and apply where a water source, embankment or channel is concerned. The Act defines "drainage works" to exclude works for sewage (s.2(l)), a "flood basin" as "the area which is required for carrying the flow of the floods" (s.2(s)), and a "water source" to include any "nallah, canal, spring, pond, lake" (s.2(zze)); bans encroachment on water bodies (s.4(zw)); prohibits obstructions (ss.52–53) and provides for drainage schemes (s.54); requires permission to build in the vicinity of an irrigation or hydraulic work (s.66); bars waste in channels (s.73); provides for flood basins to be declared after survey, objections and notification, with restrictions on the use of land (Part VI, ss.75–79), of which none was found notified; and places "the bed and banks of all water sources … city channels and flood spill channels" under I&FC (s.81). Every outfall to a river, nallah, flood spill channel or city channel needs I&FC's consent under this Manual (Chapter 5). Where a flood basin is notified under Part VI, its restrictions govern; until then the mapped design flood line of Chapter 7 applies (set by this Manual).
Jammu and Kashmir Flood Plain Zones (Regulation and Development) Act, 2005 (Act XVII of 2005)	Not in force: the Act comes into force on a date to be notified (s.1(3)), and no such notification was found [TBC]. No flood plain zone or flood zonation map is notified under it. Its "flood zone", the area needed "to carry the flow of the maximum probable floods" (s.2(d)), is not the 1% AEP line of this Manual. Where the Act is brought into force and a zone declared, its restrictions govern.
Wetlands (Conservation and Management) Rules, 2017; the Jammu and Kashmir Wetland Authority (constituted on 25 November 2020; the number of the notification is uncertain in the copy read); the Wildlife (Protection) Act, 1972 (in force in the Union Territory from 31 October 2019) and the wetland conservation reserves of Order No. 710-C of 17 July 1945; Ramsar sites Wular (18,900 ha, 1990), Surinsar–Mansar (350 ha) and Hokera (1,375 ha) (2005), Hygam (802 ha) and Shallabugh (1,675 ha) (2022)	Continue. No wetland of the Union Territory had been notified under rule 4 of the Rules by September 2024; the Wetland Authority approved the brief document of Wular "for Notification" on 3 August 2022, and a plan of 2021 to declare Wular, Dal, Nigeen, Sanasar, Manasbal and Purmandal "Protected Wetlands" was reported (as reported), neither confirmed as notified. The seven wetland reserves are held by the Wildlife Department. The NGT has called the revenue-record areas of 27 wetlands of more than 1 ha "insufficient" and asked for their extent on the ground (OA 239/2024, order of 13 November 2026, as reported). The lakes and wetlands are governed by Chapter 7.
High Court of Jammu and Kashmir and Ladakh: PIL 8/2017 with PIL 2/2014 and PIL 18/2018, *Environmental Policy Group v. Union of India* (order of 29 May 2024, reciting the orders of 24 November 2014, 24 February 2015 and 10 June 2016); PIL 159/2002 (the Dal; order of 19 July 2002, as quoted; later orders as reported); the order on Wular of November 2020 (as reported)	Apply as court directions where they bind. The Court has directed the removal of encroachments from the banks of the Jhelum "along its entire course", ordered that "the original width of the river Jhelum is restored", described itself as "Custodia Legis of river Jhelum and other water bodies", and directed the Deputy Commissioners to ensure that "no construction of any kind is raised near the water bodies". It has kept a 200 m no-construction zone round the Dal since 2002 (as quoted; the judgment of 30 October 2025 is reported to keep it [TBC]), and is reported to have ordered 200 m round Wular in November 2020 (as reported); LCMA has applied 200 m round Nigeen (2021, as quoted). These are court directions, not rules of this Manual; Chapter 7 applies the widest line that binds.
National Green Tribunal: OA 504/2024 (the Dal), OA 190/2025 (Brari Nambal), OA 239/2024 (the wetlands of Kashmir), OA 413/2025 (the Jhelum and the Chenab), OA 642/2024 (land sinking) and OA 93/2023 (Thathri)	Apply where they bind. JKPCC reported in OA 504/2024 that Srinagar generates 193.34 MLD of sewage against 62.01 MLD of treatment capacity (32.07%), and that "Untreated sewage gets entry into the Dal Lake from areas like Telbal, Lalbazar" (14 August 2024); CPCB's list of polluted river stretches of October 2025 includes the Chunt Kol (Priority III), the Jhelum from the Vishav confluence to Baramulla and the Tawi from the Tawi Bridge to the Balol Nallah (Priority IV), and the Basantar, the Devak, the Gawkadal stretch and the Lidder (Priority V) (JKPCC, OA 413/2025). The GSI note on Pernote filed in OA 642/2024 recommends "diverting the surface runoff away" and lining the drains of the affected slope. Sewage in storm drains is dealt with in Chapter 8, and slopes in Chapters 4 and 6.

Instrument	Relationship
Jammu and Kashmir Land Revenue Act, Svt. 1996; the Kahcharai Act, Svt. 2011; the Common Lands (Regulation) Act, 1956	Continue (texts not read [TBC]). Much of Jammu's drainage land is recorded as "Gair Mumkin Khad" (land recorded as uncultivable stream bed), and the Kashmir marshes as nambal and rakh (a reserved wetland or grassland, a word used in names); the recorded class and the surveyed extent diverge, and this Manual's register records both (Chapter 7).
Disaster Management Act, 2005; J&K SDMA and the District Disaster Management Authorities	Continue. No urban flood plan or standard operating procedure of J&K SDMA was read for this Manual [TBC], and no order found fixes a date for desilting; the works calendar of Chapter 10 sets this Manual's dates.
IRC:SP:42-2014 and IRC:SP:48, Hill Road Manual, and the practice of the PW (R&B) Department on road drainage	Apply to the drainage of roads and hill roads, cross-referenced from Chapter 6, where they do not conflict with it; the World Bank's flood recovery project designed its roads and bridges "per the guidelines of the Indian Roads Congress" (JTFRP, 2015); the drainage clauses of IRC:SP:48 were not read for this Manual [TBC].
CPHEEO Manual on Storm Water Drainage Systems (2019)	Engineering reference. This Manual sets higher return periods under Clause 1.3.2.
NDMA Guidelines on Management of Urban Flooding (2010) and MoHUA SOP (2017)	This Manual puts into effect the NDMA directives on catchment-based design, detention and retention, waterbody protection and climate-adjusted IDF.
NDMA Urban Flood Risk Management Programme (UFRMP) and AMRUT 2.0	Works funded under these programmes shall comply with this Manual. The development controls of Chapters 4–5 protect the capacity those works create.
IRC:SP:42-2014 and IRC:SP:50-2013	Apply to road drainage only where they do not conflict with Chapter 6.
MBBL 2016, Chapter 9	Model for RWH and for the inspection regime in Chapter 10.

Commentary. RWH in Jammu and Kashmir is framed as a water supply and recharge measure. It works well for that purpose. It cannot, however, be relied on for flood control in the SW monsoon, because RWH sumps are usually full or the ground saturated by the time a late-August or September storm, such as those of September 2014 and August 2025, arrives after weeks of rain. The Manual therefore keeps harvest volume and attenuation volume apart, while letting recharge count as retention where it truly removes water from the system.

Jammu and Kashmir is spending on its drains and its rivers, but without a design basis. After the floods of 2014 the World Bank's Jhelum and Tawi Flood Recovery Project ($250 million, approved in 2015 and extended to 31 August 2026) took up the rehabilitation of about 56 of Srinagar's storm water pumping stations (JTFRP, 2015; as reported); a drainage master plan and DPR for 767 km² of Srinagar, modelled as "a … stormwater drainage system that is separate from the sewage system", was prepared by a consultant (as reported); ten drainage projects of the Srinagar Smart City and a storm network of about 650 km were reported to the Assembly in 2026 (as reported); and the Comprehensive Plan for Flood Management Works on the Jhelum spent ₹399.29 crore on its first phase, while ₹1,623.43 crore of a second phase of ₹5,411.54 crore, with regulatory gates at Hokersar, was approved in 2022 (as reported). In Jammu, storm drains such as the Digiana–Gangyal drain were sanctioned as named projects (as quoted), and the Jammu Master Plan 2032 asks for a storm-water DPR "immediately after the approval of this Master Plan" (§11.1.3). None of the documents found states a design storm, return period or runoff coefficient. No development-control condition stops new plots in the same catchments from using up the capacity such works create. Linking Chapters 4–5 to approvals closes that gap.

The Union Territory's law holds more of the tools than most States of the series. The UBBL-2021 set the widest statutory waterway buffers found in the series (NEER reading), 50, 30 and 20 m from the edge of the bank and 30 m from the highest water level, and make a rainwater harvesting proposal mandatory from plots of 100 m²; the Water Resources (Regulation and Management) Act, 2010 puts "the bed and banks of all water sources … city channels and flood spill channels" under I&FC and provides for flood basins to be declared and their use restricted (Part VI); the Flood Plain Zones (Regulation and Development) Act, 2005 provides for flood plain zoning; the Srinagar Master Plan 2035 sets "stormwater performance standards" of full coverage and no waterlogging and asks for detention and retention "source controls"; and the High Court, as "Custodia Legis of river Jhelum and

other water bodies", has ordered the original width of the Jhelum restored and no construction near water bodies (PIL 8/2017, orders of 2015 and 2016, as recalled in the order of 29 May 2024). What the law lacks is the design standard and the use of its own flood routes. None of these instruments says how large a drain must be, which storm it must carry, how long a Srinagar sump must hold the city's runoff when the Jhelum closes its gates, how much water a hill site may put into its slope, or how much storage a paved plot removes; the Flood Plain Zones Act has not been brought into force, no flood basin has been declared under the Act of 2010, and the "flood zonation maps" to which the UBBL-2021 defer have not been found notified [TBC]. This Manual's checks are framed as part of the building permission and the online no-objection certificates of the UBBL-2021 (S.O. 304) and of the master plans, not as a separate certificate. This Manual is offered as a technical companion to these instruments, to the orders of the High Court, and to the drainage and flood works: it supplies the design storm, outfall-closed storage, hill-site drainage, infiltration and buffer numbers they do not set, as a proposal that a competent authority (for example H&UDD for building approvals, or the Jal Shakti Department for river and flood-basin matters) could adopt. Neither H&UDD, the Jal Shakti Department nor any other body has adopted it.

1.9 Roles and responsibilities

1.9.1 The responsibilities below apply under this Manual. They do not change any agency's statutory powers.

Table 1.4 — Roles and responsibilities under this Manual

Agency	Role under this Manual
Housing and Urban Development Department (H&UDD), with the Town Planning Organisations of Kashmir and Jammu	Issues amendments to the UBBL-2021 (S.O. 304 of 1 December 2025), prepares the master plans of the local planning areas, among them the Srinagar Master Plan 2035 and the Jammu Master Plan 2032, under the Jammu and Kashmir Development Act, 1970, and administers the Municipal Corporations, Councils and Committees, the Development Authorities, UEED and LCMA. Would prepare the amendment of Clause 1.3.1(a) if the Manual were adopted, show flood-sensitive catchments, drainage reserves and regional facility sites in the master plans (Chapter 11), and, through the Town Planning Organisations, give regional support to Tier B authorities (Table 1.1).
Jal Shakti Department: Irrigation and Flood Control (I&FC), with its Kashmir and Jammu wings, and Public Health Engineering (PHE)	I&FC controls "the bed and banks of all water sources … city channels and flood spill channels" and the embankments (Water Resources (Regulation and Management) Act, 2010, section 81 [section number to be confirmed]), reads the river gauges in feet at Sangam, Ram Munshi Bagh, Asham, Akhnoor and on the Tawi, issues flood declarations, and is a no-objection authority for building permission (S.O. 304); PHE runs the water supply and registers bore wells. Would supply river levels, gauge zeros and flood marks for Chapter 5, consent to every outfall to a river, nallah, flood spill channel or city channel, approve the site-specific hydrology of Clause 2.3.6(i), apply this Manual to its drainage and flood works, and, as the route for flood basins under Part VI of the Act of 2010, map them with Chapter 7's flood line in mind.
State Stormwater Technical Committee (Clause 1.3.2)	Would adopt higher standards, issue Annexes, tables and the compliance calculator, concur with Tier A alternatives, decide variances referred to it and review the Manual (Clause 1.12).
Srinagar Municipal Corporation (SMC) and the Jammu Municipal Corporation (JMC); the Municipal Councils and Municipal Committees	Grant building permission as Building Permit Issuing Authorities under the UBBL-2021 and hold and clean the drains vested in them under the Jammu and Kashmir Municipal Corporation Act, 2000 and the Jammu and Kashmir Municipal Act, 2000 (drainage sections not read [TBC]); SMC runs the Town Drainage wing and the dewatering of Srinagar with UEED, and JMC the desilting of Jammu's nallahs. Would apply this Manual to their works, receive handed-over assets (Clause 10.14), and inspect and enforce (Clauses 10.12–10.15).
Urban Environmental Engineering Department (UEED); Town Drainage of SMC and of the Directorate of Urban Local Bodies Kashmir	UEED's mandate is "planning, designing and construction of works of sewerage and drainage in urban areas" (Srinagar Master Plan 2035, §13.3); its Sewerage and Drainage Division (West) works within the limits of JMC. With the Town Drainage wings it builds and runs Srinagar's drains and pumping stations, 89 in 2019 (Srinagar Master Plan 2035) and 104 permanent dewatering stations in 2026 (as reported). Would keep the register of drains and pumping stations with their sump levels and the river stage at which each gravity gate shuts (Chapters 5 and 9), and design its drains, pumps and sewers to this Manual, keeping sewage out of the storm drains (Chapter 8).

Agency	Role under this Manual
Srinagar Development Authority (SDA), Jammu Development Authority (JDA) and the other Development Authorities under the Jammu and Kashmir Development Act, 1970	Plan and grant permission in their areas and are no-objection authorities under S.O. 304; JDA holds the Nazool and State land along Jammu's water bodies and would receive land released from the "Gair Mumkin Khad" class (Jammu Master Plan 2032, §§12.2.3–12.2.4). Would require the drainage report of Chapter 10 with each application or scheme, and release no khad land without the hydraulic study of Chapter 7.
Lake Conservation and Management Authority (LCMA, formerly LAWDA) and Wular Conservation and Management Authority (WUCMA)	LCMA manages the Dal and Nigeen and their catchment and is a no-objection authority under S.O. 304; WUCMA, constituted in 2012 under the Jammu and Kashmir Development Act, 1970, manages Wular and its feeder channels. Would consent to every outfall to the lakes and to Wular, with the sediment and dry-weather-flow interception of Chapter 8, and supply lake and outlet levels for Chapter 5.
Srinagar and Jammu Smart City companies	Build drains under the Smart Cities Mission and hand them to the Municipal Corporation. Would design them to this Manual from the dates of Clause 1.11.
Public Works (R&B) Department and the National Highways Authority of India (NHAI)	Build and maintain roads with their side drains, catch-water drains and culverts, which in the hill towns, and in Jammu, where "the road side drains serve as storm water drains" (Jammu Master Plan 2032, §5.1.3), are much of the minor drainage system. Would apply Chapter 6 and the hill-road rules to them, and discharge no road drain onto an unprotected slope.
Jammu and Kashmir State Disaster Management Authority (J&K SDMA), the District Disaster Management Authorities, and the Jammu and Kashmir Economic Reconstruction Agency (JKERA)	J&K SDMA met only once in 2010–15 (CAG, 2016); no urban flood plan or standard operating procedure of it was read for this Manual [TBC]. JKERA runs the Jhelum and Tawi Flood Recovery Project. Would supply the hazard, landslide and subsidence maps used in the screening of Clause 2.3.6(i) and the hill rules, and lead post-event reviews with the Authority (Clause 10.16).
Forest, Ecology and Environment Department, with the Jammu and Kashmir Wetland Authority (constituted on 25 November 2020) and the Wildlife Department	The Wetland Authority applies the Wetlands Rules, 2017; no wetland of the Union Territory had been notified under rule 4 by September 2024. The Wildlife Department holds Hokersar, Shallabugh, Hygam, Freshkoori, Kranchoo, Chatlam and Manibugh as wetland conservation reserves, notified by Order No. 710-C of 17 July 1945. Their consent would be needed before a wetland or Ramsar site is used for storage or an outfall (Chapter 7).
Jammu and Kashmir Pollution Control Committee (JKPCC)	Monitors rivers, lakes and treatment plants and reports to the NGT (OA 504/2024, OA 413/2025). Would receive the records of sewage found in storm drains under Chapter 8.
Revenue Department and the Deputy Commissioners	The revenue records show the rivers, nallahs, khads, nambals and rakhs, much of Jammu's drainage land as "Gair Mumkin Khad", and the common and kahcharai land; the Deputy Commissioners were directed by the High Court to ensure that "no construction of any kind is raised near the water bodies" (order of 10 June 2016, as recalled in 2024). Would record drainage reserves and the surveyed extent of waterbodies, beside their revenue class, in the land records.
JKSPDC, NHPC and the other dam operators	Operate Baglihar (JKSPDC), Salal and Dul Hasti (NHPC) and the other dams on the Chenab; Ranjit Sagar, on the Ravi below Kathua and Basohli, is operated from Punjab. Would supply reservoir levels, gate and flushing schedules and release records for Chapter 5.
Central Water Commission (CWC), a body of the Union	Publishes the Flood Estimation Report for zone 7 used in Chapters 2 and 3 and runs the river sites at Khanabal, Sangam, Ram Munshi Bagh, Safapora, Akhnoor, Ganeshpura and Sidhra. Would supply river stage records, warning and danger levels, datums and forecasts for Chapter 5.
Central Ground Water Board (CGWB), North Western Himalayan Region, Jammu, a body of the Union	Assesses the groundwater of the Union Territory (stage of extraction 22.28% in 2024, all 149 units "Safe") and holds the observation wells. Would supply groundwater levels and quality, and the shallow and artesian levels of the valley floor, with the Jal Shakti Department.
IMD (Meteorological Centre Srinagar), and road and rail owners (PW (R&B), NHAI, Indian Railways)	IMD's stations supply the rainfall records of Chapter 2. Road and rail owners would apply this Manual to road drainage (Chapter 6), culverts and linear works (Clause 1.5.7).

Commentary. Stormwater in Jammu and Kashmir is split between H&UDD, through the UBBL-2021, the master plans and the Development Authorities; the Municipal Corporations, Councils and Committees, through the drains vested in them; UEED and the Town Drainage wings, through the drains, sewers and pumping stations of Srinagar and the sewerage of Jammu; I&FC, through the rivers, nallahs, khads, embankments, flood spill channel and city channels, under section 81 of the Water Resources (Regulation and Management) Act, 2010 [section number to be confirmed]; LCMA and WUCMA, through the Dal, Nigeen and Wular; the PW (R&B) Department and NHAI, through the road drains; the dam operators, through the reservoirs of the Chenab and the Ravi; and the High Court, which treats itself as "Custodia Legis of river Jhelum and other water bodies". Srinagar shows why the split matters. A drain in the city may be built by UEED, cleaned by SMC's Town Drainage, emptied over the embankment by a pumping station run by either, and discharged into the Jhelum, the flood spill channel or a city channel whose bed and banks are I&FC's, or into the Dal, which is LCMA's; and it carries sewage, because the city could treat 32% of its sewage in 2024 (JKPCC, 2024). In Jammu the drains are largely the side drains of roads, which cover about 40% of the city, and the khads into which they run are recorded in the revenue records as "Gair Mumkin Khad" land that the Jammu Master Plan 2032 proposes to release in part (§§5.1.3, 12.2.3). The Municipal Acts of 2000 are understood to vest public drains in the local bodies (drainage sections not read [TBC]), but no rule or order found divides the drains, nallahs and khads between the bodies concerned [TBC]. Until such a rule is made, this Manual assigns the drainage elements as in Table 1.5, as Chapter 6 does for the drains themselves, and recommends that each town keep a register of its drains, nallahs, pumping stations and outfalls with an owner for each reach. The assignment is this Manual's working split for applying its clauses; it does not change any agency's powers.

Table 1.5 — Working assignment of drainage elements under this Manual

Element	Assigned to
Rivers (the Jhelum, the Tawi, the Chenab, the Ravi, the Ujh, the Basantar, the Devak and the others), nallahs and khads, with their beds and banks; the embankments; the flood spill channel and any supplementary channel; the city channels, such as the Tsunth Kol and the Padshahi Canal; canals and kuhls (कूहल; gravity irrigation channels; the "zamindari khuls" of the Act of 2010)	I&FC; within municipal limits the Municipal Corporation, Council or Committee desilts and clears the nallahs it cleans now; the land remains with its recorded owner
Drainage schemes, drains and dewatering (pumping) stations of Srinagar	UEED for planning, design and construction, and the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir for operation and maintenance, each reach and station on the register of drains
Drains of Jammu within the limits of JMC	JMC and the Sewerage and Drainage Division (West) of UEED; UEED's schemes at Bhathindi, outside the limits of JMC, with UEED until they are rationalised
Drains of the other towns	The Municipal Council or Municipal Committee concerned
Road drains, catch-water drains and culverts of roads	The PW (R&B) Department for its roads; NHAI for national highways
The Dal and Nigeen and the drains that LCMA holds in its area; Wular and its feeder channels; the wetland conservation reserves; wetlands under the Wetlands Rules, 2017	LCMA; WUCMA; the Wildlife Department; the Jammu and Kashmir Wetland Authority
Drains and storage of SDA, JDA, the Jammu and Kashmir Housing Board, the Smart City companies of Srinagar and Jammu, and colony developers, until handed over in writing	The body that built them
Reservoirs, their gates and releases, and their drawdown land	NHPC (Salal, Dul Hasti; Pakal Dul through its joint venture); JKSPDC (Baglihar); the operator of Ranjit Sagar

Element	Assigned to
Sewers, the interception of sewage from drains and nallahs, and sewage treatment plants (Clause 8.9)	UEED
Records of drainage land (Gair Mumkin Khad, nambal, rakh, kahcharai)	The Revenue Department

This Manual names departments and authorities as the statutes, orders and records name them. A manual that names one owner for each task does not fix institutions by itself, but it removes ambiguity about who signs what.

1.10 Variances and waivers

1.10.1 **Variance.** The Authority may grant a variance from a numeric requirement where the Applicant shows, through a report certified under Clause 10.6, that:

- (a) compliance is impracticable because of site conditions such as a high groundwater table, contaminated soil, rock, or a site area too small for the required facility; and
- (b) the proposed alternative gives equal or better performance at the downstream point of Chapter 5, or the shortfall is made up by fee-in-lieu or off-site works in the same catchment.

1.10.2 **Waiver.** The Authority may waive Chapter 4 detention requirements (not retention) where a hydraulic analysis certified under Clause 10.6 shows that the site discharges directly to the sea, or to a tidal reach with no flood-prone property downstream, and that undetained flow does not worsen the outfall-closed condition of Chapter 5. Jammu and Kashmir has no coast and no tidal reach, so no site in the Union Territory qualifies for this waiver. A site that drains to the Jhelum, the flood spill channel or a city channel through a gate, or only by pumping, as in Srinagar and the embanked towns of the valley, to a lake held by its outlet, such as the Dal or Wular, or to a reservoir or barrage pond, such as Salal, Baglihar or the Tawi barrage, is in the outfall-closed condition of Chapter 5 whenever the receiving water is high, and detention is not waived for it; nor is it waived for a site because it drains to a steep khad or nallah or down a hill slope.

1.10.3 **No variance or waiver.** No variance or waiver shall be granted for:

- (a) a sewage connection to a storm drain;
- (b) the lowest habitable floor level of Chapter 6;
- (c) any reduction of a waterbody setback below the Zone 1 minimum of Clause 7.4.7, or any fill or construction in the no-fill zone of Chapter 7; or
- (d) the retention requirement in a flood-sensitive catchment, except by fee-in-lieu under Clause 1.7.

1.10.4 **Procedure.**

- (a) The request shall be made on **Form 1-2** (Variance / Waiver Request) with the preliminary drainage report.
- (b) A Tier B authority shall refer any variance on a site of 1 ha or more to the State Stormwater Technical Committee.
- (c) A decision shall state its reasons and any conditions, and shall be entered in the public register of Clause 10.17.
- (d) A variance runs with the approval. It lapses if the approval lapses.

> **Commentary.** The 2006 APWA 5600 included a waivers section (5601.6), and Georgia allows waivers where downstream analysis shows a peak control is unnecessary. The waiver of Clause 1.10.2 is narrow: on a tidal coast, undetained flow can help by passing through before the tide closes the outfall, but only an analysis can show that. This Manual requires every decision to be published because publication deters case-by-case erosion of the standard; in Jammu and Kashmir the Srinagar Master Plan 2035 records that the plan of 1971–91 "triggered growth in west and southwest directions of Srinagar mostly in low lying areas, wetlands and flood

absorption basins adjacent to Flood Spill Channel", the Jammu Master Plan 2032 that the drainage channels "have fallen prey to the accelerated urban growth", and the High Court has had to order encroachments removed from the banks of the Jhelum and "the original width of the river Jhelum" restored (PIL 8/2017, orders of 2014 and 2015, as recalled in 2024).

1.11 Transition provisions

1.11.1 **Effective date.** This Manual takes effect for new applications **6 months** after notification (the effective date).

1.11.2 **Applications in process.** An application filed complete before the effective date may be decided under the rules in force when it was filed, if a decision is issued within 12 months of the effective date. Otherwise, this Manual applies.

1.11.3 **Phased start for Tier B.** In Tier B authorities, Chapters 4 and 5 apply from **24 months** after notification, except in flood-sensitive catchments, where they apply from the effective date.

1.11.4 **Public works.** DPRs sanctioned before the effective date may proceed as sanctioned. Any DPR revised or re-tendered after the effective date shall comply. Departments shall report non-compliant works in progress to the State Stormwater Technical Committee within 12 months.

1.11.5 **Before the annexes are issued.** Until an annex referred to in this Manual is issued, the Applicant shall use the method stated in the clause, with values agreed with the Authority and recorded in the drainage report.

Commentary. The 6-month lead time matches the lead time for NIH-DHAARA updates in Clause 2.14.2. Singapore gave a similar interval for its 2025 detention addendum (issued 16 Apr 2025, applied from 1 Oct 2025). The 12- and 24-month periods are set by this Manual to let Tier B authorities train staff and to let the State issue the design-aid tables (Clause 1.7).

1.12 Review and amendment

1.12.1 The State Stormwater Technical Committee shall review this Manual every **10 years**, and after any event that exceeds the 1% AEP design depth as set out in Clause 2.14.1.

1.12.2 Amendments shall be notified in the Gazette, published with a change log, and take effect 6 months after notification unless the notification states otherwise.

1.12.3 Any person may propose an amendment to the Committee. Proposals and the Committee's decisions shall be published.

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Annexes and forms

Annex / Form	Content
1A	List of Tier A authorities, with the boundaries of the Municipal Corporations and of the local planning areas of Srinagar and Jammu notified under the Jammu and Kashmir Development Act, 1970
1B	Maps of flood-sensitive catchments
1C	Policy Supplement: text of alternatives S-1 to S-5 and model council resolution
1D	Model UBBL-2021 amendment and model ULB bye-law
Form 1-1	Applicability Determination
Form 1-2	Variance / Waiver Request

CHAPTER 2

Design Rainfall and Design Storms

2.1 Purpose and scope

2.1.1 This chapter sets the rainfall inputs for every hydrologic calculation in this Manual: drain and inlet sizing (Chapter 6), retention and detention sizing (Chapter 4), downstream and tailwater analysis (Chapter 5), and waterbody and tank works (Chapter 7).

2.1.2 It specifies:

- (a) the approved sources of design rainfall depth and intensity;
- (b) how depths are converted between durations, between point and area, and from present to future climate;
- (c) how design storms (hyetographs) are constructed; and
- (d) the storms that must be applied to pre- and post-development conditions.

2.1.3 This chapter applies throughout Jammu and Kashmir. Where a Municipal Corporation, Municipal Council, Municipal Committee or Development Authority has adopted a stricter rainfall standard under Chapter 1, the stricter standard governs.

> **Commentary.** Most past drainage failures in Jammu and Kashmir trace to the rainfall input, not the hydraulics. Jammu and Kashmir shows how. No design storm, return period or runoff coefficient was found for the drains of any town in the Union Territory: the drainage master plan of Srinagar is reported to have modelled 767 km² without publishing one (as reported), and Jammu's storm-water DPR is still to be prepared (Jammu Master Plan 2032, §11.1.3). The published sources that seem to fill the gap do not. The panels of IMD Das et al. (2022) for Srinagar and Jammu repeat the generic curve that the paper prints for most of its cities: for Srinagar they give about 109 mm in 1 hour at 100 years, against 32 mm, the largest hour of its recording gauge, and about 360 mm in 24 hours, against 147.8 mm, its highest day since 1901 (IMD; CWC). The one IDF study of a town in the Union Territory with published constants, for Kupwara, does not reproduce its own tabulated intensities (Dar, Maqbool & Raazia, 2016; NEER reading). NIH-DHAARA gives 1-hour depths of only 0.10–0.16 of the 24-hour depth in its hill cells. The rainfall figures that circulate after a flood conflict: Jammu's fall of 26–27 August 2025 is given as 296 mm in the press, probably for 12 hours, and as 38 cm for 24 hours by IMD, Udhampur's as 629.4 mm, as 540 mm "in 12 hours" and as 63 cm, and the "previous record" quoted for Jammu in the same reports appears in neither of IMD's tables, which give 228.6 mm (5 August 1926) as its August record and 299.2 mm (31 July 1961) as its highest day (IMD; as reported). The CWC zone-7 report is the only regional sub-daily source, and on the outer-hill front of the Jammu division its plates lie below the falls of 1961, 1988 and 2025. Fixing one transparent source and method for the whole state is the main purpose of this chapter.

2.2 Definitions

Term	Meaning in this Manual
Annual exceedance probability (AEP)	Probability that a given rainfall depth is equalled or exceeded in any one year. A 1% AEP storm is the "100-year" storm. Both forms are used here: T-year = 1/AEP.
IDF / DDF	Intensity–duration–frequency and depth–duration–frequency relationships for a location.
Point rainfall	Rainfall at a single location, as measured by a rain gauge.
Design storm	A hyetograph (rainfall depth versus time) of stated AEP, duration and temporal pattern.
Critical duration	The storm duration that produces the largest peak flow, water level or storage requirement for the element being designed.
Areal reduction factor (ARF)	Ratio of catchment-average rainfall to point rainfall for the same AEP and duration.
SW monsoon season (JJAS)	June–September, the season of the Jammu plains and outer hills. Jammu receives 1,073.9 mm of its 1,401.9 mm a year (77%) in June–September, with 416.5 mm in July and 403.1 mm in August, and Katra 74% of 2,151.1 mm, with 666.0 mm in August (IMD, normals 1991–2020); the CWC zone-7 report gives Jammu 74% (CWC, zone 7, §2.4.1.2). IMD's normal date of onset at Jammu is 28 June and of withdrawal 21 September (new normals from 2020; 25 June and 22 September at Anantnag, 29 June and 22 September at Ganderbal); the two IMD documents that give the older normals disagree with each other. The monsoon covers most of the Union Territory by 30 June and withdraws from most of it by 1 October (IMD). Onset can be early: in 2021 it was declared on 13 June, about 18 days ahead of the usual date (as reported); actual dates for 2018–2026 were not obtained [TBC]. The antecedent moisture rule of Clause 2.11.4 refers to this season, with the additions for the valley floor below; the pre-monsoon deadline of 31 May is set ahead of the earliest onset (Chapter 10). No order found fixes a date for desilting; Jammu's practice of finishing the first phase "before the end of June" (as reported) is later than the deadline.
Western-disturbance and snowmelt season (Kashmir valley and the Pir Panjal; December–May)	Not a monsoon season, and the Manual does not treat the valley's rain as monsoon rain. Srinagar receives only 212.3 mm of its 697.5 mm a year (30%) in June–September, and its wettest month is March (104.6 mm) (IMD, normals 1991–2020); the CWC zone-7 report says that "Srinagar receives only 28% of the annual rainfall during south west monsoon season as against over 55% in the months of December - April in association with western disturbances" (CWC, zone 7, §2.4.1.2). Gulmarg, Pahalgam, Qazigund, Kokernag and Kupwara have their wettest month in March, and Banihal, Batote and Bhaderwah, on the Pir Panjal and in the Chenab hills, in February (IMD). Some of the largest falls on record are winter falls: Srinagar's highest day, 147.8 mm on 31 January 1930; Gulmarg's 293.4 mm on 20 February 1967 and 270.3 mm on 27 January 1957; Sonemarg's 300 mm on 27 February 1936 (CWC, zone 7, Annex 4.3); and the storm of 13 March 2007, which brought 261.9 mm to Katra, 145.2 mm to Jammu and 89.4 mm to Srinagar (IMD). How much of the winter falls at high stations was snow measured as water is not known (Clause 2.3.6(h)). The snow melts from March to May, and the water table of the valley is at its shallowest in May (CGWB); Srinagar ran a dewatering drive after snowmelt in January 2026 (as reported). This Manual adds to the season above, for sub-area JK-C, AMC III from 1 March to 31 May (Clause 2.11.4), a design case of 24–72 hours in March–April (Clause 2.3.6(g)), and a post-winter clearance and duty test of pumps by 15 March (Chapter 10). Above about 1,500 m snow and ice block inlets from December to March, and rain on snow adds to the runoff.
Storms outside the season	Large falls come in every month, and the largest floods of both divisions came in September, when monsoon moisture met a western trough (1988, 1992, 2014). Seven of the eleven annual 24-hour maxima in IMD's tables to 2012 fell in June–September and four in January–March (IMD). In October, Jammu recorded 160.0 mm on 5 October 1955 and Basohli 229 mm on 14 October 1955 (IMD; CWC, zone 7, Annex 4.3); in December, Banihal recorded 175.0 mm and Jammu 113.8 mm on 27 December 1967, and Srinagar 105.0 mm on 29 December 1990 (IMD); and in June, before the monsoon is established, Jammu recorded 114.8 mm on 23 June 1953 in one IMD table and Katra 147.9 mm on 30 June 2017 (IMD). Srinagar's thunderstorms peak in May (IMD), and its largest recorded hour, 32 mm, fell on 28 August 1975 (CWC, zone 7, Annex 4.4). Design statistics use annual maxima from all months, and no works deadline or operating rule shall assume that heavy rain is confined to June–September; the works calendar of Chapter 10 keeps standby to 31 October, and in JK-C from 1 March, for this reason.
Climate factor (CF)	Multiplier applied to present-day design depths to represent the design-life climate.
Approved source	A rainfall source listed in Clause 2.3.

2.3 Approved sources of design rainfall

2.3.1 **Primary source.** Design rainfall depths and intensities shall be taken from the National Institute of Hydrology, Roorkee **NIH-DHAARA** platform (Design Hydrology and Advanced Rainfall Analysis, nihdhaara.in). Use its IDF / frequency tools for the site's coordinates, for each duration and AEP required by Clause 2.4. In Jammu and Kashmir this clause is suspended until Annex 2A is published: Clause 2.3.6 sets the interim source.

2.3.2 **Station IDF.** A station-specific IDF relationship may be used in place of 2.3.1 only if all of the following hold:

- (a) it is derived from at least 30 years of recording-gauge (hourly or finer) data;
- (b) it has been published or approved by IMD, the State Hydrology Authority or the approving authority; and
- (c) the gauge is within 10 km of the site, with no major change of terrain or coastal exposure in between.

Where a station IDF is used, the design value shall be the **greater** of the station value and the NIH-DHAARA value.

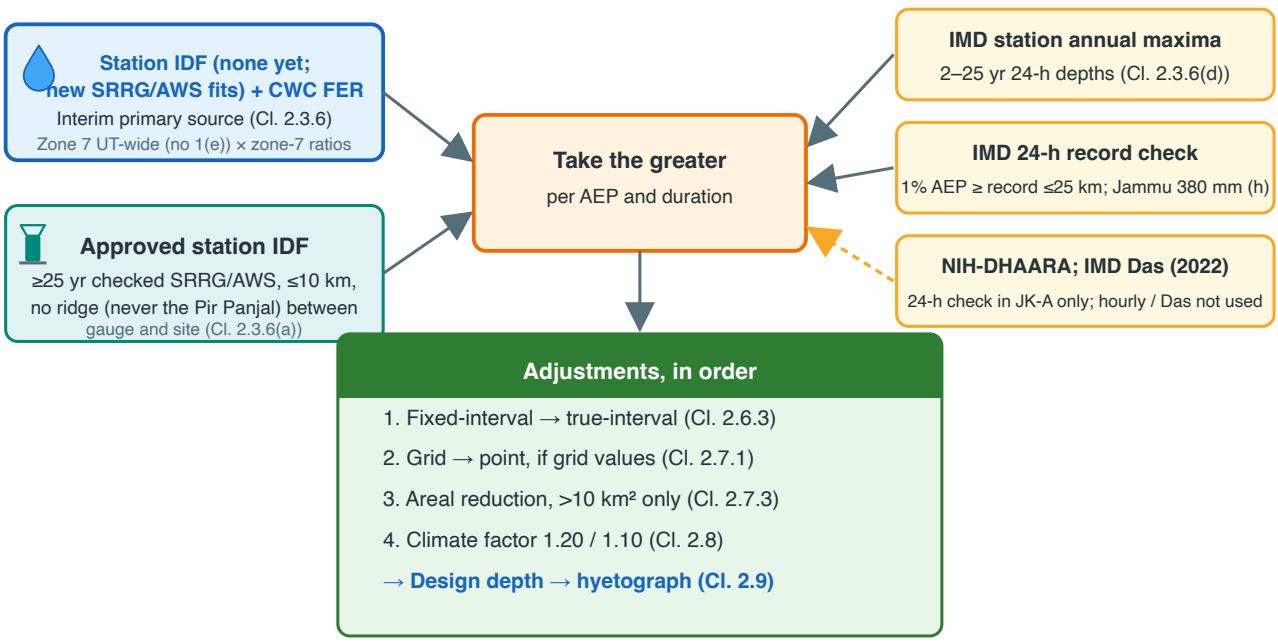
2.3.3 **Cross-checks (mandatory, not alternatives).** The designer shall report, but need not adopt, the following values for comparison:

- (a) the IMD isopluvial / IDF values of Das et al. (2022), *MAUSAM* 73(4), for durations of 1–24 h;
- (b) for catchments of 25–5,000 km², the 24-hour point rainfall from the CWC Flood Estimation Report for zone 7 (Western Himalayas), which covers the whole of Jammu and Kashmir, other than its snow-fed catchments, as applicable.

Where the design value is lower than the CWC zone 7 (Western Himalayas) value for the same AEP, the CWC value shall be adopted as a floor.

2.3.4 **Not permitted.** None of the following shall be used as a design rainfall source:

- (a) generalised all-India IDF formulae (for example Kothyari & Garde, 1992);
- (b) rainfall values that cite no source, including vendor or web-calculator tables;
- (c) single-event maxima; or
- (d) design intensities carried forward from a previous project without a stated AEP.



Jammu and Kashmir (Cl. 2.3.6): no station IDF yet; zone 7 plates × ratios; JK-C river stage governs locked outfalls; JK-D 1-h ≥ 62 mm, hazard-first.

Figure 2.1 — Design rainfall source hierarchy and adjustment sequence. Original drawing for this Manual.

2.3.5 **Version control.** Every submittal shall record the source, its version or access date, the coordinates queried, and the values extracted (Clause 2.13).

2.3.6 **Interim source in Jammu and Kashmir.** Until Annex 2A is published and confirms NIH-DHAARA, or an approved station IDF, for a zone, Clause 2.3.1 does not apply in Jammu and Kashmir, and design rainfall shall be taken as follows:

- (a) **Station IDF.** Where a station IDF fitted to a checked IMD recording-gauge (SRRG) or automatic weather station record of at least 25 years has been published in Annex 2B, it governs, within 10 km of the station and in the same sub-area of Annex 2A, for the durations and AEPs it covers, in place of (f), and subject to the 1-hour floor of (g)(i); the comparison of Clause 2.3.2 is then made with the 24-hour and longer depths of (c) to (e) and (h), and the CWC floor of Clause 2.3.3 still applies. A record is checked when its annual totals and annual maxima have been compared with the IMD normals and station extremes for the station, and every year that disagrees has been explained or removed. An IDF derived from daily data by the one-third rule (Clause 2.6.4) or by any other fixed ratio is not a station IDF. In Jammu and Kashmir Clause 2.3.2(a) is read with 25 years in place of 30 (set by this Manual, so that the recording gauges and automatic weather stations of the main towns can qualify once analysed), and the gauge shall not be separated from the site by a ridge, and in no case by the Pir Panjal (set by this Manual, because the Pir Panjal divides the two rainfall regimes of the Union Territory: Srinagar receives 697.5 mm a year, 30% of it in June–September, and its wettest month is March, while Banihal, just across the range, receives 1,364.8 mm with its wettest month in February, and Jammu 1,401.9 mm, 77% of it in June–September (IMD, normals 1991–2020)). No IDF has yet been published in Annex 2B, and no station IDF with usable constants was found for any town in the Union Territory: the panels of IMD Das et al. (2022) for Srinagar and Jammu repeat a generic curve (n); the IDF relations published for Kupwara do not reproduce their own tabulated intensities (o); the constants of the relations fitted to satellite rainfall for the Jhelum watersheds (Attar et al., 2025) were not seen [TBC]; and NIH-DHAARA's hourly depths are not used (m). The first data request of this Manual is for the annual maximum series and return-period tables, from recording gauges and automatic weather stations where they exist, of the IMD stations at Srinagar (42027), for the SMC and SDA area; Jammu (42056) and Jammu Airport, for sub-area JK-A; Udhampur IAF and Katra, for Udhampur, Katra and Reasi; Qazigund (42044) and Kokernag, for Anantnag and the south of the valley; Banihal (42045) and Batote, for Ramban, Batote and Banihal; Bhaderwah, for Doda and Bhaderwah; Gulmarg (42026) and Pahalgam, for sub-area JK-D; and Kupwara; and of the rain gauges and automatic weather stations at Kathua, Samba, Rajouri, Poonch, Anantnag, Baramulla, Doda and Kishtwar, to be fitted under this paragraph. With it goes a request for the hourly records of 26–27 August 2025 at Jammu, Jammu Airport and Udhampur IAF, of 3–7 September 2014 at every automatic weather station, and of Srinagar's convective storms, Jammu's first, because the 1-hour depths that (f) gives at Jammu have never been measured there. The years of recording-gauge and automatic weather station data held at each station are to be confirmed [TBC].

- (b) **Report, zone and sub-area.** One CWC report covers the whole Union Territory: the report for zone 7, Western Himalayas (WH/22/1994), which names Jammu and Kashmir among the States of the zone and drew on the ordinary rain gauges of 10 of its districts. No part of the Union Territory lies in subzone 1(e), Upper Indo-Ganga Plains, and no town in it needs a 1(e) cross-check: the contours of the zone-7 plates run across the Jammu plains to the international border and end south of Kathua, in Gurdaspur district of Punjab; the 1(e) plates stop at about Dera Baba Nanak, near 32.0° N, and do not reach the Union Territory; and Annex 4.3 of the zone-7 report lists the Jammu and Kathua districts without the mark it gives to districts partly outside the zone (CWC; positions read by eye on the plates). Lakhanpur, the southern tip of the Union Territory at about 32.28° N, lies inside zone 7. The rainfall zone and sub-area of the site are those of Annex 2A: zone **JK-Z1 Jammu plains**, with sub-area **JK-A Jammu plains, Kandi and Sirowal (Jammu–R.S. Pura–Akhnoor–Samba–Kathua)**; zone **JK-Z2 Pir Panjal–Chenab hills**, with sub-areas **JK-B Outer and middle hills (Udhampur–Katra–Reasi–Rajouri–Poonch–Ramban–Banihal)** and **JK-B1 Inner Chenab hills (Doda–Kishtwar–Bhaderwah)**; zone **JK-Z3 Kashmir valley**, with sub-area **JK-C Kashmir valley floor and Karewas (Srinagar–Anantnag–Pampore–Sopore–Baramulla–Kupwara)**; and zone **JK-Z4 High mountains**, with sub-area **JK-D High mountains and snow-fed catchments (Gulmarg–Pahalgam–Sonamarg–Gurez–Paddar; hazard-first)**. They fix the floor of (g)(i), the design cases of (g)(ii) and the

rule of (i); the ratios of (f) are the same in every sub-area. Uri and the Jhelum gorge below Baramulla, which the research for this Manual did not place, take the rainfall of JK-C with the hill rules of JK-B [TBC]. A catchment that crosses the line between two zones or two sub-areas of Annex 2A takes, at every duration, the higher value of the two (set by this Manual). The town lists of Annex 2A are a guide, and their boundaries are to be confirmed [TBC]. The Union Territory of Ladakh is outside Annex 2A; Supplement S01 applies there.

- (c) **24-hour depth, 2% and 1% AEP (50- and 100-yr).** The 24-hour point value at the site read from the 50- and 100-year isopluvial plates of the zone-7 report (Plates 9 and 10), whatever the catchment area. Where the site lies between two contours, the higher contour value is used; where it lies inside a closed high, a closed contour with no higher contour within it, the value is that contour plus one contour interval (40 mm); where it lies inside a closed low, a closed contour whose value is lower than the contours outside it, the value is the enclosing contour, never lower; and where the plate cannot be read at the site, the highest contour legible within 25 km of the site is used until the plate has been read for it [TBC] (all set by this Manual). The rule for a closed low is added for Jammu and Kashmir because the plates draw one over Srinagar, inside which no value is printed, and the city's record, 147.8 mm in a day since 1901, lies just below the 100-year enclosing contour of 160 mm (IMD). Plates are read by the coordinates of the site, not by the town labels. On the copy used for this Manual Plates 8 and 9 were registered on 25 graticule crossings, to about 0.01°, and the printed dots of Srinagar and Gulmarg fall on their positions; Plate 10 is misregistered and was read by transfer from Plate 9 on the printed town dots, with lower confidence; the scan is poor and its legends are illegible, so every reading is by eye to about one contour, and each is recorded on Form 2-1 with the contours on either side. For orientation only, the 50-year plate gives **a closed low over Srinagar**, inside the 120 mm contour, which the rule above takes as **120 mm** (100 mm at 25 years and **160 mm** at 100 years); about 120–160 mm at Gulmarg, Pahalgam, Baramulla, Sopore and Uri; about 160 mm at Anantnag and 160–200 mm at Kupwara, Poonch and Kishtwar; 200–240 mm at Qazigund, Kokernag, Doda and Bhaderwah, and at Sonamarg and Gurez, round **a closed high over Sonamarg** whose inner label, about 240 mm, is partly illegible [TBC]; 240–280 mm at Banihal, Ramban, Batote, Katra, Udhampur and Rajouri; about 240–280 mm at Jammu and Akhnoor, just inside the 240 mm line, and about 240 mm at R.S. Pura, Bishnah and Samba, on it; 280–320 mm at Reasi, round **a closed high of more than 320 mm at Mahore–Gulabgarh** on the southern flank of the Pir Panjal, which the rule above takes as 360 mm; and, at Kathua and Hiranagar, a value between 240 and 320 mm that could not be resolved [TBC]. The 100-year values are about one contour (40 mm) higher: about 160 mm at Gulmarg, 200 mm at Anantnag, 240–280 mm at Qazigund, 280–320 mm at Banihal, Ramban, Batote and Katra, about 280 mm at Udhampur and 320 mm at Reasi, with a closed cell of more than 360 mm on the Pir Panjal flank, which the rule above takes as 400 mm; the Jammu plains lie at about 240–280 mm on both plates. Where the Gumbel estimate of (d) for the station of the site is higher for the same AEP, it governs; the 24-hour depth is then checked under (h).

- (d) **24-hour depth, 50%, 20%, 10% and 4% AEP (2-, 5-, 10- and 25-yr).** The depth is the Gumbel (EV1) estimate from the annual maximum daily rainfall series, of all months, of the IMD station agreed with the Authority, with 30 or more years of daily record, checked as in (a), multiplied by the fixed-interval factor of Clause 2.6.3; the 4% AEP depth is not less than the 25-year plate value (Plate 8) read as in (c) (set by this Manual). IMD's tables give the daily records of the Union Territory's stations as: Srinagar (42027) and Gulmarg (42026) from 1901, Jammu (42056) from 1910, Banihal (42045) from 1961, Qazigund (42044) from 1962, Batote, Bhaderwah and Kupwara from 1977, Kokernag and Pahalgam from 1978 and Katra from 1980 (IMD, *Extremes … up to 2012*). The station is, for example, Srinagar for the SMC and SDA area, Ganderbal, Budgam and Pampore; Qazigund, with Kokernag as a check, for Anantnag, Bijbehara and Kulgam; Kupwara for Kupwara and Handwara; Jammu for sub-area JK-A; Katra for Katra and Reasi, and for Udhampur until the record of Udhampur IAF is confirmed; Batote for Ramban and Batote; Banihal for Banihal; Bhaderwah for Doda and Bhaderwah; and Gulmarg and Pahalgam for the local catchments of JK-D. No station serves Sopore and Baramulla; Srinagar is used, with Kupwara as a check, until the Authority agrees another [TBC]. No Gumbel fit to the annual maxima of any station in the Union Territory was found for this Manual [TBC]. The two IMD tables read for this Manual disagree on some monthly records: at Srinagar in September (102.4 mm on 1 September 1928 in one and 69.6 mm on 10 September 1992 in the other), at Jammu in June (114.8 mm and 92.3 mm), at Gulmarg in June (156.2 mm and 94.1 mm), and at Bhaderwah in August (74.6 mm and 124.6 mm) and September (164.4 mm and 170.2 mm) (IMD); IMD is to confirm which

series each belongs to before the stations are fitted [TBC], and until then the higher value is kept in the series. A day of record excluded under (h) is left out of the series, and the fit with it is reported beside the fit without it on Form 2-1 (set by this Manual).

- (e) **48- and 72-hour depths.** The Gumbel estimate from the annual maximum 2-day and 3-day rainfall series of the same station, with the fixed-interval factors of Clause 2.6.3, and not less than the 24-hour depth for the same AEP, as checked under (h). The 1% AEP 48- and 72-hour depths are, in addition, not less than the highest 48- and 72-hour falls recorded within 25 km of the site at a gauge that passes the tests of (h) (set by this Manual): at present those of September 2014 at Katra, 488.6 mm in 48 hours and 698.6 mm in 72 hours, and at Qazigund, 362.7 mm and 519.4 mm, as published by IMD's authors (Ray et al., 2015), which this Manual accepts for these durations until IMD's own table of 2- and 3-day records is obtained [TBC].

- (f) **Durations of 1 to 24 hours.** The 24-hour depth of (c) or (d), before the check of (h), multiplied at every AEP by the ratios of zone 7 in Table 2B.1: 0.425 at 1 hour, 0.600 at 3 hours, 0.725 at 6 hours, 0.790 at 9 hours, 0.845 at 12 hours, 0.895 at 15 hours and 0.935 at 18 hours, derived from the 10-year depths of the nine recording gauges of the zone with eight years or more of data (CWC, zone 7). They apply in sub-areas **JK-A**, **JK-B**, **JK-B1** and **JK-C**, and in the local catchments of JK-D that (i) allows, with no exception (set by this Manual).

  The zone-7 ratios are the highest of any report in the series; the report found them comparable at return periods beyond 5 years, and they are applied at every AEP. In the Kashmir valley they are consistent with the hours of record. At Srinagar, on the closed-low reading of 120 mm at 50 years, they give about 51 mm in 1 hour, against 32 mm, the largest hour of its recording gauge (28 August 1975), and about 40 mm, the largest hour of 1970–2005 (as quoted), so they are conservative by a factor of about 1.3–1.6; at Gulmarg they give about 51–68 mm, against 62 mm recorded on 9 September 1980 (CWC, zone 7, Annex 4.4). The low ratios of the storm of September 2014, 35 mm in 1 hour and 101 mm in 3 hours against 260 mm in 24 hours at the Kawa automatic weather station (ratios of 0.13 and 0.39), come from a long monsoon storm of about 340 mm in 14 hours in which the rain rates "remained less than 20 mm/h at other stations" (Ray et al., 2015); they describe how a long storm falls, not how large a short burst can be, and do not justify a lower ratio, the more so because the valley's own recording gauges show single-burst ratios of 0.48 at Srinagar and 0.63 at Gulmarg. No recording gauge in the Union Territory shows a lower 1-hour ratio for a storm of design size, so no sub-area is given one. In the Jammu division the ratio gives about 102–119 mm in 1 hour at 50 years at Jammu, Katra and Udhampur, a depth that no gauge there has measured: the zone-7 report used no recording gauge in the division, and no published hourly maximum for Jammu was found; the hourly records requested under (a) are to test it, and until then the ratio applies. NIH-DHAARA's hourly ratios are not used (m). Between the tabulated durations the ratio is interpolated on logarithmic axes; the 2-hour ratio, which the report does not give, is interpolated in the same way. The 24-hour depth itself is that of (c) or (d) as checked under (h).

- (g) **Short storms and the valley floor.** No absolute floor in millimetres is set for any sub-area other than JK-D, because the ratios of (f), applied to the plate depths, already give 1-hour depths at or above the hours of record in the Kashmir valley, and no hour has been recorded in the Jammu division against which a floor could be set. Two further rules apply (all set by this Manual):

  - (i) **High mountains.** In sub-area JK-D, for a local catchment designed under (c) to (h), the 1-hour depth for the 10% AEP (10-yr) and every rarer AEP shall be not less than 62 mm, the largest hour of the Gulmarg recording gauge (9 September 1980; CWC, zone 7, Annex 4.4), including where a station IDF governs under (a). The zone-7 ratio on the plate depths at Gulmarg, about 120–160 mm at 50 years, gives 51–68 mm, so that the plate alone can fall below an hour that has been measured; the floor binds wherever the 24-hour depth used is less than about 146 mm (62 mm divided by 0.425). The gauge's record is short, of at least five years but of a length the report does not print [TBC], so its largest hour is treated as no rarer than a 10-year depth, and the floor is not applied to the 50% and 20% AEPs, for which a short-record maximum would overstate the depth. This is the only floor in millimetres in the Union Territory.
  - (ii) **Kashmir valley floor.** In sub-area JK-C two design cases are run for every storage element and for every drain whose outfall is gated or pumped, and the more severe governs: a summer convective storm of 1 to 3 hours, of May to September, with the depths of (f) and the AMC of Clause 2.11.4; and a long western-

disturbance or snowmelt event of 24 to 72 hours, of March and April, with the depths of (c) to (e), AMC III and, where snowmelt is to be added, a melt rate agreed with the Authority and recorded on Form 2-1 [TBC]. Srinagar's thunderstorms peak in May, and its largest recorded hour fell on 28 August 1975, while its largest daily falls come in winter and spring, as on 31 January 1930 and 13 March 2007 (IMD; CWC). For any drain whose outfall the Jhelum, the flood spill channel, a city channel or a lake held by the river can close, the governing case is the river stage and the pump capacity of Chapter 5 (Clauses 5.8, 5.10 and 5.12), not the storm: the drain is checked with its outfall closed for the lock that Chapter 5 sets, of not less than seven days (Clauses 5.8.5(a) and 5.10), and its storage and pumps hold and remove what arrives while the outfall is closed. In September 2014 Srinagar's own rain was about 140–152 mm in four days, below its 100-year 24-hour depth, while the river that had received 400–600 mm over the catchments upstream held the city's outfalls shut and broke through its embankments (Ray et al., 2015); the breach of an embankment is a residual risk of Chapters 5 and 7, not a design case.

Where the floor of (g)(i) governs the 1-hour depth, the 2-hour depth shall be not less than the value interpolated on logarithmic axes between the 1-hour and 3-hour depths for the same AEP. The floor is a present-day, true-interval value: the fixed-interval factor of Clause 2.6.3 is not applied to it, and the climate factor of Clause 2.8 is. The rules of this paragraph are interim, to be revisited when Annex 2B publishes frequency analyses of the recording-gauge and automatic weather station records of the stations of (a), beginning with Jammu, Srinagar, Udhampur IAF and Gulmarg: if any shows 1- or 3-hour depths above those of (f) and (g) for a sub-area, a floor shall be set or raised for it; if together they show depths well below them, a reduction may be proposed to the State Stormwater Technical Committee. The depths of (f) and (g) are present-day, true-interval values once the fixed-interval factor has been applied to the 24-hour depth; the climate factor of Clause 2.8 is then applied.

- (h) **24-hour record check.** The 1% AEP (100-yr) 24-hour depth of (c) or (d) shall be not less than the highest qualifying 24-hour rainfall recorded at any station or district rain gauge within 25 km of the site, where that record is higher; the record is used as printed, without the fixed-interval factor, and is treated as a 1% AEP depth; the 2% AEP (50-yr) 24-hour depth is then not less than the 1% AEP depth so raised less one contour interval of the plates, 40 mm (all set by this Manual). A record qualifies only when it is printed by IMD (in *Extremes of Temperature and Rainfall for Indian Stations*, the all-time record pages of the Meteorological Centre Srinagar, a later IMD table or an IMD press release that names the gauge and the day) or in Annex 4.3 of the zone-7 report, which CWC prepared jointly with RDSO, IMD and the Ministry of Surface Transport; the number of years of data at its gauge is confirmed by an IMD table as at least 20; it was made in 1901 or later, or IMD has confirmed that the gauge that made it stood where the present gauge stands and was read in the same way; it falls in a month in which a fall of that size is plausible for the station; the location of its gauge is known; and it is not contradicted by another IMD table for the same gauge. A record that fails any test is excluded until IMD confirms what it lacks (set by this Manual). IMD's *Extremes* gives the data periods of the eleven stations of the Union Territory, so their records can count. **Jammu, 380 mm on 27 August 2025** (IMD, press release of 27 August 2025, which names Jammu and the 24 hours to 08:30), at a station whose daily record runs from 1910, counts: it is 81 mm above the station's previous highest day, 299.2 mm on 31 July 1961, and a new highest day on IMD's own tables (IMD). It raises the 1% AEP 24-hour depth within 25 km of the Jammu gauge, which takes in Jammu city, Nagrota, Gangyal, Bari Brahmana, R.S. Pura, Bishnah and Akhnoor, to **380 mm**, against a plate value of about 240–280 mm, and the 2% AEP depth to not less than **340 mm**; it is the largest change that any record makes to the plates in the series (NEER reading). IMD is to confirm that the "Jammu" of the release is the observatory (42056) and not Jammu Airport [TBC]. The figure of 296 mm given in the press for the same day, with a "previous record" for August 1973, is not used: 296 mm is most probably a 12-hour value, and that previous record appears in neither of IMD's tables, which give 228.6 mm (5 August 1926) as Jammu's August record (as reported; IMD). **Batote, 316.2 mm, and Katra, 292.4 mm, both on 25 September 1988** (IMD), count, and raise the 1% AEP 24-hour depth within 25 km of their gauges wherever the plate reading at the site is lower, for example at Udhampur, about 20 km from Katra, where the 100-year plate reads about 280 mm (NEER reading of distance). Srinagar's 147.8 mm (31 January 1930) counts and lies below the 160 mm of the closed-low reading; Qazigund's 206.0 mm (5 September 2014), Banihal's 205.6 mm (28 August 1997), Bhaderwah's 170.2 mm (5 September 1995), Kokernag's 149.5 mm (5 September 2014), Pahalgam's 115.8 mm (13 March 2007) and Kupwara's 108.1 mm (17 March 1978) count and lie below their plates; the disagreements between IMD's two tables listed under (d) raise no

plate whichever value holds (IMD). Excluded pending confirmation [TBC]: **Udhampur IAF, 63 cm on 27 August 2025**, which IMD's release names but whose gauge's period of record is in no IMD table read for this Manual, and for which the press gives 629.4 mm, 540 mm "in 12 hours" and a previous record of 342 mm (31 July 2019) (IMD; as reported). It is the first record to confirm: once its gauge is confirmed to have at least 20 years of record, it raises the 100-year 24-hour depth within 25 km of the gauge, in Udhampur, Ramnagar, Chenani and Katra (NEER reading of distances), to 630 mm, about 2.3 times the plate value of about 280 mm; until then the designer reports it on Form 2-1 beside the design depth as the stress case of sub-area JK-B, and an Authority may require works whose failure would endanger life within 25 km of the gauge to be checked against it (a recommendation of this Manual). Also excluded: **Gulmarg's 293.4 mm (20 February 1967) and 270.3 mm (27 January 1957)** and **Sonemarg's 300 mm (27 February 1936; CWC, zone 7, Annex 4.3)**, winter falls of which it is not known how much was snow measured as water, at sites of sub-area JK-D where (i) governs in any case; **Partapsinghpura's 305 mm (11 September 1941) and Babapura's 229 mm (27 February 1958)**, 52% and 43% of the annual normals of their gauges in one day, whose locations have not been found; **Gulabgarh's 371 mm (14 September 1906)**, because two places bear the name, one in Mahore tehsil of Reasi, where the closed high of the plates lies, and one in Paddar; **Poonch's 268 mm (31 August 1928) and Akhnoor's 249 mm (25 September 1917)**, one-day values of the zone-7 annex whose gauges' periods of record are not confirmed, of which Poonch's would raise the town's 100-year depth of about 200–240 mm; and the 277 mm of Kotli (2 July 1914), beyond the Line of Control, a data point of the report of 1994 only (CWC, zone 7, Annex 4.3). Until Annex 2A is published, the designer lists on Form 2-1 every record within 25 km of the site, with the tests it passes or fails. The check raises the 24-hour depth and, through (e), the 48- and 72-hour depths, in every sub-area, and in JK-D as a minimum for the study of (i). It does not raise the depths of (f) and (g) for 1 to 18 hours, because no hourly record of any of these falls exists, and multiplying Jammu's 380 mm by the ratio of (f) would give about 162 mm in 1 hour, a rate no gauge in the Union Territory has recorded; but if IMD confirms that some 296 mm fell at Jammu in about 12 hours on 26 August 2025, it exceeds the 12-hour depth that (f) gives there at 100 years, about 237 mm on a plate value of 280 mm, and Annex 2B shall set a 12-hour floor for JK-A [TBC]. The check is made because the plates cannot be relied on in the tail on the outer-hill front of the Jammu division, where the falls of 1961, 1988 and 2025 reach or exceed the 100-year plate values (NEER reading).

- (i) **Snow-fed catchments and sub-area JK-D.** The zone-7 report states that its unit hydrograph is not to be used for design floods in the snow-fed area of the zone, and that its recommendations are to be applied with caution where catchments are covered by snow and glaciers (CWC, zone 7). In sub-area JK-D (High mountains and snow-fed catchments), and in any catchment elsewhere with permanent snow or a glacier within it, such as the upper catchments of the Sind above Sonamarg, the Lidder above Pahalgam, the Kishanganga at Gurez, the Warwan and the Marusudar, and the Chenab above Kishtwar, whose headwaters rise in Lahaul, outside the Union Territory, the design is hazard-first: the design rainfall and design flood are site-specific, the method, data and values are agreed with the Authority and I&FC and recorded on Form 2-1, and they are not less than the values of (c) to (h) for the rain falling on the part of the catchment below the snow [TBC]. For a local catchment wholly below the snow and without a glacier, such as the slopes of Gulmarg or Pahalgam, (c) to (h) apply as in JK-B, with the floor of (g)(i). No design in JK-D, and no design in any sub-area for a site with a glacier, a glacial lake, a moraine- or landslide-dammed lake, an avalanche path or a mapped debris-flow fan in the catchment above it, is complete without a glacial lake outburst flood (GLOF), landslide-lake, debris-flow and avalanche screening recorded in the drainage report: it identifies the glacial lakes, moraine dams, landslide dams, avalanche paths and debris-flow fans upstream, from the glacial lake monitoring of CWC and the hazard and landslide maps of J&K SDMA and GSI where they exist [TBC], and states whether the site lies on their flow path; where it does, the siting, setback and floor-level rules of Chapters 6 and 7 govern, because no drain is sized to carry a debris flow or an outburst (all set by this Manual). The disasters of the high valleys have been floods and debris flows that the gauges did not measure: on 8 July 2022 a flood at the Amarnath cave killed 16 people while the automatic weather station 50 m below the cave recorded 25 mm in the hour (MoES; as reported); on 14 August 2025 a cloudburst at Chasoti, on the Machail route in Paddar, killed more than 60 people where there was no gauge (as reported); and in February 2005 a snow blizzard at Waltengu Nad in Kulgam killed 175 (CAG, 2016).

- (j) **Cloudbursts.** The Ministry of Earth Sciences considers a cloudburst to be rainfall "at the rate of 10 cm/ hour or more over a geographical area of approximately 20-30 square km" (Lok Sabha Starred Question *158, 27 July 2022). No design rule is drawn from the term. No gauge in the Union Territory was found in a primary source to have recorded 100 mm or more in an hour: the largest hours on record are 62 mm at Gulmarg (1980), 35 mm at Kawa (2014) and 32 mm at Srinagar (1975) (CWC; Ray et al., 2015), and the 25 mm recorded below the Amarnath cave on 8 July 2022 "does not satisfy the criteria for cloud burst" (MoES). The bursts of Chasoti (14 August 2025), Jodh Ghati in Kathua (16–17 August 2025) and Dachhan in Kishtwar (28 July 2021) were not measured (as reported), and the "more than 27 cloudburst or cloudburst-like incidents" reported for July 2026 are counts of damage reports, not measurements (as reported). The 1-hour design depths of (f) at 50 and 100 years, about 102–136 mm in JK-A and on the outer front of JK-B before the climate factor, are of the same order as the threshold, so a burst of that size is within the range for which the major system of Chapter 6 is checked. What a burst does in a steep hill catchment that a design storm does not represent is to bring down boulders, slope debris and muck in its first minutes; the floods of the Chenab and the Tawi in August 2025 were reported to have been worsened by muck dumped from road and project works (as reported). In such catchments the capacity of inlets, debris racks and culverts to stay open governs more than the conveyance of the drain, and Chapters 6 and 9 size them for it.

- (k) **Durations below 1 hour.** No sub-hourly frequency analysis for any station in the Union Territory was found in research for this Manual. Until Annex 2B gives one, the ratio of the depth for a duration below 1 hour to the 1-hour design depth is agreed with the Authority, from a published recording-gauge analysis whose source is stated, and recorded on Form 2-1 [TBC]; the average intensity for a duration below 1 hour shall be not less than the 1-hour design intensity for the same AEP (set by this Manual). The zone-7 report puts 73% of a 3-hour storm, and 52% of a 6-hour storm, in its first hour (CWC, zone 7, Annex 4.1); the storm of September 2014 at Kawa was flatter, with 101 mm, about 30% of some 340 mm, in its wettest 3 hours (Ray et al., 2015; NEER reading).

- (l) **Order of depths.** For the same AEP, no depth shall be less than the depth for a shorter duration.

- (m) **NIH-DHAARA.** NIH-DHAARA was queried at 22 town cells of the Union Territory for this Manual (dataset IMDAA, 13 November 2026). Its 24-hour depths are close to the plates at Srinagar (140 mm at 50 years) and higher than the plates across the Jammu division (334 mm at 50 years and 374 mm at 100 years at Jammu, 388 mm and 435 mm at Udhampur, and 411 mm and 459 mm at Kathua). In sub-area JK-A its present-day 24-hour depths at the site are reported on Form 2-1 beside the interim values, as a cross-check only. In the other sub-areas it is not used or reported. Its 1-hour depths are not used anywhere: in its hill cells they are 0.10–0.18 of the 24-hour depths of the same cells (0.10 at Ramban), and in the plains 0.21–0.27, below the ratio of (f). Its projected depths are not used under Clause 2.8.4; the ratio of its projected to its present-day depths may be reported as a check on the climate factors of Table 2.2, which apply.

- (n) **IMD Das et al. (2022).** The paper has panels for Srinagar (xxvi) and Jammu (xii). Both repeat the generic curve that the paper prints for most of its cities and are not station data: for Srinagar they give about 109 mm in 1 hour at 100 years, against the 32–40 mm recorded, and about 360 mm in 24 hours, against a highest day of 147.8 mm in more than a century (IMD; CWC; NEER reading). The cross-check of Clause 2.3.3(a) is recorded on Form 2-1 as not available, and the paper is not used as a value, a check or a floor.

- (o) **Earlier design values.** No design storm, return period, runoff coefficient or drain standard was found for the drains of any town in the Union Territory. The drainage master plan and DPR of Srinagar, for 767 km², publish none (as reported); the Srinagar Master Plan 2035 sets benchmarks of full coverage and no waterlogging without a return period (§13.3); the storm-water DPR of Jammu has not been prepared (Jammu Master Plan 2032, §11.1.3); and the World Bank's flood recovery project designed its roads and bridges to the guidelines of the Indian Roads Congress (JTFRP, 2015). Road drains follow IRC:SP:42-2014 (10-year drains and 25- or 50-year culverts on national and State highways; Chapter 6) and IRC:SP:48. The IDF relations published for Kupwara (Dar, Maqbool & Raazia, 2016) give 22–31 mm an hour at 100 years for 0.16 hours, where the paper reports 81.13 mm an hour, and plot hours where the text says days (NEER reading); they are cited as existing, and not used. The return periods of Table 2.1 and the depths of this clause apply.

- (p) **Other clauses.** Where Clauses 2.3.2, 2.6.1, 2.7.1 and 2.13, Annexes 2A to 2C and Form 2-1 refer to the NIH-DHAARA value, the value under this clause is meant.

Commentary. NIH-DHAARA is a national, publicly accessible product from a Government of India institution, and it can be queried at any point in the State. That makes it a reproducible default that an approving authority can check. NIH-DHAARA's sub-daily values are derived from hourly records, not disaggregated from daily totals. That makes it the only public source suitable for sizing drains, which depend on short-duration intensity. Its values should still be checked against the long IMD daily record at 24 hours and longer (Annex 2A). In Jammu and Kashmir the platform has not yet been shown to meet that purpose. It was queried at 22 town cells of the Union Territory for this Manual: its 24-hour depths are close to the plates in the Kashmir valley and higher than them in the Jammu division, but its 1-hour depths are only 0.10–0.18 of its 24-hour depths in the hill cells, and 0.21–0.27 in the plains, where the recorded hours of the valley and the zone-7 ratio are higher. A source that breaks down at the durations that size drains cannot be adopted, so Clause 2.3.6 uses the CWC zone-7 report and the IMD station records until Annex 2A has been done, and allows NIH-DHAARA's 24-hour depths as a cross-check in the Jammu plains only. Jammu and Kashmir is the third mountain edition of the series and the first with two rainfall regimes, the south-west monsoon of the Jammu division and the western disturbances and snowmelt of the Kashmir valley, and with a valley-floor city behind river embankments, and three things set its interim source apart. First, one hill report covers the whole Union Territory, with no plains report anywhere: the 1(e) plates stop south of the border, so no floor of the plains applies. The Union Territory's own gauges carry little weight in the report: its annex of recording-gauge maxima has two gauges in Jammu and Kashmir, at Srinagar and Gulmarg, and none in the Jammu division, and one of the six catchments on which its unit hydrograph rests, the Sewa in Kathua district, drains the Union Territory (CWC, zone 7). The zone-7 ratio of 0.425 at 1 hour is consistent with the hours recorded in the valley, 32 mm at Srinagar against about 51 mm by the ratio at 50 years, and 62 mm at Gulmarg against 51–68 mm, which is why Clause 2.3.6(f) keeps it everywhere and (g)(i) adds a floor only in the high mountains; Srinagar sits in a closed low of the plates, which its record supports (147.8 mm, its highest day since 1901, below the 160 mm contour of the 100-year plate), so the low is kept and read at its enclosing contour. Second, the plates fail on the outer-hill front of the Jammu division. Jammu recorded 380 mm on 27 August 2025 and 299.2 mm on 31 July 1961, Batote 316.2 mm and Katra 292.4 mm on 25 September 1988, and Udhampur IAF 63 cm on 27 August 2025, against 100-year plate values of about 240–320 mm (IMD). Clause 2.3.6(h) answers that with a check rather than a new statistic, as the series does elsewhere. Here IMD's tables confirm the record lengths of the main stations, so Jammu's 380 mm counts and sets the 100-year depth near Jammu, and Batote's and Katra's fill in the front; Udhampur's 63 cm waits for IMD to confirm its gauge, and meanwhile is the stress case of the outer hills. The test of plausibility keeps out the winter falls of Gulmarg and Sonemarg, which may be snow measured as water, and the one-day values of the zone-7 annex at Partapsinghpura and Babapura, which are half their gauges' annual rain. The check stops at 24 hours for the 1-hour design, because a record day says nothing about its peak hour. Third, on the Kashmir valley floor the governing case is not the storm. Srinagar's own rain in September 2014 was about 140–152 mm in four days, below its 100-year depth, while the Jhelum, fed by 400–600 mm on the catchments upstream, shut its outfalls and broke through its embankments; and the city's pumps, about 2,300 cusecs in 2026 (as reported), can remove only about 0.3 mm an hour from its 767 km² (NEER reading). That is why Clause 2.3.6(g)(ii) sends every gated or pumped drain to the outfall-closed rules of Chapter 5, and why the valley floor is also checked for the long falls of March and April. The hazards of the high mountains and of the Chenab hill towns are not all rainfall either: the floods at the Amarnath cave (2022) and Chasoti (2025), which no gauge measured, and the subsidence of Thathri (2023) and Pernote (2024), where surface water entered the slope, are represented by no design storm, which is why Clause 2.3.6(i) sets a screening and not a depth, and why the hill rules of Chapters 4, 6 and 8 keep water out of slopes. The interim rules for the more frequent AEPs, the 48- and 72-hour depths, the reading of the plates, the rule for a closed low, the sub-area of each town, the 1-hour floor of JK-D, the two design cases of the valley floor, the record check, the snow-fed and debris-flow rules and durations below 1 hour are set by this Manual. Several points are unresolved. The plate values were read by eye, to about one contour, on a scan of about 100 dots per inch whose legends cannot be read, with Plate 10 misregistered; the value at Kathua and Hiranagar was not resolved, and the inner labels of the closed highs at Sonamarg and at Mahore–Gulabgarh are uncertain [TBC]. The two IMD tables disagree on five monthly records; the window of Jammu's fall of 26–27 August 2025 (296 mm or 380 mm), the period of record of

the Udhampur IAF gauge, the location of Gulabgarh and the nature of the winter falls at Gulmarg are to be obtained from IMD (Clause 2.3.6(h)). No storm-drain DPR for any town of the Union Territory with its design rainfall analysis was found for this Manual [TBC], so the design basis of the drainage master plan of Srinagar could not be compared with this clause.

2.4 Design return periods (summary)

2.4.1 Design AEPs are set in the chapters for each element. They are summarised here so that the correct rainfall is extracted at the start of design.

Table 2.1 — Design return periods (summary)

Element	Design AEP (return period)	Check event	Chapter
Minor drains: Srinagar, Jammu, Anantnag, Baramulla and Udhampur core and high-density areas	10% (10-yr)	1% (100-yr) overland path	6
Minor drains: other Class I urban areas	20% (5-yr)	1% overland path	6
Minor drains: other areas	50% (2-yr)	1% overland path	6
Arterial roads and crossings	2–4% (25–50-yr)	next higher AEP	6
Collector / local roads	4% / 10% (25 / 10-yr)	2% / 4% (50 / 25-yr), plus the 1% overland path	6
Major (overland) system	1% (100-yr)	—	6
Retention volume	Percentile daily rainfall (Clause 2.10)	—	4
Detention: standard catchments	50%, 10%, 1% (2, 10, 100-yr)	1% emergency spillway	4
Detention: flood-sensitive catchments	Mixed-frequency rule, Clause 2.11	1%	4
Building floor levels	1% + 0.5 m freeboard	—	6
Detention emergency spillway	1% with outlet blocked	0.2% (500-yr) where high hazard	4

Commentary. These values exceed the CPHEEO (2019) national advisory minimums of 5-yr (Class I cities) and 2-yr (other areas). CPHEEO allows a State to set higher values. The values are set in Chapters 4 and 6, and the table is reproduced here for convenience.

2.5 Design durations

2.5.1 **Conveyance elements** (pipes, open drains, inlets, culverts) shall be designed with the intensity for a duration equal to the time of concentration (Tc) of the contributing area (Chapter 3). The minimum duration is **10 minutes**.

2.5.2 **Storage elements** (detention, retention, tanks, pumped sumps) shall be checked for every duration in the set {1, 2, 3, 6, 12, 24, 48, 72 h}. The largest required storage or water level governs. The 24-, 48- and 72-hour storms are **mandatory** checks at every site, whatever the critical-duration result.

2.5.3 **Tidally influenced outfalls.** For storage draining to a tidally influenced outfall (Chapter 5), the 48- and 72-hour storms shall also be run with the tailwater boundary of Clause 2.12.

> **Commentary.** Jammu and Kashmir's worst floods have come when days of rain fill the soils, marshes and lakes and raise the rivers. In September 2014 Qazigund received 599.8 mm in four days and Katra 698.6 mm in three, and the week of 4–10 September brought more than the average rain of a whole monsoon season to six of the eighteen districts of the State as it then was (Ray et al., 2015); Srinagar itself received only about 140–152 mm in 3–6 September, but the Jhelum, fed by the rain over the south Kashmir catchments, rose to its highest levels at Sangam on 4 September and at Ram Munshi Bagh on 8 September, broke its embankments and kept parts of the city under water for up to 25 days (CWC data as transcribed by SANDRP; Malik, 2021). In August 2025 Jammu had received 190.4 mm on 24 August, three days before its 380 mm (as reported; IMD), and August 1996 brought 1,261.3 mm to Katra and 1,087.5 mm to Jammu in the month (IMD). In the Kashmir valley and the Pir Panjal the long falls are those of western disturbances and snowmelt, as in March 2007, and the subsidence at Thathri followed a reported 201.2 mm in 20–31 January 2023 (as reported). The khads and nallahs rise within an hour of a burst, but the river stage that closes Srinagar's outfalls, the water table of the valley floor and the Sirowal, and the slopes of the hill towns are set by the whole wet spell, not its peak hour. A rule based only on critical duration, applied to a small site, picks a 1–2 hour storm and misses this failure mode. That is why the long-duration checks are mandatory.

2.6 Sub-daily rainfall

2.6.1 Where NIH-DHAARA or an approved station IDF provides values directly for the required duration, those values shall be used.

2.6.2 Where only daily (24-hour) depths are available for a duration below 24 hours, the sub-daily depth shall be derived using the **ratio set of Annex 2B**. These are duration-to-24-hour ratios calibrated to Jammu and Kashmir recording gauges. They shall not be lower than the ratios of the CWC Flood Estimation Report for zone 7 (Western Himalayas), which covers the whole of Jammu and Kashmir. The IMD Das et al. (2022) panels for Srinagar and Jammu repeat a generic curve and are not used.

2.6.3 **Fixed-interval adjustment.** Depths from fixed observation windows (for example 08:30–08:30 IST daily data, or clock-hour data) shall be converted to sliding-window ("true interval") depths:

- 1.13 for a single fixed observation interval;
- 1.04 for 2 intervals;
- 1.02 for 3–4 intervals.

This adjustment does not apply where the approved source already gives true-interval values.

2.6.4 The empirical relationship P(t) = P(24)·(t/24)^(1/3) shall not be used for design unless Annex 2B confirms it for the zone concerned.

> **Commentary.** The one-third power rule is common in Indian project reports, but no primary IMD source for it was found during research for this Manual. It applies one fixed curve shape everywhere: P(1h)/P(24h) = 0.35, P(3h) = 0.50, P(6h) = 0.63 and P(12h) = 0.79. It cannot represent the difference between a short convective burst and a long SW monsoon soak, and it tends to understate short-duration depths in convective coastal storms. Annex 2B shall tabulate the NIH-DHAARA ratios P(t)/P(24h) against these values by zone. That comparison shows whether the rule is acceptable anywhere in the State and corrects older daily-based analyses. The fixed-interval factors are the standard WMO (Hershfield) values. The IMD 2022 study applies similar clock-hour to any-hour corrections.

2.7 Point, grid and areal rainfall

2.7.1 Design depths are point values. Where an approved source provides grid-average values (for example 0.25° cells), they shall be converted to point values with the grid-to-point factors in Annex 2C before use.

2.7.2 For catchments **≤ 10 km²**, ARF = 1.0.

2.7.3 For catchments **> 10 km²**, apply ARF as follows:

- for 25–5,000 km² in zone 7 (Western Himalayas): use the ARF curves of the applicable CWC Flood Estimation Report;
- for 10–25 km²: interpolate linearly between ARF = 1.0 at 10 km² and the CWC value at 25 km².

2.7.4 An ARF shall never be applied to storage design for a single development site.

> **Commentary.** Gridded and district-average return levels are much lower than point values. For example, in the 24 hours to 08:30 on 27 August 2025 IMD recorded 38 cm at Jammu and 63 cm at Udhampur IAF, about 35 km apart, but 17 cm at Samba and 12 cm at Kathua (IMD); and in 4–10 September 2014 the district totals ran from 605.5 mm in Udhampur to 148.0 mm in Srinagar, while Qazigund's gauge alone recorded 599.8 mm in four days (Ray et al., 2015). Single storms are patchy at a scale that no reanalysis cell of about 12 km or district average can show, least of all across the Pir Panjal, and the annual normals of the gauges run from 2,151.1 mm at Katra and 1,401.9 mm at Jammu to 1,364.8 mm at Banihal and 697.5 mm at Srinagar (IMD, normals 1991–2020). Neither error can be corrected without the factors of Annex 2C. Using grid values as point values without correction would make site-level design unsafe.

2.8 Climate factor

2.8.1 Until a statewide future-climate rainfall product is adopted, present-day design depths shall be multiplied by the following interim climate factors:

Table 2.2 — Interim climate factors

Duration	Climate factor (CF)
≤ 6 h	**1.20**
> 6 h to 72 h	**1.10**

2.8.2 The CF applies to all elements with a design life of more than 25 years. For temporary works (design life ≤ 5 years), CF = 1.0.

2.8.3 The climate factor does not apply to the retention depth (Clause 2.10) or to the water quality volume depth (Chapter 8). Those depths are percentile or frequent-event statistics of everyday rainfall, not AEP design values.

2.8.4 Where NIH-DHAARA, or a product adopted on review under Clause 2.14, provides projected future-climate depths, those depths shall replace the interim factors.

> **Commentary.** CPHEEO (2019) considers a fixed climate factor "not feasible" nationally and recommends trend testing instead. That leaves designers without a usable number. The 1.20 short-duration factor matches the UK value cited by CPHEEO itself. It is at or below published projections for India: Ali and Mishra (2018) project 3-

hourly 100-year maxima rising by about 20% at 1.5 °C and 25% at 2.0 °C of warming. No design uplift factor has been adopted in Jammu and Kashmir. The State Action Plan on Climate Change of 2012 (often cited as 2013) gives none; it projects that "The intensity of rain fall is likely to increase by 1-2 mm/ day" and that annual rainfall will rise by 5% to 13% by the 2030s, "with some areas of Jammu and Kashmir showing an increase of up to 50%", and it asks for a storm water management plan without a number (Government of Jammu and Kashmir, 2012); a revised plan was reported in draft in February 2026 (as reported; not read [TBC]). The observed trends are mixed: annual rainfall has decreased at several stations of the Kashmir valley since 1980, most in spring (Zaz et al., 2019), while Srinagar's extreme indices show "a slight increase" over 1969–2018 (Dar et al., 2021). Recent extremes have not fallen: September 2014 set new 24-hour records at Qazigund, Kokernag and Anantnag and new 48- and 72-hour records at Katra (Ray et al., 2015), and August 2025 brought 380 mm to Jammu and 63 cm to Udhampur IAF and new highest levels on the Tawi at Sidhra and the Jhelum at Khanabal (IMD; CWC data as transcribed by SANDRP). In the Jammu division the larger correction is to the base value, not the uplift: Jammu's 380 mm is 36–58% above its 100-year plate reading of about 240–280 mm before any climate factor (NEER reading), against 10–20% for the factors of Table 2.2, and Clause 2.3.6(h) makes that correction through the record check. NIH-DHAARA was queried for 22 cells of the Union Territory for this Manual (13 November 2026), but its projected depths were not compared with its present-day ones (Clause 2.3.6(m)). The factors of Table 2.2 are therefore interim values, not Jammu and Kashmir estimates.

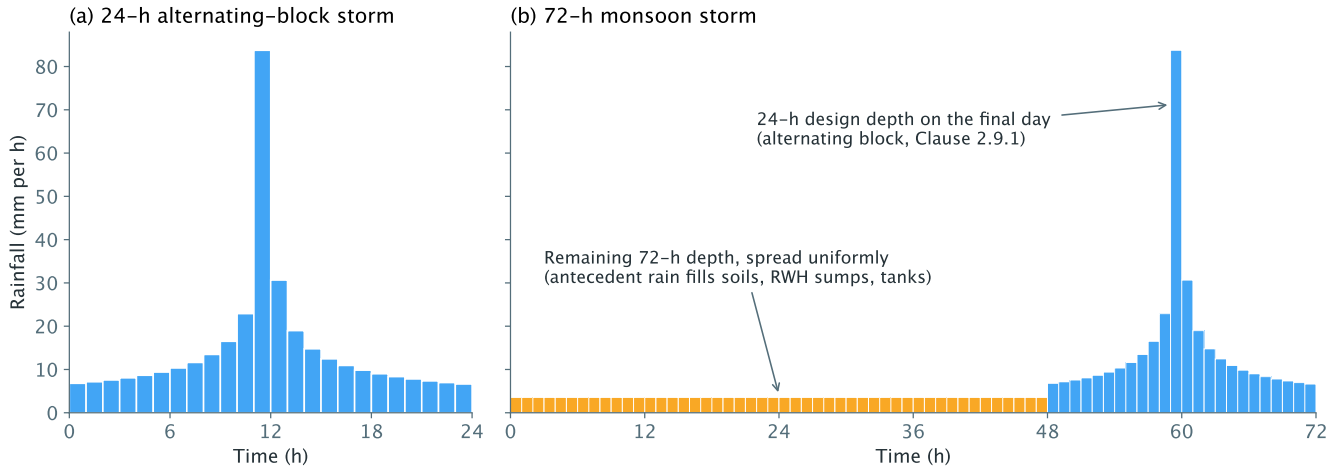
2.9 Temporal patterns (design hyetographs)

2.9.1 **Storms up to 24 hours.** Use the nested **alternating-block** method:

- construct the storm from the same IDF relationship (after the climate factor), at time steps no longer than Tc/3 and no longer than 15 minutes;
- place the peak block at **50%** of the storm duration.

2.9.2 **48- and 72-hour storms (SW monsoon pattern).** Construct as follows:

- (a) The total storm depth equals the design depth for the full duration (48 or 72 h).
- (b) The **final 24 hours** contain the 24-hour design depth for the same AEP, distributed by the alternating-block method of 2.9.1.
- (c) The remaining depth (total minus the 24-hour depth) is spread uniformly over the preceding 24 or 48 hours.



Illustrative — not design values (100-yr 24-h = 350 mm, 72-h = 520 mm, hourly blocks).

Figure 2.2 — (a) 24-hour alternating-block design storm; (b) 72-hour SW monsoon design storm with the 24-hour design depth on the final day. Illustrative depths only. Original drawing for this Manual. The alternating-block method follows Chow, Maidment & Mays, Applied Hydrology (1988), §14.4.

2.9.3 **Other temporal patterns.** Huff-type or mass-curve patterns derived from Jammu and Kashmir storms may be used instead of 2.9.1 and 2.9.2 only after they are published in Annex 2D. SCS Type I, IA, II and III distributions shall not be used.

2.9.4 **Large catchments.** For catchments of 25–5,000 km², the CWC Flood Estimation Report time-distribution curves may be used, and a sensitivity run with 2.9.1 shall be reported.

> **Commentary.** The alternating-block storm embeds every shorter-duration design intensity in one hyetograph. That makes it conservative and consistent across durations. The 72-hour pattern puts the most intense day last. This reproduces the sequence in both of Jammu and Kashmir's rainfall regimes: by the time the largest falls arrive in late August or September, the Jammu plains have had weeks of monsoon rain, the Sirowal is waterlogged and the Tawi, the Chenab and the Ujh are high; in the Kashmir valley a September storm, as in 1992 and 2014, or a western disturbance of March or April after snowmelt, falls on a valley floor whose water table is within 2 m of the surface, on lakes and marshes already full and on a Jhelum already near its flood-declaration stage. SCS distributions are excluded because they come from US convective and Gulf storm data and have no basis in Jammu and Kashmir records.

2.10 Retention rainfall depth

2.10.1 The **retention design depth** is the 24-hour rainfall depth not exceeded on **90%** of days with rain (≥ 2.5 mm) in the long-term record, read from the zone value in Annex 2E.

2.10.2 The site must retain on site the runoff from this depth (Chapter 4). Retention earns a detention credit equal to the reduction in required detention storage found by routing with the retention in place (Clause 4.4.6). The credit is not the retained volume subtracted one-for-one.

> **Commentary.** This follows the Kansas City Metro APWA 5600 (2025.01) Required Retention Volume concept and Georgia's 1.0-inch runoff reduction standard. Both are based on percentile storms. A percentile depth is a statistic of everyday rainfall, not an AEP value, so it is computed from the daily record rather than from the frequency curves.

2.11 Design storms for pre- and post-development comparison

2.11.1 **Same storm for both scenarios.** Pre- and post-development runs shall use the same design storms:

- same AEP, duration, temporal pattern and climate factor;
- same antecedent moisture condition (Clause 2.11.4).

The two runs differ only in land surface parameters and Tc.

2.11.2 **Standard catchments.** For each of the 50%, 10% and 1% AEP storms and each duration in Clause 2.5.2:

> $Q_{post}(T) \le 0.9 \times Q_{pre}(T)$

2.11.3 **Flood-sensitive catchments** (as listed in Chapter 4: the catchments of Srinagar behind the Jhelum embankments, of the towns of the upper and lower Jhelum and Wular, of Jammu's khads and the Tawi, of Kathua–Hiranagar, Samba, the Sirowal towns and Akhnoor, of Udhampur and Katra, and of the hill towns of the Chenab valley, and any catchment notified by the authority). The **mixed-frequency rule** applies:

> Q_{post}(1% AEP, 100-yr) ≤ Q_{pre}(10% AEP, 10-yr), and Q_{post}(50% AEP, 2-yr) ≤ Q_{pre}(50% AEP, 2-yr),

The post-development peak is checked for each duration in Clause 2.5.2. The caps are taken at the **pre-development critical duration**. The 10-yr cap is the largest pre-development 10-yr peak over all durations, and the 2-yr cap is the largest pre-development 2-yr peak over all durations. Each cap applies to every post-development duration.

2.11.4 **Antecedent moisture.** Use **AMC III** (wet conditions) for every design storm, whatever its duration, from 1 March to 31 May on the floor of the Kashmir valley (the alluvium, Gurti clay and Nambal peat of sub-area JK-C of Annex 2A), and at any time of year there while the Jhelum stands at or above its flood-declaration level at Sangam or Ram Munshi Bagh (I&FC gauges, as reported). Use AMC III for every design storm from 1 July to 30 September on the Sirowal and the valley-floor alluvium of sub-area JK-A (Jammu plains, Kandi and Sirowal) and at a site in sub-area JK-B (Outer and middle hills) or JK-B1 (Inner Chenab hills). Use AMC III for every design storm at any time of year in sub-area JK-D (High mountains and snow-fed catchments), and in a catchment that drains to a reservoir or barrage pond or its backwater, such as Salal, Baglihar, Dul Hasti, Ranjit Sagar or the Tawi barrage at Jammu, or to a lake whose outlet the river can close, such as Dal, Anchar or Wular. At any other site or time, including the Kandi belt of sub-area JK-A and the Karewas, use AMC III for a design storm that follows, or contains, a 5-day rainfall total of more than 53 mm. Use AMC II (average conditions) for every other storm. AMC I is not used for design.

2.11.5 **Pre-development condition.** Pre-development is defined in Chapter 3: greenfield, open land in good condition for the mapped hydrologic soil group. Existing impervious cover is not counted as pre-development.

> Commentary. Matching each site's post-development peak to its own pre-development peak does not protect the catchment. Denver's analysis found that 100% matching at every site still produced 106% of historic peak downstream, which led to the 90% rule. The mixed-frequency rule is stricter. It caps the 100-yr post-development release at what the undeveloped site produced in a 10-yr storm. Malaysia (DID 2008: all ARIs ≤ pre-development 2-yr) is a tropical precedent for this kind of cap. AMC III for long storms reflects that SW monsoon extremes arrive after weeks of rain. In Jammu and Kashmir the ground and the receiving waters, more than the season alone, decide how wet a catchment is, and they differ across the Union Territory. On the Kashmir valley floor the water table stands 0–2 m below the surface over the central and south-western valley, wells flow on both sides of the Jhelum, and the water levels are shallowest in May, after the winter rain and snow (CGWB); the spring snowmelt, the western-disturbance maxima of March and April and a Jhelum at its flood-declaration stage all keep the ground saturated. In the Sirowal of the Jammu plains the water table is 2–5 m down, with waterlogging and flowing wells in the south-west (CGWB), and it rises through the monsoon. In the Kandi above the spring line, by contrast, the water table lies 7–30 m down and the boulder-gravel takes water fast (CGWB), although the khads that cross it gather their water from the Siwalik slopes above. On the Murree and Siwalik hills of the Chenab towns the clay layers swell and the slopes drain slowly through springs and seepage (GSI, 2024), and in the high mountains the ground is frozen or wet with snowmelt whenever a design storm can fall. This Manual therefore uses AMC III on the valley floor of JK-C from 1 March to 31 May and whenever the Jhelum stands at or above its flood-declaration stage at Sangam or Ram Munshi Bagh (as reported by I&FC); on the Sirowal and the valley-floor alluvium of JK-A, and in the hill towns of JK-B and JK-B1, from 1 July to 30 September; in JK-D for every design storm; and at any time of year where the outfall is a reservoir or barrage pond (Salal, Baglihar, Dul Hasti, Ranjit

Sagar, the Tawi barrage) or a lake whose outlet the river can close (the Dal, Anchar, Wular), because those receiving waters are high only when the catchment is wet; elsewhere, including the Kandi, AMC III follows a 5-day total of more than 53 mm, the NRCS growing-season threshold, which also covers a multi-day western-disturbance spell in the hills; AMC II otherwise (Clause 2.11.4). AMC I is not used. These are interim choices set by this Manual; no study in the Union Territory has yet validated AMC classes against observed runoff.

Illustrative scale of the mixed-frequency rule. The values below are not design values. They assume a 2 ha site in a colony draining to a khad in Jammu with 24-h depths of 200 mm (10-yr) and 350 mm (100-yr), SCS-CN runoff with Ia = 0.2S, and CN 70 pre-development and CN 92 post-development:

Table 2.3 — Illustrative scale of the mixed-frequency rule (not design values)

Case	Runoff depth	Runoff volume (2 ha)
Pre-development, 10-yr 24 h	111 mm	2,210 m³
Post-development, 100-yr 24 h	325 mm	6,500 m³

The post-development 100-yr storm generates about three times the runoff volume of the pre-development 10-yr storm. A peak-rate cap at the pre-development 10-yr level means most of the difference must be stored and released slowly, so storage of the order of 0.2 m³ per m² of site may be needed. For this reason the rule applies only in flood-sensitive catchments (Clause 2.11.3); elsewhere the 0.9 × Q_pre rule of Clause 2.11.2 applies.

2.12 Joint occurrence with tailwater

2.12.1 For outfalls under tidal or river backwater influence, the design rainfall of this chapter shall be combined with the tailwater conditions of Chapter 5 as follows. The more severe case governs.

- (a) Design rainfall (AEP as required) with a mean high water springs (MHWS) tailwater plus the sea-level allowance.
- (b) A 10% AEP (10-yr) 48-hour storm with the 1% AEP still-water level (tide plus surge) plus the sea-level allowance.

Jammu and Kashmir has no coast, so no outfall in the Union Territory is tidal and cases (a) and (b) do not arise. The tailwater is the river, nallah, khad, lake, nambal, talab or reservoir into which a town drains. For an outfall under river, lake or reservoir backwater, the site storm is combined with the receiving-water level under Clause 5.8.4, which pairs a design event on one side with a 10-yr event on the other in the same way as case (b), and the river and reservoir levels are those of Clause 5.8.2; for an outfall that the Jhelum, the flood spill channel or a city channel can close, as in Srinagar and the embanked towns of the valley, the outfall-closed check of Clause 5.10 and the pumping rules of Clause 5.12 also apply, and generally govern (Clause 2.3.6(g)(ii)). Four CWC sites on the Jhelum forecast levels and have warning and danger levels: Ram Munshi Bagh in Srinagar, with a warning level of 1,584.87 m, a danger level of 1,585.48 m and a highest level of 1,588.99 m (8 September 2014) in the list of 2022, against 1,585.53 m, 1,586.45 m and 1,589.65 m in the list of 2018, a conflict to be resolved with CWC, until which Chapter 5 uses the higher highest level [TBC]; Sangam, above Srinagar, with 1,589.96 m, 1,590.88 m and 1,595 m (4 September 2014; 1,595.7 m in the list of 2018); Khanabal, with 1,591.2 m and 1,592.5 m and a highest level of 1,595.43 m set on 3 September 2025; and Safapora, below Srinagar, with 1,579.36 m, 1,579.66 m and 1,582.1 m (9 September 2014). Three monitor levels only and have a highest level and no warning level: the Chenab at Akhnoor, 324.29 m (10 September 1992); the Tawi at Sidhra in Jammu, 318.85 m (6 September 2014), raised to 321.1 m on 26 August 2025; and the Lidder at Ganeshpura (CWC data as transcribed by SANDRP; no CWC bulletin was read for this Manual). The gauges of I&FC read in feet from zeros that are not published, and their readings go below zero, so they cannot be converted to the metres of CWC: at Ram Munshi Bagh the flood-declaration stage is 18 ft and the danger stage 21 ft; at Sangam 21 ft and 25 ft, with the labels reversed in some reports and a danger stage of 23 ft in others; at Asham 14 ft and 16.5 ft, with 14 ft also called

danger; at Akhnoor an alert stage of 32 ft and a danger stage of 35 ft; and on the Tawi at Udhampur 15 ft and 20 ft, also given as 17 ft (as reported). The difference between the highest and danger levels of CWC at Ram Munshi Bagh, 3.20 m or 10.5 ft, against 8.5 ft between the peak of 2014 and the danger stage on the gauge of I&FC, shows that the two sets of thresholds are not the same levels (NEER reading). Wular's danger level is given as 1,578 m (as reported). Of the reservoirs, Baglihar has a full reservoir level of 840 m and Salal 487.68 m, and Ranjit Sagar, on the Ravi below Kathua, 527.91 m in one source and 527.13 m in another, a conflict to be resolved with the operator [TBC]; the pool level and gate rules of the Tawi barrage at Jammu, opened in 2026, and the operating levels of the Dal at the Dal Gate and of Anchar and Wular on a stated datum were not found [TBC] (as reported). The khads and nallahs that cross the towns are ungauged; they rise within an hour of a burst and carry boulders and debris, so their levels are known only from surveyed flood marks and the debris lines of 2014 and 2025. These levels are set by rain and snowmelt over catchments upstream, by embankment breaches, and by the gates and flushing of Baglihar and Salal, which since the Indus Waters Treaty was placed in abeyance in April 2025 may come without notice downstream (as reported); the Tawi, the Basantar, the Ujh and the Chenab cross into Pakistan within about 10–30 km of Jammu, R.S. Pura, Samba and Akhnoor, and their tailwater beyond the border is not monitored. No document found in research for this Manual sets a design receiving-water level for the outfalls of any town in the Union Territory [TBC], and Chapter 5 sets the interim rule. Every level is stated on a named gauge and datum, as Chapter 5 requires; no source found states the datum of the CWC levels quoted here [TBC].

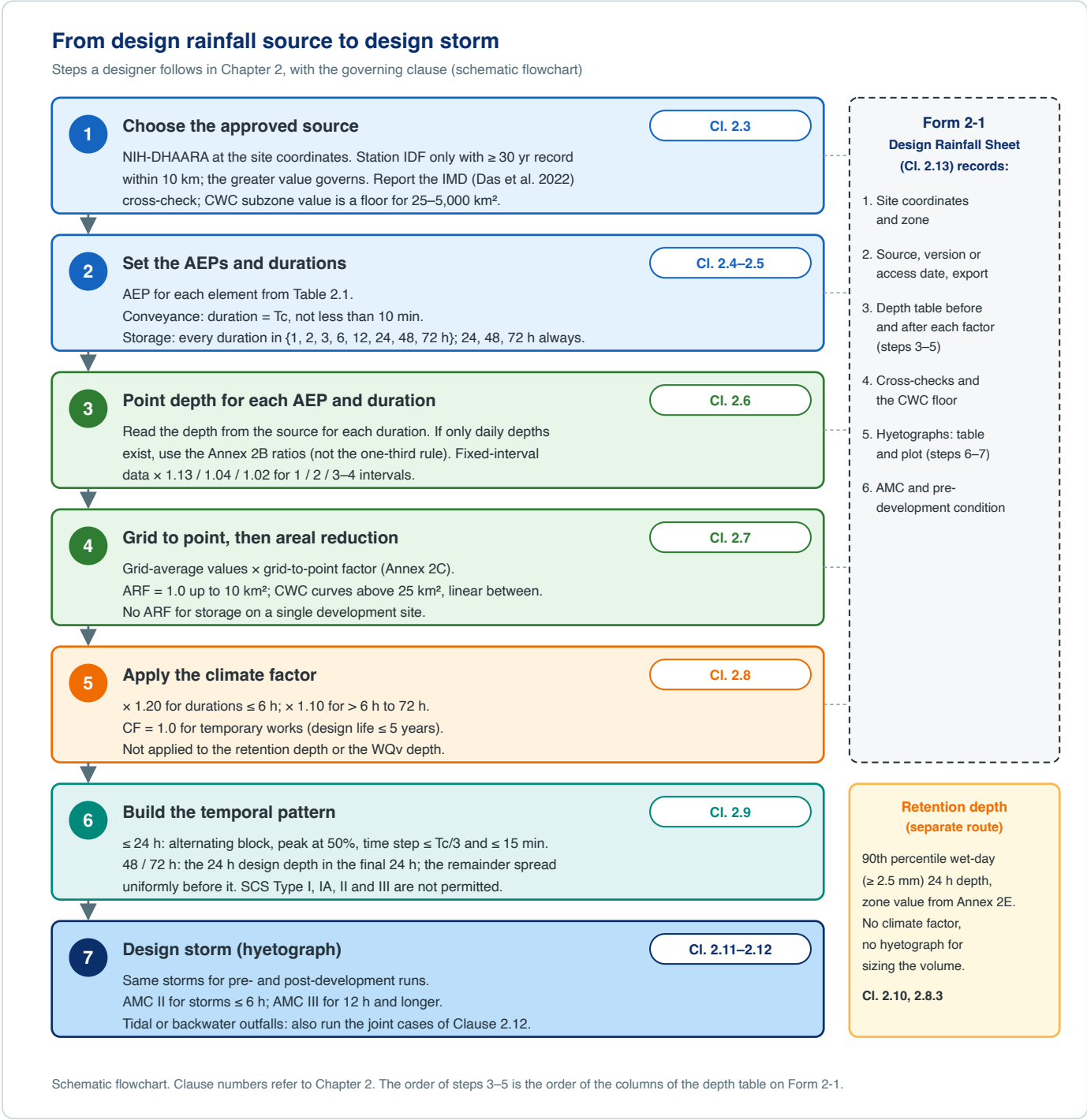
> Commentary. Jammu and Kashmir has no coast, so no outfall is tidal and there is no storm surge; the coincident load is the level of the rivers, lakes and reservoirs that receive the town drains, and on the Kashmir valley floor it decides whether the drains can discharge at all. The coincidence is on record. In September 2014 the storm that brought 400–600 mm to the catchments of south Kashmir raised the Jhelum to its highest levels at Sangam on 4 September and at Ram Munshi Bagh on 8 September while Srinagar received only about 140–152 mm, so that the city's gravity outfalls were shut by the river and its streets were flooded through the embankments (Ray et al., 2015; CWC data as transcribed by SANDRP). On 26 August 2025 the Tawi at Sidhra reached 321.1 m, its highest level, at 17:00, within the same 24 hours in which Jammu recorded 380 mm, and in early September the Jhelum set a new highest level of 1,595.43 m at Khanabal while it stood above its danger stage of 21 ft at Ram Munshi Bagh (IMD; CWC data as transcribed by SANDRP; as reported). In the hill towns the khads themselves are the receiving waters: they rise within an hour of a burst on the slopes above, while the storm is still falling on the town below. These levels are set by rain and snowmelt over the catchments upstream, by the gates of the Dal, Wular and the dams of the Chenab, whose flushing and gate operations may since 2025 come without notice downstream (as reported), and by embankment breaches, so they give no warning of a local storm that falls while they are high. The levels quoted by different sources differ: the peak at Ram Munshi Bagh in 2014 is given as 22.40 ft, 23 ft and about 29.5 ft on the gauge of I&FC, and as 1,588.99 m and 1,589.65 m in two lists of CWC; the capacity of the flood spill channel as 4,000, 8,000, 8,700 and 27,000 cusecs; and the gauges of I&FC read in feet from zeros that are not published, so that their readings cannot be converted to the metres of CWC (as reported; NEER reading). That is why Chapter 5 requires every level to name its gauge, its source and its datum. Because rainfall and surge share a weather cause (in Jammu and Kashmir, which has no coast, the counterpart of surge is the stage of the rivers, lakes and reservoirs that receive the town drains, raised by the same storms that bring the heaviest rain to the towns: in September 2014 the storm that brought 599.8 mm in four days to Qazigund raised the Jhelum to its highest levels at Sangam and Ram Munshi Bagh and shut Srinagar's outfalls, and on 26 August 2025 the Tawi at Sidhra reached its highest level, 321.1 m, within the 24 hours in which Jammu recorded 380 mm, all as reported), they cannot be treated as independent. Case (b) is a simple joint-probability surrogate until a statistical joint analysis is adopted.

2.13 Submittal requirements

Every hydrologic submittal shall include a **Design Rainfall Sheet** (Form 2-1) stating:

1. the site coordinates and zone;
2. the source (Clause 2.3), version or access date, and a screenshot or export of the values extracted;
3. a depth table for each AEP and duration used, before and after the fixed-interval factor, grid-to-point factor, ARF and climate factor;
4. the cross-check values of Clause 2.3.3 and the floor check;
5. the hyetographs used, as a table and a plot, for each design storm; and
6. the AMC and pre-development definition adopted.

Figure 2.3 shows the steps of this chapter in the order in which the sheet records them.



Schematic flowchart. Clause numbers refer to Chapter 2. The order of steps 3–5 is the order of the columns of the depth table on Form 2-1.

Figure 2.3 — From design rainfall source to design storm: the steps a designer follows (source, AEPs and durations, point depth, grid-to-point and areal reduction, climate factor, temporal pattern, design storm), the clause that governs each step, what Form 2-1 records, and the separate route for the retention depth. Schematic. Original drawing for this Manual.

2.14 Review and update

2.14.1 The approving authority shall review this chapter **every 10 years**. It shall also review it within 2 years of any event in which recorded rainfall exceeds the 1% AEP 24-hour or 72-hour design depth at two or more approved gauges in the State.

2.14.2 Updates to NIH-DHAARA take effect for new submittals **6 months** after release, unless the authority notifies otherwise.

References (chapter)

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Annexes

Annex	Content
2A	NIH-DHAARA vs IMD station and IMD gridded checks at benchmark points; zone map
2B	Sub-daily ratios P(t)/P(24h) by zone: NIH-DHAARA (hourly-based) vs the one-third rule
2C	Grid-to-point factors
2D	Jammu and Kashmir temporal patterns (Huff curves)
2E	Retention percentile depths by zone
Form 2-1	Design Rainfall Sheet

CHAPTER 3

Hydrologic Methods

3.1 Purpose and scope

3.1.1 This chapter sets out how design rainfall from Chapter 2 is turned into runoff peaks, volumes and hydrographs for:

- (a) drain, inlet and culvert sizing (Chapter 6);
- (b) retention and detention sizing, and the pre- vs post-development comparison (Chapter 4);
- (c) downstream and tailwater analysis (Chapter 5); and
- (d) waterbody, tank (talab) and regional facility studies (Chapter 7).

3.1.2 It specifies:

- (a) which method may be used for which purpose and catchment size (Clause 3.4);
- (b) how the pre- and post-development land surfaces are defined (Clause 3.3);
- (c) the parameters of each method: runoff coefficients, time of concentration, soils, curve numbers, unit hydrographs and routing (Clauses 3.5–3.12);
- (d) when continuous simulation and model calibration are required (Clauses 3.13 and 3.15);
- (e) the step-by-step pre- vs post-development comparison (Clause 3.14); and
- (f) software acceptance and documentation (Clauses 3.16 and 3.17).

3.1.3 Rainfall inputs (depth, duration, areal reduction, climate factor, temporal pattern and antecedent moisture) are governed by Chapter 2 and shall not be varied in this chapter.

> **Commentary.** The CPHEEO (2019) Manual on Storm Water Drainage Systems gives a full Rational Method procedure and names SWMM for hydrograph work, but it is a drain-sizing guide. It does not say how a regulator should define "pre-development" or which method must be used to test a development against it (CPHEEO Part A §4.4, §8.5.1). APWA Section 5600 does both: it limits the Rational Method, names baseline hydrograph methods, and fixes the land-use assumptions for existing and proposed conditions (KC Metro APWA 5600, 2011, §5602.2–5602.3; Version 2025.01, §5603.4). This chapter follows that model.

3.2 Definitions

Term	Meaning in this Manual
Pre-development condition	The reference land surface defined in Clause 3.3.2, against which post-development runoff is tested. It is not the existing condition.
Post-development condition	The land surface after the proposed works are complete, as defined in Clause 3.3.3.
Point of comparison (POC)	A location where site runoff leaves the site, at which pre- and post-development flows are compared (Clause 3.14).

Term	Meaning in this Manual
Time of concentration (Tc)	The time for runoff to travel from the hydraulically most distant point of the catchment to the point of interest.
Lag (tL)	The time from the centroid of rainfall excess to the peak of the runoff hydrograph.
Hydrologic soil group (HSG)	The NRCS classification (A, B, C, D) of a soil by its minimum infiltration rate when wet (USDA NRCS, NEH Part 630, Ch. 7).
Curve number (CN)	The NRCS parameter that combines soil group, land cover and antecedent moisture into a single runoff-potential index (USDA NRCS, NEH Part 630, Ch. 9–10).
Antecedent moisture condition (AMC)	The soil wetness at the start of a storm: AMC I (dry), II (average), III (wet).
Directly connected impervious area (DCIA)	Impervious surface that drains to a drain, pipe or channel without first flowing over a pervious surface.
Disconnected impervious area	Impervious surface whose runoff flows as sheet flow over a pervious surface before reaching the drainage system, and meets Clause 3.9.3.
Peak rate factor (PRF)	The constant in the unit hydrograph peak equation (484 in US customary units; 0.208 in the SI form of Clause 3.11.2).
Continuous simulation	A model run over a long rainfall record (years), with soil moisture, storage and tank levels carried forward between storms.
Tank cascade	A chain of tanks (talabs) in which the surplus of one tank feeds the next.

3.3 Pre-development and post-development land surface

3.3.1 **Same site, same storm.** Pre- and post-development runs shall cover the same area draining to each POC, and use the same design storms (Clause 2.11.1). They shall differ only in the land-surface parameters of this clause, the resulting Tc, and the stormwater controls.

3.3.2 **Pre-development condition.** The pre-development land surface shall be **greenfield: open land in good condition for the mapped hydrologic soil group**, as follows:

- (a) All land within the site, including land that is now built on, paved, compacted or cultivated, is treated as open land (grass cover > 75%) in good condition. **Existing impervious cover shall not be counted.**
- (b) The curve number is the TR-55 value for "open space, good condition" for the HSG of Clause 3.7: **CN 39 (A), 61 (B), 74 (C), 80 (D)** at AMC II (Table 3.5).
- (c) The HSG is the natural HSG of Clause 3.7, including the dual-group rule for high water table (Clause 3.10.1). No HSG improvement for drainage works is allowed.
- (d) Tc is computed on the pre-development ground surface using unchannelled overland and shallow concentrated flow and natural channels only (Clause 3.6). Existing pipes, lined drains and kerbs are ignored.
- (e) Existing waterbodies, tank waterspreads up to the full tank level (FTL), natural channels and supply or surplus channels are kept as they are, and modelled as water surfaces or channels, not as open land.

3.3.3 **Post-development condition.** The post-development land surface shall represent the proposed works at full build-out:

- (a) Impervious areas shall be measured from the site plan, separately for roofs, paved surfaces, roads and other sealed surfaces, and classified as directly connected or disconnected (Clause 3.9). Lot-size residential rows of TR-55 shall not be used for the site itself.

- (b) Pervious areas disturbed by construction (graded, filled or trafficked) shall be assigned one HSG lower in infiltration capacity than the natural HSG (A to B, B to C, C to D), unless post-construction infiltration tests (Clause 3.7.3) show otherwise. Soil disturbed by construction shall never be classed as HSG A.
- (c) Rainwater harvesting (RWH) sumps shall be treated as full at the start of storms of 12 hours or more, and the roof area draining to them as directly connected for those storms (Chapter 4).
- (d) Retention and detention facilities shall be represented explicitly as storage (Clause 3.12), not by lowering CN.

3.3.4 **Redevelopment.** The pre-development condition of Clause 3.3.2 applies to redevelopment as well. A site that is already fully paved is tested against greenfield, not against its existing state. For the constrained-redevelopment route of Clause 4.5.6, the existing condition shall also be modelled, with existing impervious areas as surveyed, so that the 50% minimum can be checked.

3.3.5 **Off-site areas.**

- (a) For conveyance design (Chapter 6), areas upstream of the site shall be taken at their ultimate land use under the approved master plan or development plan. Where no plan exists, upstream undeveloped land shall be assumed to be at least 35% impervious.
- (b) For the pre- vs post-development comparison, off-site run-on shall be modelled identically in both runs, at its existing condition (Clause 3.14.2).

> Commentary. A greenfield reference stops each redevelopment from being judged against an already degraded baseline. The UK non-statutory standards and KC APWA take the same approach in different forms: APWA caps existing agricultural land at no more than "good condition pasture, grassland or range (C = 0.30, CN = 74)" for HSG C, and forbids disturbed soils from being classed as HSG A or B (KC Metro APWA 5600, 2011, §5602.3A and E). The TR-55 "open space, good condition" values used in (b) are identical to TR-55's "pasture, grassland or range, good" values (USDA SCS TR-55, 1986, Tables 2-2a and 2-2c), so this Manual's pre-development CN equals the APWA cap on HSG C soils. The one-class downgrade for disturbed soils in 3.3.3(b) is set by this Manual as a simpler, less strict version of the APWA rule, suited to the Kandi boulder-gravel fans and the Sirowal of the Jammu plains, the Siwalik and Murree sandstone and clay of the hills, the Karewa tablelands, and the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, where an HSG A to C jump would be excessive. The 35% minimum imperviousness for unplanned upstream land in 3.3.5(a) is the APWA value (2011, §5602.3E.2). Using the master-plan land use for conveyance follows CPHEEO, which requires C to reflect "ultimate development of the catchment as per the master plan" (CPHEEO 2019, Part A §4.4.1.5).

3.4 Selection of method

3.4.1 The method shall be selected from Table 3.1 by purpose and catchment size. Figure 3.1 shows the same rules as a flowchart.

Table 3.1 — Permitted hydrologic methods

Purpose	Catchment / condition	Permitted method	Clause
Peak flow for one conveyance element (inlet, pipe reach, drain reach, culvert)	≤ 16 ha contributing, no upstream storage, no backwater	Rational Method	3.5
Peak flow for conveyance	> 16 ha, or any upstream storage, tank or pond	Hydrograph method (SCS-CN with SCS unit hydrograph, SWMM or HEC-HMS)	3.8–3.12
Retention, detention, any storage; pre- vs post-development comparison	Any size	Hydrograph method; **Rational Method not permitted**	3.8–3.12, 3.14

Purpose	Catchment / condition	Permitted method	Clause
Pipe or drain network with backwater, tidal or tank tailwater	Any size	Hydrograph method with dynamic-wave hydraulic routing	3.12.4; Chapter 5
Catchment-scale flows	25–5,000 km² in CWC zone 7 (Western Himalayas)	HEC-HMS or SWMM, benchmarked against the CWC synthetic unit hydrograph (SUH)	3.11.4
Regional facilities	Draining > 25 km²	Design-storm hydrograph method **plus** continuous simulation	3.13
Tank (talab) cascades	Any size	Design-storm hydrograph method **plus** continuous simulation	3.13
Tier B: small sites under Chapter 1	Within the limits of the design aid	Design aids issued under Chapter 4, which are themselves derived by the methods of this chapter	3.4.4
Small sites, any authority	≤ 1 ha, within the limits of Clause 4.14.3	Fixed-coefficient route of Chapter 4 (fixed release coefficients, rainfall-mass storage)	3.4.4; 4.14.3

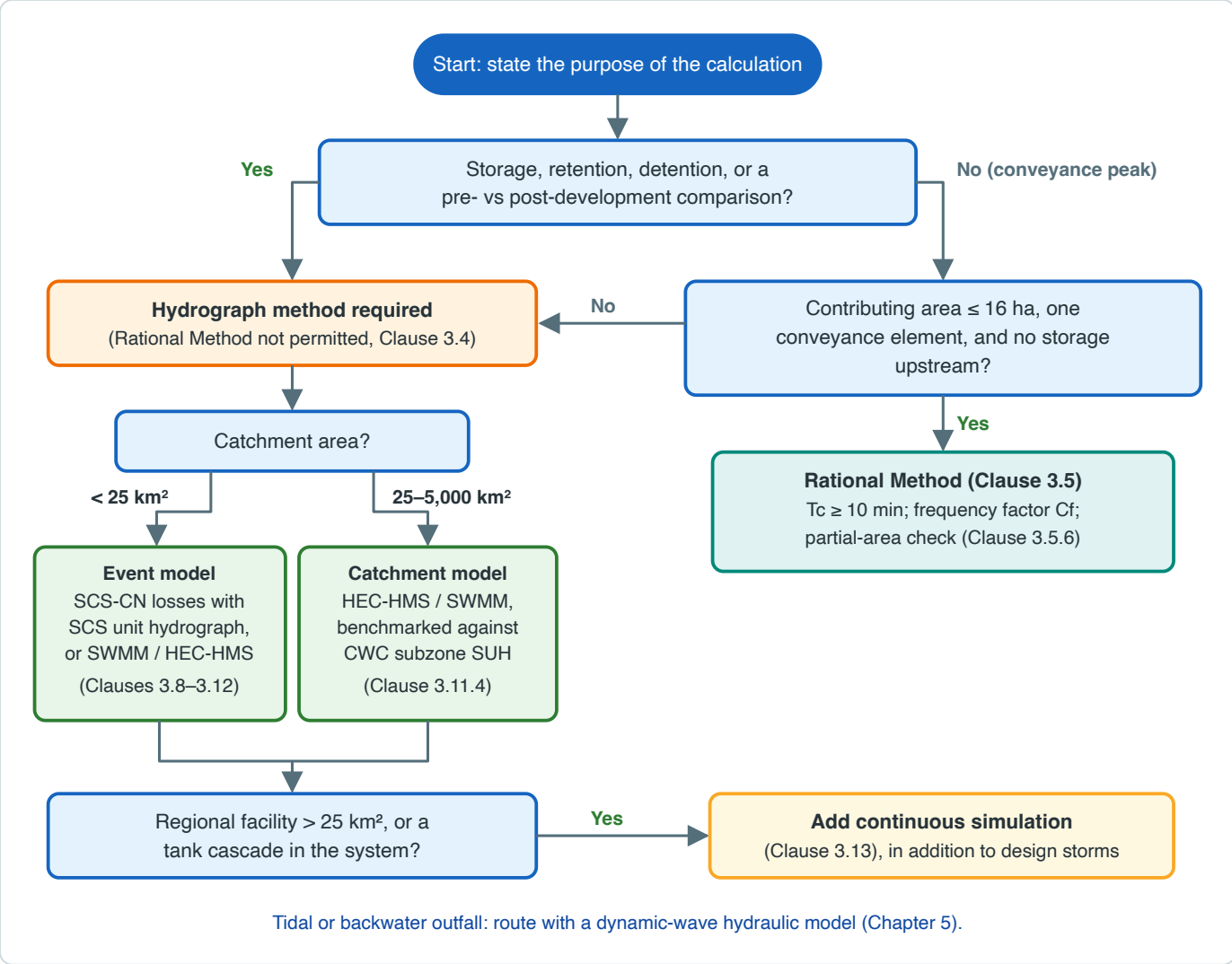

Figure 3.1 — Selection of hydrologic method. Original drawing for this Manual, adapted from KC Metro APWA, Section 5600 Storm Drainage Systems and Facilities, 2011 (§5602.2) and Version 2025.01 (§5603.4, Policy Supplement, 2025).

3.4.2 **Rational Method limits.** The Rational Method shall be used only for catchments of **16 ha or less** and only to compute the peak flow to a **single conveyance element**. It shall **never** be used to size retention, detention or any other storage, nor to derive a hydrograph or runoff volume.

3.4.3 **Hydrograph methods.** Above 16 ha, and for every storage calculation, a hydrograph method shall be used: SCS-CN losses with the SCS (NRCS) unit hydrograph, EPA SWMM, or HEC-HMS. For 25–5,000 km² the CWC synthetic unit hydrograph shall also be computed as a benchmark (Clause 3.11.4).

3.4.4 **Simplified routes.** In Tier B areas (Chapter 1), sites within the limits stated on a design aid issued under Chapter 4 may use that design aid in place of a site-specific hydrograph model. In any area, sites of 1 ha or less may use the fixed-coefficient route of Clause 4.14.3; it is the only exception to the rule in 3.4.2 that rainfall-based peak methods shall not be used for storage. The Rational Method remains available for conveyance under 3.4.2.

3.4.5 **Catchments above 5,000 km².** These are outside the scope of this Manual and require a basin study approved by the Jal Shakti Department (Irrigation and Flood Control).

> **Commentary.** The 16 ha limit and the single-element rule follow APWA 5600 Version 2025.01, which cut the Rational Method from 200 ac to 40 ac and restricted it to "a single pipe segment". The MARC Policy Supplement adds that it "cannot be used to size runoff reduction practices or determine retention volumes and detention volumes" (MARC, APWA Stormwater Standards Supplement, 2025). CPHEEO (2019, Part A §4.4.1.3) allows the Rational Method up to 8–10 km², which is too large for a method that assumes uniform rainfall intensity over the whole catchment for the whole of Tc and gives no volume. The Rational Method is excluded from storage design because it gives a peak, not a hydrograph, and storage depends on volume and timing.

3.5 Rational Method

3.5.1 **Equation.** The peak flow shall be computed as:

> $$Q = C \cdot Cf \cdot i \cdot A / 360$$

where Q is the peak flow (m³/s); C is the runoff coefficient (Table 3.2); Cf is the frequency factor (Table 3.3), with $C \cdot Cf \le 1.0$; i is the rainfall intensity (mm/h) for a duration equal to Tc, from Chapter 2 (with the climate factor of Clause 2.8); and A is the contributing area (ha).

> **Commentary.** This is the CPHEEO equation Qp = 10 C I A, with Qp in m³/h (CPHEEO 2019, Part A §4.4.1.1–4.4.1.3), converted to m³/s.

3.5.2 **Runoff coefficients.** C shall be taken from Table 3.2. Within a range, the designer shall use the upper half of the range unless site data justify a lower value.

Table 3.2 — Runoff coefficient C (for AEP of 10% or more frequent)

Surface or land use	C	Source
Commercial	0.70–0.95	CPHEEO 2019, Table 4.2
Industrial	0.60–0.90	CPHEEO 2019, Table 4.2
Institutional	0.70–0.95	CPHEEO 2019, Table 4.2
Residential, high density	0.60–0.75	CPHEEO 2019, Table 4.2
Residential, low density	0.40–0.60	CPHEEO 2019, Table 4.2

Surface or land use	C	Source
Recreational	0.10–0.25	CPHEEO 2019, Table 4.2
Asphalt	0.70–0.95	CPHEEO 2019, Table 4.2
Concrete	0.80–0.95	CPHEEO 2019, Table 4.2
Brick paving	0.70–0.85	CPHEEO 2019, Table 4.2
Roofs: tiles	0.80–0.90	CPHEEO 2019, Table 4.2
Roofs: metal	0.70–0.90	CPHEEO 2019, Table 4.2
Roofs: concrete	0.70–0.90	CPHEEO 2019, Table 4.2
Lawns, sandy soil, flat (≤ 2%)	0.05–0.10	ASCE/WPCF 1969
Lawns, sandy soil, average (2–7%)	0.10–0.15	ASCE/WPCF 1969
Lawns, sandy soil, steep (> 7%)	0.15–0.20	ASCE/WPCF 1969
Lawns, heavy (clay) soil, flat (≤ 2%)	0.13–0.17	ASCE/WPCF 1969
Lawns, heavy soil, average (2–7%)	0.18–0.22	ASCE/WPCF 1969
Lawns, heavy soil, steep (> 7%)	0.25–0.35	ASCE/WPCF 1969
Undeveloped land (maximum for any condition)	0.30	KC APWA 5600 (2011), §5602.3E

3.5.3 **Frequency factor.** For design AEPs rarer than 10%, C shall be multiplied by Cf from Table 3.3. The product C · Cf shall not exceed 1.0.

Table 3.3 — Frequency factor Cf

Design AEP (return period)	Cf
10% (10-yr) and more frequent	1.00
4% (25-yr)	1.10
2% (50-yr)	1.20
1% (100-yr)	1.25

3.5.4 **Composite C.** Where a catchment contains more than one surface, C shall be the area-weighted value $C = \Sigma(C_j \cdot A_j) / \Sigma A_j$, computed from the measured areas of each surface. Cf is applied to the composite C.

3.5.5 **Time of concentration and networks.**

- (a) Tc shall be computed by Clause 3.6 and shall not be less than **10 minutes**.
- (b) For each reach of a network within the 16 ha limit, the peak shall be computed with the cumulative $\Sigma(C \cdot A)$ upstream of that reach and the longest Tc to that reach. Peaks from upstream reaches shall not be added.

3.5.6 **Partial-area check.** Where a compact, highly impervious part of the catchment has a much shorter Tc than the whole, the peak shall also be computed for that part alone, using its own area, C and Tc. The larger peak governs.

> **Commentary.** The developed-surface coefficients in Table 3.2 are CPHEEO Table 4.2, which CPHEEO adapted from ASCE/WPCF (1969). CPHEEO keeps C constant for all return periods. Table 3.3 instead adopts the APWA antecedent-precipitation factors (KC Metro APWA 5600, 2011, §5602.2A: K = 1.1, 1.2 and 1.25 for 4%, 2% and 1% storms, with C·K ≤ 1.0). These factors matter here because Jammu and Kashmir's rare storms arrive on wet ground (Clause 2.11.4). The 10-minute minimum Tc matches the minimum design duration of Clause 2.5.1.

> APWA 2011 bounds inlet time between 5 and 15 minutes (§5602.7A). The partial-area check follows CPHEEO's treatment of "partial area effect" (CPHEEO 2019, Part A §4.4.1.7). This Manual requires the upper half of each range in 3.5.2 because Indian urban plots are typically more densely covered than the US land uses behind the ASCE ranges.

3.6 Time of concentration

3.6.1 **General.** Tc shall be computed separately for the pre- and post-development conditions, along the flow path that gives the longest travel time to the point of interest, as the sum of travel times in each flow segment. Tc shall not be less than **10 minutes** for either condition.

3.6.2 **NRCS velocity (segment) method.** The NRCS segment method is the default for all catchments. Tc = Tt(sheet) + Tt(shallow) + Tt(channel), where:

- (a) **Sheet flow:**

  > Tt = 0.091 (n · L)^0.8 / (P2^0.5 · S^0.4)

  where Tt is in hours; n is the sheet-flow roughness from Table 3.4; L is the sheet-flow length (m); P2 is the present-day 50% AEP (2-yr) 24-hour rainfall (mm) from Clause 2.3, without the climate factor; and S is the land slope (m/m).

- (b) **Sheet-flow length.** In urban areas, and for all post-development conditions, the sheet-flow length shall not exceed **30 m**. For pre-development greenfield surfaces, up to 90 m may be used only where survey shows unchannelled planar ground; otherwise 30 m applies.

- (c) **Shallow concentrated flow:** Tt = L / (3,600 V), with V = 4.918 S^0.5 (unpaved) or V = 6.196 S^0.5 (paved), V in m/s, L in m and S in m/m.

- (d) **Channel and pipe flow:** Tt = L / (3,600 V), with V from Manning's equation at bank-full or pipe-full flow.

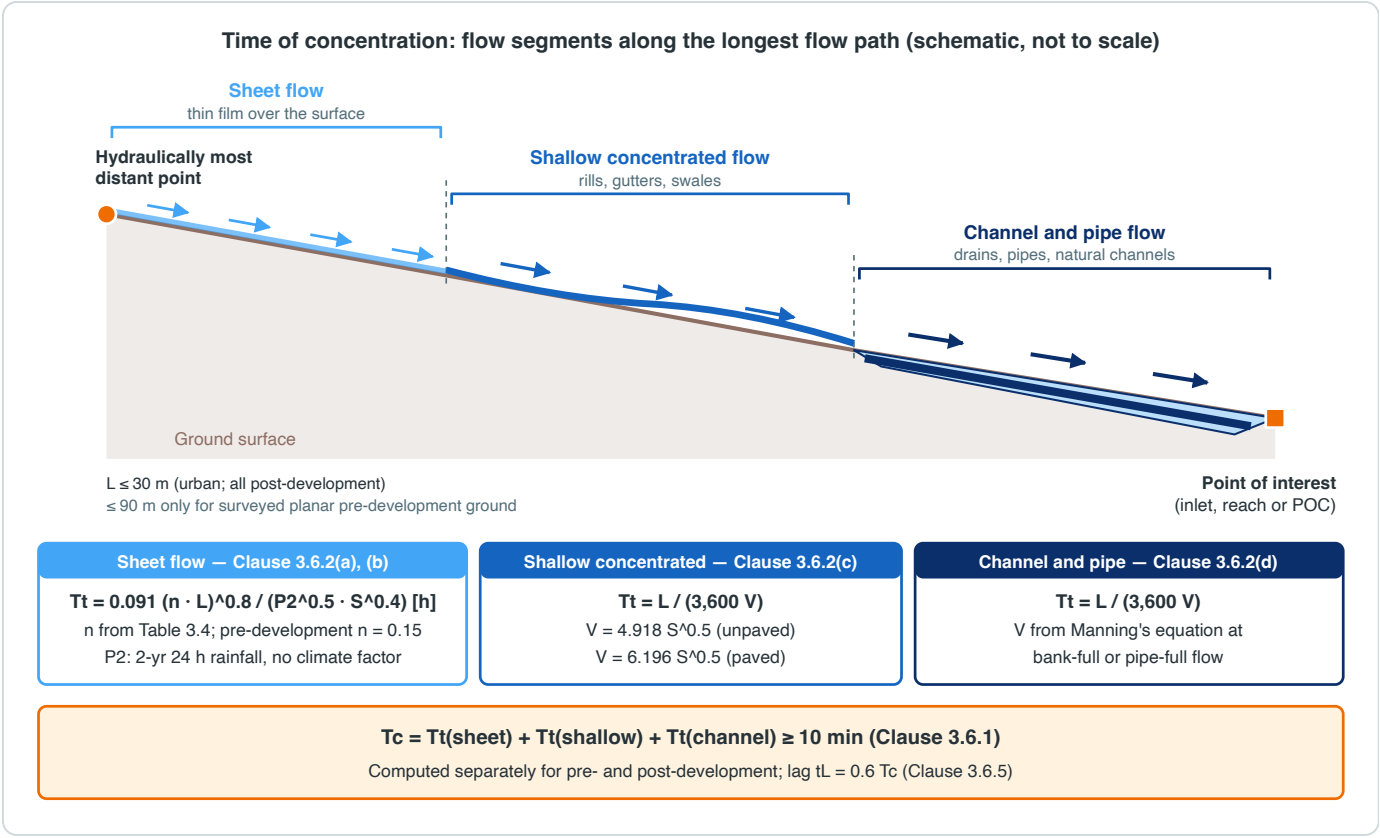

Figure 3.2 — Time of concentration by the NRCS segment method: sheet flow, shallow concentrated flow and channel or pipe flow along the longest flow path, with the travel-time equations and limits of Clause 3.6. Schematic, not to scale. Original drawing for this Manual, adapted from USDA SCS TR-55 (1986), Ch. 3, and USDA NRCS, NEH Part 630, Ch. 15 (2010).

Table 3.4 — Manning's n for sheet flow (USDA SCS TR-55, 1986, Table 3-1)

Surface	n
Smooth surfaces (concrete, asphalt, gravel, bare soil)	0.011
Fallow (no residue)	0.05
Cultivated, residue cover ≤ 20%	0.06
Cultivated, residue cover > 20%	0.17
Grass: short-grass prairie	0.15
Grass: dense grasses	0.24
Range (natural)	0.13
Woods: light underbrush	0.40
Woods: dense underbrush	0.80

3.6.3 **Pre-development roughness.** For the pre-development greenfield surface of Clause 3.3.2, sheet-flow n shall be **0.15** unless the designer justifies another Table 3.4 value from the natural vegetation of the area.

3.6.4 **Kirpich formula.** The Kirpich formula may be used only as a cross-check, or for pre-development rural catchments with a defined main channel:

> tc = 0.0195 L^0.77 S^−0.385

where tc is in minutes, L is the length of the main flow path (m) and S is its average slope (m/m). It shall not be used for urban or post-development catchments.

3.6.5 **Lag.** Where a unit hydrograph method requires lag, tL = 0.6 Tc.

3.6.6 **Check.** Post-development Tc shall normally be shorter than pre-development Tc. Where it is longer, the designer shall explain why in the submittal.

> Commentary. The segment method and its equations are from TR-55 (USDA SCS, 1986, Ch. 3) and NEH Part 630, Ch. 15 (USDA NRCS, 2010). The SI constants are direct conversions of the US equations: 0.007 becomes 0.091 with L in m and P2 in mm, and 16.1345 and 20.3282 ft/s become 4.918 and 6.196 m/s. TR-55 (1986) allowed sheet flow up to 300 ft (≈ 90 m). NEH 630 Ch. 15 states that sheet flow typically lasts no more than about 100 ft (≈ 30 m) before becoming shallow concentrated flow (citing Merkel, 2001), and many US agencies now cap it there. This Manual sets the 30 m urban limit in 3.6.2(b) on that basis: in Indian urban plots, flow reaches a drain, kerb or compound-wall weep hole within a few metres. The undisturbed P2 is used in the sheet-flow equation because P2 is a parameter of the travel-time relationship, not a design load. The default n = 0.15 for greenfield is the TR-55 short-grass value; this Manual adopts it to avoid long pre-development Tc values that would make Q_pre artificially low. The Kirpich formula is the SI form given by Chow, Maidment and Mays (1988, Table 15.1.2), from small agricultural catchments in Tennessee (Kirpich, 1940), so it does not suit urban surfaces. The lag ratio 0.6 is the NRCS value, also used by APWA (2011, §5602.7C).

3.7 Soils and hydrologic soil groups

3.7.1 **Mapping.** HSG shall be assigned from the soil series mapped by the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) or the Agriculture Production Department, Jammu and Kashmir (soil survey) [TBC], using the soil-series-to-HSG lookup of Annex 3A. The source map and its scale shall be stated.

3.7.2 **Assignment rule.** Where Annex 3A is not yet available for a series, the HSG shall be assigned from the measured saturated hydraulic conductivity and depth to an impermeable layer or water table using the criteria of NEH Part 630, Ch. 7. Until Annex 3A is published, this Manual sets the following interim groups for Jammu and Kashmir: the boulder-gravel fans and khad beds of the Kandi belt of the Jammu plains, north of Jammu, round Nagrota and Samba and in the north of Kathua and Hiranagar, HSG A, and HSG B where a loamy or clayey cover lies over the gravels or the ground is compacted urban ground; the finer sediments of the Sirowal below the spring line, round R.S. Pura, Bishnah, Arnia and southern Hiranagar, HSG C, HSG B on sandy ground, and HSG D wherever the seasonal high water table is within 2 m of the surface, wells flow or the land is waterlogged; the regolith of the Siwalik and Murree sandstone and clay of the outer and middle hills, HSG D for design, with no infiltration credit on slopes; the Upper Karewa tablelands of Budgam, Pulwama, Pampore and the airport plateau, HSG C on silt and HSG D on marl or varved clay or where perched water is found; the Lower Karewa where it is exposed, HSG B on sand and HSG C on clay; the alluvium, Gurti clay and Nambal peat of the floor of the Kashmir valley, HSG D for every design storm; the terraces and floodplains of the rivers and khads elsewhere, HSG B on sandy or gravelly terraces and HSG C on silty ones, and HSG D wherever the seasonal high water table is within 2 m of the surface; the colluvium, slide debris and moraine of the hills and high mountains, HSG D for design, with no infiltration credit on slopes, whatever group the material itself would take; exposed rock, HSG D; the soils of the high mountains and snow-fed catchments of sub-area JK-D, HSG C, and HSG D when frozen or under snow; and urban fill, HSG C, and HSG D where it is clayey or compacted. A field infiltration test is required on every site larger than the limits of the simplified method of Clause 4.14.1, at the depth of the proposed facility; on smaller sites, a soil

that has not been tested shall be given the less permeable of the groups listed for it. Whether an infiltration practice may be built at all is governed by the valley-floor rule, the Kandi recharge rule and the hill infiltration rule of Clause 4.11, not by its HSG. Clause 3.10.1 applies to all of these groups.

3.7.3 **Site verification.** For every site that relies on retention by infiltration (Chapter 4), the mapped HSG shall be verified by site infiltration tests at the location and depth of each infiltration facility. Where the tests show a lower infiltration capacity than the mapped HSG, the test result governs for both the retention design and the post-development CN. Where they show a higher capacity, the pre-development HSG shall not be changed without the approval of the authority.

3.7.4 **Disturbed and filled ground.** Clause 3.3.3(b) applies.

> Commentary. NBSS&LUP soil maps are typically at 1:250,000 to 1:50,000 scale and classify soils by series and taxonomy, not by HSG. A lookup table is therefore needed (Annex 3A). Site tests matter most at the edges of the belts, where one site can span two groups: at the spring line between the Kandi and the Sirowal, where the boulder gravels pass into finer sediments and the water table rises from tens of metres below ground to a few metres within a short distance; at the edges of the Karewa tablelands, where silt and marl give way to the alluvium of the valley floor; on the Siwalik and Murree hills, where sandstone and clay alternate; and on hill sites, where a test pit in debris can show a high rate that is in fact water entering a slope that cannot take it (Clause 4.11). No HSG map or table for Jammu and Kashmir, and no measured infiltration rate usable for design, was found during research for this Manual [TBC]: the CGWB's aquifer-mapping reports for the Kashmir valley and for the outer plains of the Jammu province both list the soil infiltration rate as "Not Available on any Scale" (NAQUIM, Kashmir Valley; NAQUIM, Outer Plains of Jammu Province). Infiltration rates reported for the Basantar catchment in Samba and Kathua districts were seen only in a summary whose method and sites could not be checked, and are not used. The interim groups therefore follow the geology. The Jammu plains are divided, parallel to the Siwalik hills, into the Kandi and the Sirowal, "equivalent to Bhabar and Tarai formations of Indo-Gangetic Plains": the Kandi, about 6 km wide at 320–440 m with a gradient of 1:90 to 1:120, "is underlain by boulder, gravel, which acts as a very good medium for the recharge", with water 7–30 m below ground in most of the belt and transmissivities of 21.1–1,197 m²/day in Jammu district and 692–2,613 m²/day in Kathua district; below it the Sirowal, at a gentler 1:250 to 1:300, where "coarser sediments are replaced by finer sediments", has water mostly two to five metres below ground, waterlogging towards its south-western extremity and flowing wells at Hiranagar, Rajpura, Jangi Chak, Airwan and Nagri, and in Kathua district "More than 50% of the wells are under flowing condition", with heads up to more than 9 m above ground (NAQUIM, Outer Plains of Jammu Province). These are aquifer values, not surface infiltration rates, but they support HSG A on the Kandi and HSG C–D on the Sirowal. In the Kashmir valley the Upper Karewa forms "high and dry table lands and terraces" of laminated marls, silts and varved clays, with "Perched water bodies" and "Low permeability"; the Lower Karewa, of alternating sand and clay, has "Moderately high permeability" and is "confined to flowing"; and the alluvium of the valley floor has "high permeability, mostly confined with occasional flowing" (NAQUIM, Kashmir Valley). Its soils include Gurti, the clayey soil of the Jhelum flood plain in the southern parts of Srinagar, whose "water retaining capacity is high", and Nambal, the peaty soil "Near the banks of the Jhelum River and in the vicinity of the Wular, Manasbal, and Anchar lakes" (CGWB, Ground Water Year Book 2021–22). Water stands 0–2 m below ground over the central and south-western valley and wells flow on both sides of the Jhelum (Commentary to Clause 3.10), so the valley floor is HSG D whatever its texture (Clause 3.10.1). In the hills the Lower Murree rocks round Ramban are "dominantly an argillaceous assemblage" of "alternating layers of permeable sandstone and weak impermeable clay", and water that enters them raises the pore pressure in the slope (GSI note on Pernote, 2024; Commentary to Clause 4.11). That is why hill slopes, colluvium, slide debris and moraine are designed as HSG D: the group decides the runoff, and on a slope none of the water is to be put back into the ground. A single group D for the whole Union Territory would be conservative for peak flows, but it would deny recharge on the Kandi, which the CGWB calls "a very good medium for the recharge", in plains whose groundwater supplies Jammu city (CGWB, Ground Water Year Book 2021–22). The only regional measure of losses is the design loss rate of the CWC zone 7 report, 0.5 cm/h (5 mm/h) (Annex 3E). It is a φ-index fitted to the floods of whole rural catchments of the outer hills, one of them the Sewa in Kathua district; it shall be used only in rural SUH runs under Clause 3.11.4 in the Jammu

division, not in the Kashmir valley, not to assign an HSG, not in an urban SCS-CN or SWMM model, and not to size an infiltration practice. The interim groups of Clause 3.7.2, the 2 m water-table threshold for the Sirowal and the river terraces, the treatment of the valley floor, of hill slopes and of colluvium, slide debris and moraine, and the rule for untested soil on small sites are set by this Manual pending a soil-series lookup for Jammu and Kashmir. Slope matters as much as soil in the Union Territory, at both ends: hill towns whose runoff reaches a channel within minutes, and a valley floor so flat that its drains empty only as fast as the river and the pumps allow. The following rules are set by this Manual. (a) On the hill streets and nallahs of the outer and middle hills, with slopes of 10–60%, as at Udhampur, Katra, Reasi, Ramban, Batote, Doda, Kishtwar, Rajouri and Poonch, Kirpich and similar formulae give times of concentration of 1–5 minutes; Tc shall be found by the segment method of Clause 3.6.2 and shall not be taken below the 10-minute minimum of Clause 3.6.1, which matches the shortest design duration of Chapter 2, and the Kirpich formula, derived from small farm catchments of moderate slope, shall not be used even as a cross-check where the average slope of the flow path exceeds 10%. (b) The sheet-flow segment over bare rock, scree, a road cut or a paved hill street shall use the smooth-surface n of Table 3.4 and shall not exceed 30 m. (c) A catchment that runs from a hill flank onto a fan or a valley floor, such as the khads that leave the Siwalik hills onto the Kandi north of Jammu, Samba and Kathua, the nallahs that leave the Pir Panjal and the Zabarwan hills onto the Karewas and the floor of the Kashmir valley, or the side streams of the Chenab and the Tawi at Ramban, Doda and Udhampur, shall be split at the break of slope, and the hill sub-area modelled on its own, so that a long, flatter lower reach does not average away the fast response of the hill. A catchment that crosses the Kandi spring line shall also be split there, because below it the khads "gain water through groundwater seepage" (NAQUIM, Outer Plains of Jammu Province) and the land takes the groups and the AMC of the Sirowal. Channel losses into the boulder beds of the Kandi khads, which are "dry for most parts of the year" (same report), shall not be credited in a design storm, because the governing storms of the Jammu division come after weeks of monsoon rain, unless a continuous simulation calibrated under Clause 3.15 shows them. (d) On the floor of the Kashmir valley, where the land is nearly flat and the outfalls are closed whenever the Jhelum is high, Tc and the peak-flow methods size the minor drains only; the governing condition is the storage of the drains and low land, the capacity of the pumps and the stage of the river, modelled under Clauses 3.12 and 3.13 and Chapter 5 (Commentary to Clause 3.12). (e) No method of this chapter predicts debris flow; in steep catchments the design flow is bulked for sediment and debris, and inlets and culverts are protected against blockage, under Chapters 6 and 9.

3.8 SCS curve number (SCS-CN) loss method

3.8.1 **Runoff equation.** Runoff depth shall be computed by:

$$Q = (P - I_a)^2 / (P - I_a + S) \text{ for } P > I_a;\ Q = 0 \text{ otherwise } S = 25{,}400 / CN - 254$$

where Q is runoff depth (mm), P is the cumulative rainfall depth (mm), S is potential maximum retention (mm) and Ia is initial abstraction (mm). In hydrograph models the equation is applied to the cumulative rainfall at each time step to obtain incremental rainfall excess.

3.8.2 **Curve numbers.** CN at AMC II shall be taken from Table 3.5, for the HSG of Clause 3.7.

Table 3.5 — Runoff curve numbers, AMC II, Ia = 0.2S (USDA SCS TR-55, 1986, Tables 2-2a and 2-2c)

Cover type	HSG A	HSG B	HSG C	HSG D
Pre-development reference (Clause 3.3.2): open space, good condition (grass > 75%)	39	61	74	80

Cover type	HSG A	HSG B	HSG C	HSG D
Open space, fair condition (grass 50–75%)	49	69	79	84
Open space, poor condition (grass < 50%)	68	79	86	89
Impervious: roofs, paved parking, driveways, paved roads with kerbs and drains	98	98	98	98
Paved roads with open ditches (including right-of-way)	83	89	92	93
Gravel roads (including right-of-way)	76	85	89	91
Dirt roads (including right-of-way)	72	82	87	89
Newly graded areas (pervious, no vegetation)	77	86	91	94
Fallow, bare soil	77	86	91	94
Meadow (continuous grass, protected from grazing)	30	58	71	78
Brush, good condition	30	48	65	73
Woods, good condition	30	55	70	77
Woods, fair condition	36	60	73	79
Woods, poor condition	45	66	77	83
Water surfaces, tank waterspreads, wet detention basins	Runoff = rainfall (no losses)			

3.8.3 **Use of Table 3.5.**

- (a) Post-development CN shall be built up from measured surfaces (Clause 3.9). The TR-55 urban district and residential lot-size rows shall not be used for the site.
- (b) Pervious areas in the post-development condition shall use "open space" in the condition the landscape plan will achieve. Where no landscape plan is submitted, fair condition applies.
- (c) Cultivated rows of TR-55 may be used for off-site existing conditions, but never for the pre-development reference of Clause 3.3.2.

3.8.4 **Antecedent moisture.** AMC shall follow Clause 2.11.4: AMC III for every design storm, whatever its duration, from 1 March to 31 May on the floor of the Kashmir valley (the alluvium, Gurti clay and Nambal peat of sub-area JK-C of Annex 2A), and at any time of year there while the Jhelum stands at or above its flood-declaration level at Sangam or Ram Munshi Bagh (I&FC gauges, as reported); AMC III for every design storm from 1 July to 30 September on the Sirowal and the valley-floor alluvium of sub-area JK-A (Jammu plains, Kandi and Sirowal) and at a site in sub-area JK-B (Outer and middle hills) or JK-B1 (Inner Chenab hills); AMC III for every design storm at any time of year in sub-area JK-D (High mountains and snow-fed catchments), and in a catchment that drains to a reservoir or barrage pond or its backwater, such as Salal, Baglihar, Dul Hasti, Ranjit Sagar or the Tawi barrage at Jammu, or to a lake whose outlet the river can close, such as Dal, Anchar or Wular; at any other site or time, including the Kandi belt of sub-area JK-A and the Karewas, AMC III for a design storm that follows, or contains, a 5-day rainfall total of more than 53 mm; and AMC II for every other storm. CN for AMC I and III shall be obtained from AMC II by:

> $CN(I) = 4.2\ CN(II) / (10 - 0.058\ CN(II))$ $CN(III) = 23\ CN(II) / (10 + 0.13\ CN(II))$

The conversion shall be applied **to the pervious component only**. Impervious surfaces stay at CN 98 for all AMC. Composite CNs shall not be converted directly.

Illustrative — not design values. Pre-development reference CNs at AMC III are: HSG A 59.5; HSG B 78.2; HSG C 86.7; HSG D 90.2.

3.8.5 **Initial abstraction.**

- (a) **Default:** Ia = 0.2S, with the CNs of Table 3.5.
- (b) **Sensitivity run (mandatory):** every storage design shall also be run with Ia = 0.05S. For this run, S shall be converted as S0.05 = 1.33 · S0.20^1.15 (S in inches), which in SI is:

  > S0.05 = 25.4 × 1.33 × (S0.20 / 25.4)^1.15 (mm)

- (c) The design shall be based on the default run. The sensitivity results shall be reported on Form 3-2. Where the sensitivity run increases the required retention volume or water quality volume, the larger value governs for that volume.

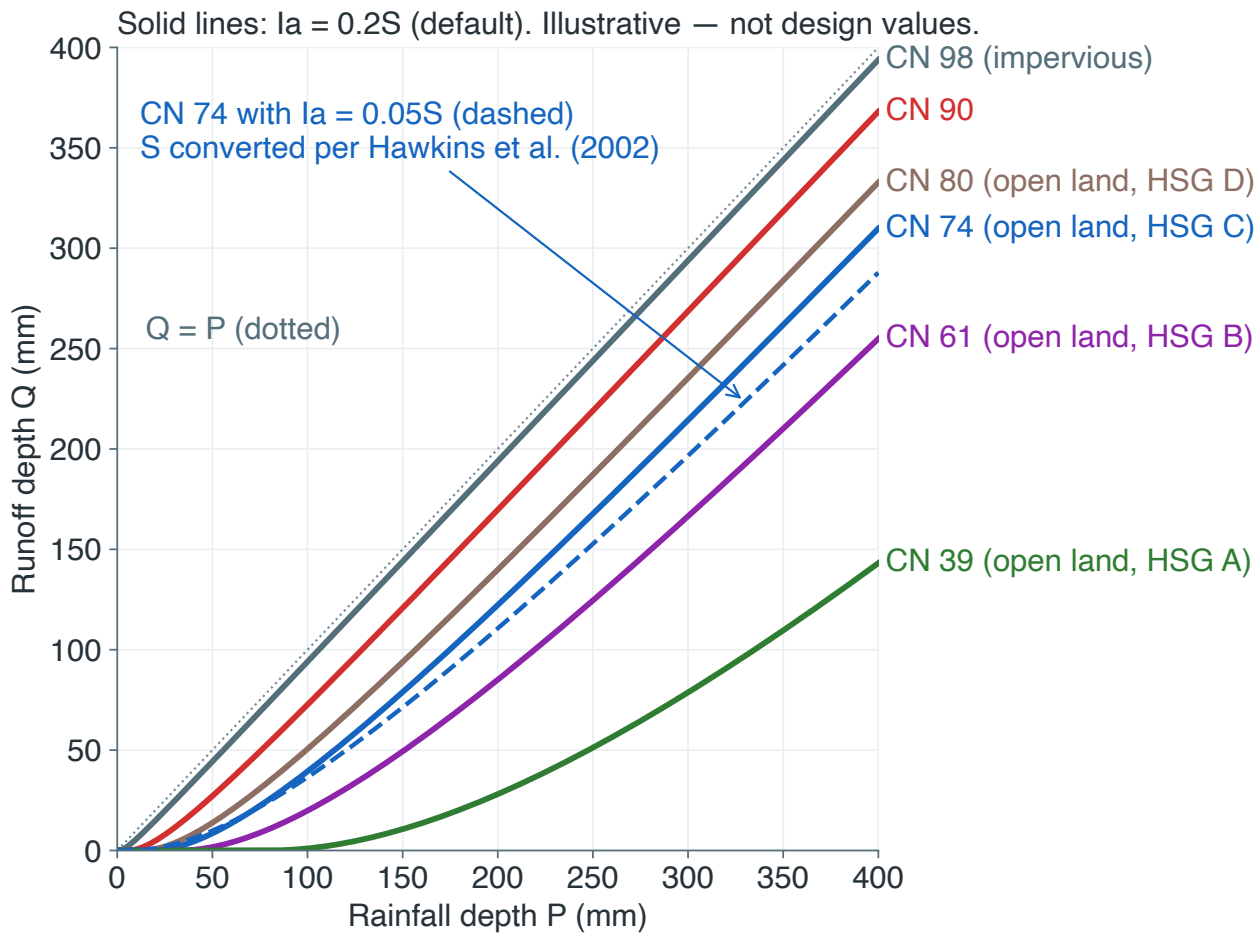

Figure 3.3 — SCS-CN runoff depth versus rainfall depth for selected curve numbers at Ia = 0.2S, with the Ia = 0.05S sensitivity case for CN 74. Original drawing for this Manual, computed from the runoff equation of USDA NRCS, NEH Part 630, Ch. 10 (2004) and USDA SCS TR-55 (1986), and the S-conversion of Hawkins et al. (2002). Illustrative — not design values.

> **Commentary.** Table 3.5 reproduces standard NRCS TR-55 (1986) values. They were derived from US catchments and have not been calibrated in Jammu and Kashmir. The AMC conversion equations are the standard NEH-4 relationships as given by Chow, Maidment and Mays (1988, §5.5). Converting only the pervious component follows APWA, which states that "direct conversion of composite antecedent moisture conditions is not appropriate" (KC Metro APWA 5600, 2011, §5602.2C). Converting a composite CN would wrongly lower the CN of the impervious part.
>
> Ia = 0.2S is the original NRCS ratio. Analysis of US rainfall–runoff data found that 0.05S fits better on average (Hawkins et al., 2002; Woodward et al., 2003), and gave the conversion of 3.8.5(b). NRCS has not formally replaced 0.2S, so this Manual keeps it as the default. Figure 3.3 shows why the sensitivity run is needed: for CN 74, the 0.05S case gives **more** runoff for small storms (about 2.0 mm vs 0.5 mm from 25 mm of rain) but **less** for large storms (about 242 mm vs 262 mm from 350 mm). *Illustrative — not design values.* The ratio therefore matters most for retention and water quality volumes, and the default 0.2S is the conservative choice for peak and detention design. The rule in 3.8.5(c) that the larger retention or water-quality volume governs has no direct precedent; this Manual sets it because the 0.05S case gives more runoff from the small storms that set those volumes.

3.9 Impervious connectivity

3.9.1 **Classification.** Every impervious surface in the post-development condition shall be classified as directly connected (DCIA) or disconnected, and shown on the drainage plan.

3.9.2 **Preferred representation.** In hydrograph models, DCIA and pervious areas shall be modelled as separate sub-areas (or as the separate impervious and pervious fractions of a SWMM subcatchment), each with its own loss parameters. The runoff from disconnected impervious areas shall be routed onto the receiving pervious area.

3.9.3 **Disconnection criteria.** An impervious area may be classed as disconnected only if all of the following hold:

- (a) its runoff discharges as sheet flow onto a pervious area, without a pipe, channel or kerb;
- (b) the pervious flow path is at least as long as the impervious flow path draining to it;
- (c) the pervious area is not compacted, not HSG D, and is protected from paving by the approved plan; and
- (d) for storms of 12 hours or more, it does not drain to an RWH sump or tank (Clause 3.3.3(c)).

3.9.4 **Composite CN.** Where a single composite CN is used instead of 3.9.2, it shall be computed as:

- for directly connected impervious area: $CNc = CNp + (Pimp / 100)(98 - CNp)$;
- where total impervious area is below 30% and part of it is disconnected: $CNc = CNp + (Pimp / 100)(98 - CNp)(1 - 0.5\,R)$,

where CNp is the pervious CN, Pimp is the percentage of impervious area and R is the ratio of disconnected to total impervious area. The composite CN shall not be used for retention or water quality volumes.

> **Commentary.** The composite equations are from TR-55 (USDA SCS, 1986, Ch. 2, Figures 2-3 and 2-4). This Manual prefers separate representation in 3.9.2 because a composite CN spreads the impervious response over the whole area, which suppresses runoff from small storms. For a site that is 50% directly connected impervious on HSG B open space (CNp 61), 25 mm of rain gives about 9.9 mm of runoff when the two parts are modelled separately, but only about 1.8 mm with the composite CN 79.5. At 200 mm the two methods agree (139.5 mm vs 138.4 mm). *Illustrative — not design values.* The error is largest for the frequent storms that set retention and

water-quality volumes. The disconnection criteria of 3.9.3 are set by this Manual, drawing on common practice in US runoff-reduction manuals. Criterion (d) follows the rule of Clause 3.3.3(c) that RWH sumps are full at the start of SW monsoon storms.

3.10 Groundwater, high water table and tank backwater

3.10.1 **High water table (dual HSG).** Where the seasonal high groundwater table is within 0.6 m of the ground surface, the soil shall be assigned HSG D for both the pre- and post-development runs, whatever its texture, unless it is permanently drained by works that are maintained under Chapter 10. This rule applies in every case to storms of 12 hours or more, which are run at AMC III (Clause 2.11.4).

3.10.2 **Water-table data.** The seasonal high water table shall be taken as the highest level recorded in the SW monsoon season (June–September), from site piezometers or trial pits, or from the nearest Central Ground Water Board (CGWB) or Jal Shakti Department observation well, adjusted for ground level.

3.10.3 **Infiltration-based losses.** Where Green–Ampt, Horton or soil-moisture-accounting losses are used instead of SCS-CN, the cumulative infiltration in any storm shall not exceed the storage available in the soil above the seasonal high water table.

3.10.4 **Tank and waterbody backwater.** Where a site or sub-catchment drains to a tank, talab, marsh or other waterbody:

- (a) the water level in the receiving waterbody shall be applied as the downstream boundary of the model, per Chapter 5 and Chapter 7;
- (b) land below the level of the receiving waterbody in the design event (including the tank foreshore below FTL) shall be modelled as water surface or storage, with no losses; and
- (c) where the outfall is submerged by the waterbody level, the routing shall use the dynamic-wave method of Clause 3.12.4.

Commentary. The dual-group rule follows NEH Part 630, Ch. 7 (USDA NRCS, 2009), which places wet soils with a water table within 60 cm (24 in) of the surface in group D in their undrained state, with a dual group (A/D, B/D, C/D) where drainage is feasible. This Manual applies the undrained group to long storms because much of the land on which the people of Jammu and Kashmir live is wet for part of the year. On the floor of the Kashmir valley water stood 0–2 m below ground over the central and south-western parts in November 2014, and "artesian wells are seen throughout the valley … on either sides of Jhelum River", with piezometric levels "between 2 m agl and 12 m bgl"; in Anantnag district "almost all the wells drilled below 25 m by CGWB shows flowing conditions" (NAQUIM, Kashmir Valley), and a well at Charsoo flowed 2.50 m above ground (CGWB, Anantnag district booklet). In May 2021, 55% of the observation wells of the Kashmir region and 81.8% of those of Baramulla district stood within 2 m of the surface (CGWB, Ground Water Year Book 2021–22), and in Srinagar district water stands 2.00–3.00 m below ground before the monsoon and 1.50–2.50 m after it (CGWB, Srinagar district booklet, data to 2008); the only Srinagar well in the 2021–22 year book, at Regal Chowk, read 4.02 m and 3.84 m. The valley's groundwater year does not follow the plains': winter rain, snowfall and snowmelt recharge the aquifers, the deepest levels come in November and "shallowest water levels are observed during May" (NAQUIM, Kashmir Valley). Clause 3.10.2 reads the seasonal high water table in the SW monsoon season; in sub-area JK-C the levels of March to May shall also be read wherever records exist, and the higher of the two shall govern, so that the snowmelt high is not missed (set by this Manual). On the valley floor the design groundwater level for flotation is ground level in any case (Clause 4.12.1). In the Jammu plains the Sirowal, below the Kandi spring line, has water "less than one metre to about ten metres" below ground, in its major part two to five metres, with waterlogging towards its south-western extremity and flowing wells at Hiranagar, Rajpura, Jangi Chak, Airwan and Nagri; in Kathua district "More than 50% of the wells are under flowing condition" (NAQUIM, Outer Plains of Jammu Province). The Kandi above it is the opposite case, with water 7–30 m below ground over most of the belt and up to 84 m in the deeper

aquifers. In the hills groundwater occurs in fractures, weathered rock and debris and is perched in places: at Pernote in Ramban district "the water table is shallow", and springs and seepages flowing at 0.5–1.5 L/min loosened the slope that failed in April 2024 (GSI note, 2024). The floodplains and low terraces of the rivers and khads, where the water table follows the river, and the margins of the lakes, nambals, talabs and reservoirs are the other wet land. No monsoon or snowmelt water-table depths for individual town sites, and no map of the seasonal high water table, were obtained [TBC]; Annex 3A is to supply them. Clause 3.10.4 reflects the Union Territory's receiving waters, which are an embanked river above a pumped city, lakes whose gates the river shuts, khads with no gauges and reservoirs held for power. Srinagar drains to a Jhelum that in flood stands above much of the city behind its embankments: the CWC site at Ram Munshi Bagh has a danger level of 1,585.48 m and a highest level of 1,588.99 m, set on 8 September 2014 (CWC, as transcribed by SANDRP), while I&FC declares a flood at 18 ft and danger at 21 ft on its own gauge there, whose zero is not published (as reported), so the two sets of levels cannot be tied together and no I&FC foot reading is converted to metres in this Manual. Dal discharges through the Dal Gate, a lock to the Tsunth Kol and the Jhelum, and through the Nallah Amir Khan to Nigeen, Gilsar, Khushalsar and Anchar (JKPCC, 2024), and when the river rises to a certain height the gates of the Dal "automatically close" (Grierson, *A Dictionary of the Kashmiri Language*, *Ḍal-darwāza*), so land in the Dal catchment below the lake's level drains to a water surface, and Clause 3.10.4(b) applies to it; the same holds for the land round Wular, whose danger level is reported as 1,578 m (I&FC, as reported). In the Jammu division the Tawi at Sidhra rose to 321.1 m on 26 August 2025, above its earlier highest level of 318.85 m (2014), and the Chenab at Akhnoor holds its highest level of 324.29 m from 10 September 1992 (CWC, as transcribed by SANDRP); the Tawi barrage at Jammu, whose first phase was dedicated on 14 April 2026 (as reported), holds a pond whose level is not published [TBC]; and Akhnoor, Reasi and the Chenab towns lie on or below the reaches of the Salal (full reservoir level 487.68 m) and Baglihar (840 m) reservoirs (as reported). The 365 ponds of the Kandi belt, 249 in Jammu district and 116 in Kathua district, of which 165 are perennial (NAQUIM, Outer Plains of Jammu Province, citing NIH, 2000), and the surviving talabs of Jammu are small waterbodies to which Clause 3.10.4 applies in the same way.

3.11 Unit hydrographs and runoff transformation

3.11.1 **Permitted transforms.**

- (a) SCS (NRCS) dimensionless unit hydrograph, curvilinear or triangular, for catchments below 25 km² and for any sub-area of a larger model;
- (b) the SWMM non-linear reservoir with kinematic overland flow;
- (c) Clark or ModClark unit hydrograph in HEC-HMS, where parameters are calibrated under Clause 3.15; and
- (d) the CWC synthetic unit hydrograph, for 25–5,000 km² (Clause 3.11.4).

3.11.2 **SCS unit hydrograph.** The peak and time to peak of the unit hydrograph shall be:

> qp = PRF′ · A · Q / tp, with PRF′ = 0.208 (SI form of the standard peak rate factor 484) tp = Δt / 2 + tL, tL = 0.6 Tc

where qp is the peak flow (m³/s); A is the area (km²); Q is the runoff depth (mm), equal to 1 mm for the unit hydrograph; tp is the time to peak (h); and Δt is the computation interval (h).

3.11.3 **Computation interval and sub-areas.**

- (a) Δt shall not exceed 0.133 Tc of the smallest sub-area, nor the hyetograph time step of Clause 2.9.1.
- (b) Sub-areas shall be reasonably uniform in HSG, land cover and slope. Pervious and directly connected impervious areas shall be separate sub-areas, per Clause 3.9.2.

3.11.4 **CWC synthetic unit hydrograph.** For catchments of 25–5,000 km² in CWC zone 7 (Western Himalayas), which covers the whole of Jammu and Kashmir, other than its snow-fed catchments:

- (a) the SUH parameters, design storm duration, loss rate, base flow, areal reduction and time distribution shall be taken from the applicable CWC Flood Estimation Report, using the catchment's physiographic parameters measured from survey or a DEM;
- (b) the 24-hour design rainfall shall follow Clause 2.3.3(b) and Clause 2.7.3, and the climate factor of Clause 2.8 shall be applied;
- (c) the SUH result shall be reported alongside the HEC-HMS or SWMM result for the existing natural condition; and
- (d) where the hydrograph model gives a lower 1% AEP peak than the CWC SUH, the designer shall either justify the model by calibration under Clause 3.15 or adopt the CWC SUH peak.

3.11.5 **Peak rate factor for flat coastal land.** The standard factor (484; PRF' = 0.208) is the default. A lower factor may be used only:

- (a) for unchannelled, flat coastal-plain land without piped or lined drainage;
- (b) in the same way in both the pre- and post-development runs for any land that stays unchannelled; and
- (c) after the authority adopts calibrated values in Annex 3D.

Land drained by pipes, lined drains or kerbs in the post-development condition shall use the standard factor.

> Commentary. The SCS unit hydrograph, the 0.6 lag ratio and the 0.133 Tc interval are from NEH Part 630, Ch. 16 (USDA NRCS, 2007). The interval follows from the unit hydrograph geometry: with tp = Δt/2 + 0.6 Tc and Tc + Δt = 1.7 tp, Δt = 0.133 Tc. The SI constant 0.208 is the direct conversion of 484 (cfs, mi², in, h). APWA uses the SCS dimensionless unit hydrograph as its basis (2011, §5602.5). The CWC Flood Estimation Reports give regression equations for SUH parameters, a design storm duration, a constant loss rate and ARF and time-distribution curves for each subzone (CWC 1994; see Chapter 2). They were derived from natural, mostly rural catchments with data that predate the report of 1994 (one of its six gauged catchments, the Sewa at the Sewa hydro-electric project in Kathua district, drains Jammu and Kashmir; the other five were gauged at railway bridges outside the Union Territory in 1962–67), so they represent pre-development conditions, not urbanised ones. That is why the SUH is used as a benchmark rather than as the post-development model. Clause 3.11.4(d) mirrors the floor principle of Clause 2.3.3. HEC-HMS has been calibrated against CWC subzone SUH responses in Indian studies, which shows the two can be linked.
>
> The lower-factor option of 3.11.5 is based on the NRCS Delmarva unit hydrograph, which uses a peak rate factor of 284 (PRF' ≈ 0.122) for flat, poorly channelled coastal-plain catchments on the Delmarva Peninsula (Welle et al., 1980, as adopted by NRCS; New Jersey Department of Agriculture, Delmarva bulletin, which uses 285). A lower factor gives a lower, later peak. Used only in the pre-development run, it would lower Q_pre and make the release cap stricter; used in a piped post-development run, it would understate Q_post. Clause 3.11.5(b) prevents both biases.

3.12 Routing

3.12.1 **Storage routing.** Routing through detention and retention facilities, tanks, ponds and any storage behind embankments shall use level-pool (modified Puls, storage-indication) routing with:

- (a) a stage–storage relationship from the design grading or survey;
- (b) a stage–discharge relationship for every outlet (orifices, weirs, surplus weirs, pumps), including the minimum orifice and trash screen of Chapter 4; and
- (c) the tailwater boundary of Chapter 5, where the tailwater affects the outlet rating.

3.12.2 **Channel routing.** Routing through channels and drains shall use the Muskingum–Cunge method, or the Muskingum method with parameters K and X that are derived from channel geometry or calibration. For the Muskingum method, the routing interval Δt shall satisfy $2KX \le \Delta t \le 2K(1 - X)$.

3.12.3 **Incidental storage.** Storage behind road embankments, culverts or boundary walls that is not part of an approved facility shall not be counted in the design unless the authority is satisfied that it will be maintained for the design life.

3.12.4 **Dynamic-wave routing.** Dynamic-wave (full Saint-Venant) routing, in SWMM or HEC-RAS unsteady flow, shall be used where:

- (a) the outfall is under tidal, river or tank backwater (Chapter 5, Clause 3.10.4);
- (b) flow can reverse, or the network has loops or overflow links; or
- (c) the network surcharges in the design event and the hydraulic grade line sets the design.

3.12.5 **Tank cascades.** Tanks in a cascade shall each be routed by Clause 3.12.1, with the surplus weir and sluice ratings and the documented operating rule of Chapter 7. The starting water level in each tank shall be FTL unless continuous simulation (Clause 3.13) supports a lower level.

> Commentary. Modified Puls routing for storage and Muskingum–Cunge for channels are the APWA requirements (KC Metro APWA 5600, 2011, §5602.8). APWA also excludes "incidental detention" behind embankments unless it will be maintained, which 3.12.3 adopts. CPHEEO's detention procedure uses the same three inputs as 3.12.1: an inflow hydrograph, a stage–storage curve and a stage–discharge curve (CPHEEO 2019, Part A §8.5.3). The Muskingum stability limits are standard (Chow, Maidment and Mays, 1988, §8.4). This Manual starts lakes, nambals, talabs, reservoirs and barrage ponds at their full or highest working level in 3.12.5 because the heaviest rain of both of the Union Territory's rainfall regimes falls on waterbodies that are already high. In the Kashmir valley the lakes and marshes rise in spring, when western disturbances bring the year's wettest month (March, 104.6 mm at Srinagar), snowmelt raises the Jhelum and the water table is at its shallowest in May (IMD normals 1991–2020; NAQUIM, Kashmir Valley), and the Union Territory's great floods have come in September, after weeks of rain, as in 1988, 1992 and 2014. In the Jammu division Jammu receives 77% of its annual 1,401.9 mm in June–September, with the peak in July, and Katra peaks in August (IMD normals 1991–2020). Design storms come in every season (Chapter 2). No lake, nambal or reservoir level in the Union Territory was found tied to a stated datum, and the I&FC gauges read in feet on zeros that are not published [TBC]; no I&FC foot reading is converted to metres in this Manual. The starting levels are as follows.
>
> - **Dal and Nigeen.** Dal drains through the Dal Gate, a weir and lock to the Tsunth Kol and the Jhelum, and through the Nallah Amir Khan to Nigeen, Gilsar, Khushalsar and Anchar (JKPCC, 2024), and its gate shuts when the river rises (Commentary to Clause 3.10). A Dal level of "10.5 feet" was reported in September 2025, with releases possible "only to the extent of two to three feet" because of silt (as reported), but neither the gauge nor its datum is known, so the figure is not used as a level. Until LCMA publishes the levels of its gauge, the Dal Gate weir and the Nallah Amir Khan outlet, with their datum [TBC], Dal and Nigeen are started at the crest of their outlets, with no outflow through the Dal Gate while the Jhelum at Ram Munshi Bagh stands at or above flood-declaration stage (Chapter 5).
> - **Wular.** Wular is started at 1,578 m, the danger level reported for its gauge (I&FC, as reported; datum to be confirmed [TBC]); the gauge was reported at 1,575.66 m on 27 August 2025. Wular is the outfall of the Jhelum below Asham and of the flood spill channel, so its level is set by the river, not by the towns on its shore.
> - **Anchar, Hokersar, Narkara, Shallabugh, Rakh-e-Arth and the other nambals and flood basins.** No outlet level, gate rule or level record was found [TBC]. They are started at their spill or outlet level, and, while the Jhelum stands at or above flood-declaration stage, they are modelled as part of the river's flood storage, at the river's level where they connect to it, not as storage for the town beside them. Regulatory gates at Hokersar are reported among the works of the second phase of the Jhelum flood plan (as reported); once built, they are modelled with their published operating rule.

- **Manasbal, Mansar and Surinsar.** No outlet level or level record was found [TBC]; they are started at their spill or outlet level.
- **Kandi ponds and Jammu talabs.** The ponds of the Kandi belt and the surviving talabs of Jammu are rain-fed and small; they are started full from 1 July.
- **Reservoirs and barrage ponds.** Salal (full reservoir level 487.68 m, NHPC) and Baglihar (840 m, JKSPDC) are reported levels (as reported); the Ranjit Sagar full reservoir level is reported as 527.91 m and, in another account, 527.13 m, and the higher is used; the levels of Dul Hasti, Ratle and Pakal Dul and the pond level of the Tawi barrage were not found [TBC]. Each is started at the maximum water level published by its operator (NHPC, JKSPDC, the operator of Ranjit Sagar in Punjab or I&FC), or, where none is published, at its full or pond level plus 0.5 m. Their gates are opened for desilting and flood passage, Salal's at least once a month in the monsoon, and since April 2025 such operations may not be announced (as reported) (Chapter 5).

A gated reservoir, barrage or lake is modelled with its gate rule from its operator, and a waterbody is modelled below these levels only where a continuous simulation under Clause 3.13 or a notified operating rule supports it. In sub-area JK-C every drainage system whose outfall the Jhelum can close shall be modelled under Clause 3.13 by a continuous run, or a long-event run of at least the outfall-closed duration of Chapter 5, that carries the storage of its drains, sumps and low land, the pump curves, starting levels and switching rules of its pumping stations, the gate of each gravity outfall, and a time-varying Jhelum stage at the nearest CWC site (Ram Munshi Bagh, Sangam or Safapora) as Chapter 5 sets it; its calibration under Clause 3.15 shall include one long western-disturbance or snowmelt event of March–May as well as one SW monsoon event, such as September 2014 (set by this Manual). The city's own rain is not the governing input there: Srinagar's stations recorded only about 140–152 mm over the storm of September 2014, while the flood came down the river (Ray et al., 2015). The window of 1 March to 31 October in Clause 3.13.5(a) is set by this Manual. It starts on 1 March because the Kashmir valley's lakes, nambals and water table are high from the western disturbances and snowmelt of March–May, and because many of the Union Territory's largest falls came outside the SW monsoon, such as 261.9 mm at Katra and 145.2 mm at Jammu on 13 March 2007 (IMD). It ends on 31 October because the monsoon withdraws from most of Jammu and Kashmir only by 1 October (IMD), the normal withdrawal at Jammu being 21 September, and because October storms are a real threat: Jammu recorded 160.0 mm on 5 October 1955 and Basohli 229 mm on 14 October 1955 (IMD; CWC zone 7 report, Annex 4.3). In sub-area JK-C pumps and gates stay on standby from 1 March to 31 October, and elsewhere pumps, gates and debris screens stay on standby to 31 October (Chapter 10).

3.13 Continuous simulation

3.13.1 **When required.** Continuous simulation shall be carried out, in addition to the design-storm analysis, for:

- (a) regional facilities draining more than 25 km²; and
- (b) any system that includes a tank cascade whose storage is counted in the design (Chapter 7).

The authority may also require it for any facility where the starting storage level governs the design.

3.13.2 **Rainfall input.**

- (a) The longest available hourly record from IMD or another approved recording gauge representative of the catchment shall be used.
- (b) Where hourly data are shorter than 30 years, the record shall be extended with the IMD 0.25° gridded daily data. The full gridded record (1901 to present) should be used; at least the most recent 30 years shall be. The daily data shall be disaggregated to hourly by a method stated in the submittal and checked against the hourly gauge for the overlapping years. Grid values shall be converted to point values under Clause 2.7.1 where applicable.

- (c) A future-climate run shall scale the record by the climate factors of Clause 2.8.

3.13.3 **Model content.** The model shall include soil-moisture accounting with evaporation (IMD pan evaporation or equivalent), groundwater or base flow, tank storage with operating rules and irrigation withdrawals, and the tailwater series of Chapter 5 (predicted tides plus a surge allowance for coastal outfalls).

3.13.4 **Use of results.** Annual maxima of water level, storage and volume, and the duration of outfall closure, shall be extracted and fitted by frequency analysis. Results shall be compared with the design-storm results. The more severe result at each AEP governs. Peak flows in drains and channels with a response time of less than one day shall be taken from the design-storm analysis where the continuous record was disaggregated from daily data, because the disaggregated hourly peaks are synthetic.

3.13.5 **Two-step approach.** The continuous simulation need not use the full hydraulic model. It may use a simplified hydrologic and storage model, at a daily or hourly step, that represents the soil moisture, groundwater, tank storage, operating rules and tailwater of 3.13.3. Its results shall then be passed to the design-storm runs of the full hydraulic model as:

- (a) the **starting level of each tank**, taken as the level exceeded on 10% of the days from 1 March to 31 October over the record; and
- (b) the **antecedent soil-moisture condition**, taken from the same days and compared with the AMC rule of Clause 3.8.

The designer shall show that the simplified model reproduces the water balance of the full model for at least one recorded event.

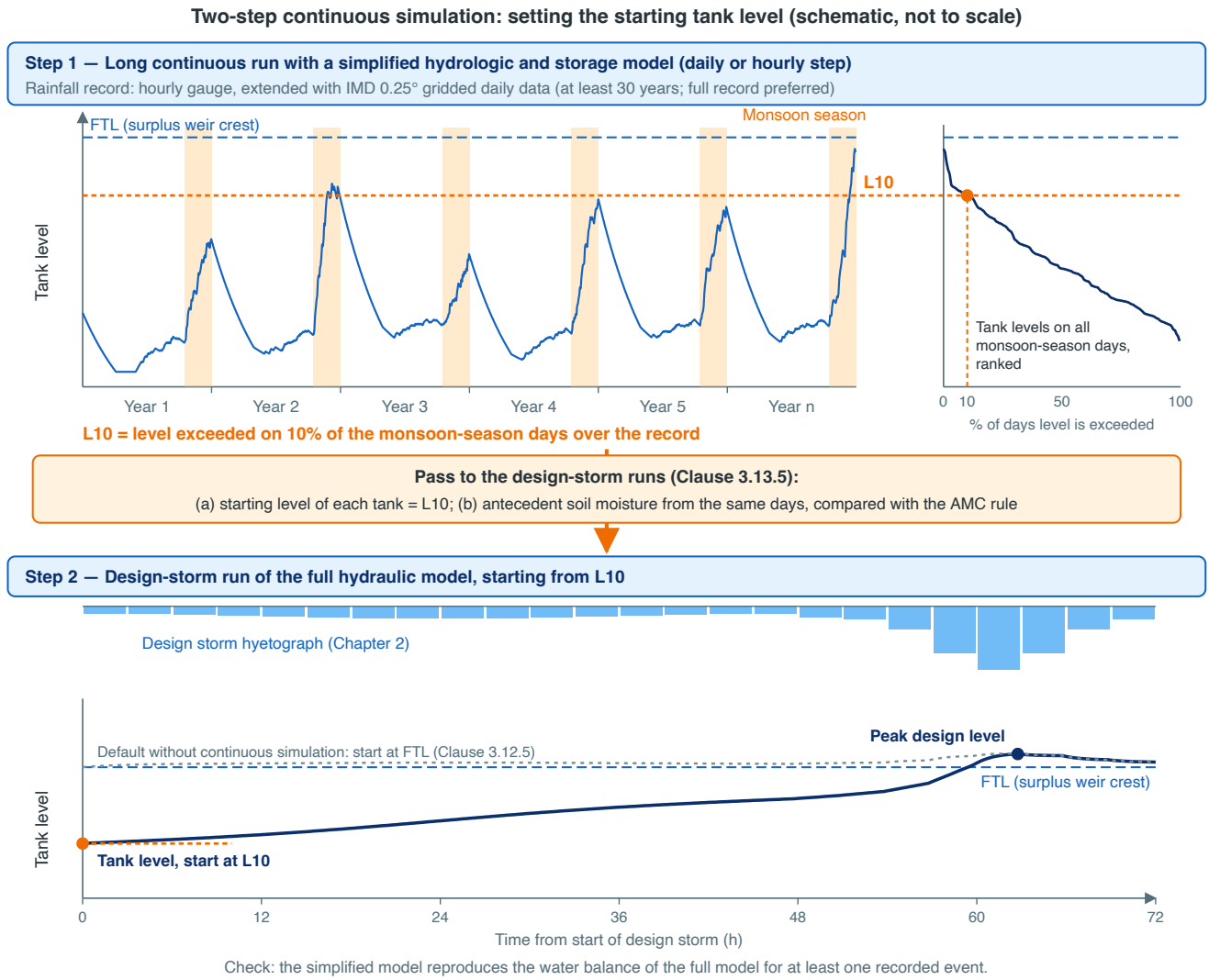

Figure 3.4 — Two-step approach of Clause 3.13.5. Step 1: a long continuous run with a simplified hydrologic and storage model gives the tank level exceeded on 10% of the days from 1 March to 31 October (L10). Step 2: the design storms are run in the full hydraulic model from that starting level, in place of the default start at FTL of Clause 3.12.5. Schematic, not real data. Original drawing for this Manual, illustrating the two-step approach set by this Manual in Clause 3.13.5.

> **Commentary.** Design storms assume one starting condition, but in a tank cascade the governing variable is how full the tanks are when the storm arrives, which depends on the weeks of rain before it. An Australian study of 20 real on-site detention systems found that designs based on one temporal pattern, or even an ensemble of ten, "cannot reliably produce an OSD system design that will always be effective" under real rainfall, and continuous simulation showed frequent-event peaks exceeding pre-development levels (Water Science and Engineering, 2019). The 30-year minimum in 3.13.2(b) matches the station IDF rule of Clause 2.3.2; a longer record is better, and the IMD gridded daily record, which starts in 1901, is the practical long series for Jammu and Kashmir. The record length matters less than what the simulation is for. Its main purpose here is to find how full the tanks and soils usually are when a south-west monsoon storm arrives, and how often heavy rain coincides with a closed outfall. A design storm cannot answer either question, because it starts from one assumed condition. It is not intended to replace design storms for the peak flow in urban drains. Clause 3.13.5 therefore allows the long run to be made with a simple storage model, which takes minutes, and passes the starting tank levels to the detailed hydraulic model, which is then run only for the design storms. Running a detailed 1D–2D city model continuously for decades is rarely practical and is not required. The 10% exceedance level in 3.13.5(a) is set by this Manual: it represents a wet but not exceptional monsoon, so that the design storm arrives on tanks that are already well filled, as they were in September 2014, when the Jhelum broke through its embankments at Srinagar, Wular and the flood basins west of the city, Hokersar, Narkara and Anchar among them, filled, about 34% of the Srinagar planning area (262 km²) went under water (Srinagar Master Plan 2035) and parts of the city stayed flooded for up to 25 days (Malik, 2021).

3.14 Pre- vs post-development comparison procedure

3.14.1 The comparison required by Clause 2.11 and Chapter 4 shall be carried out by the following steps. The results shall be recorded on Form 3-2.

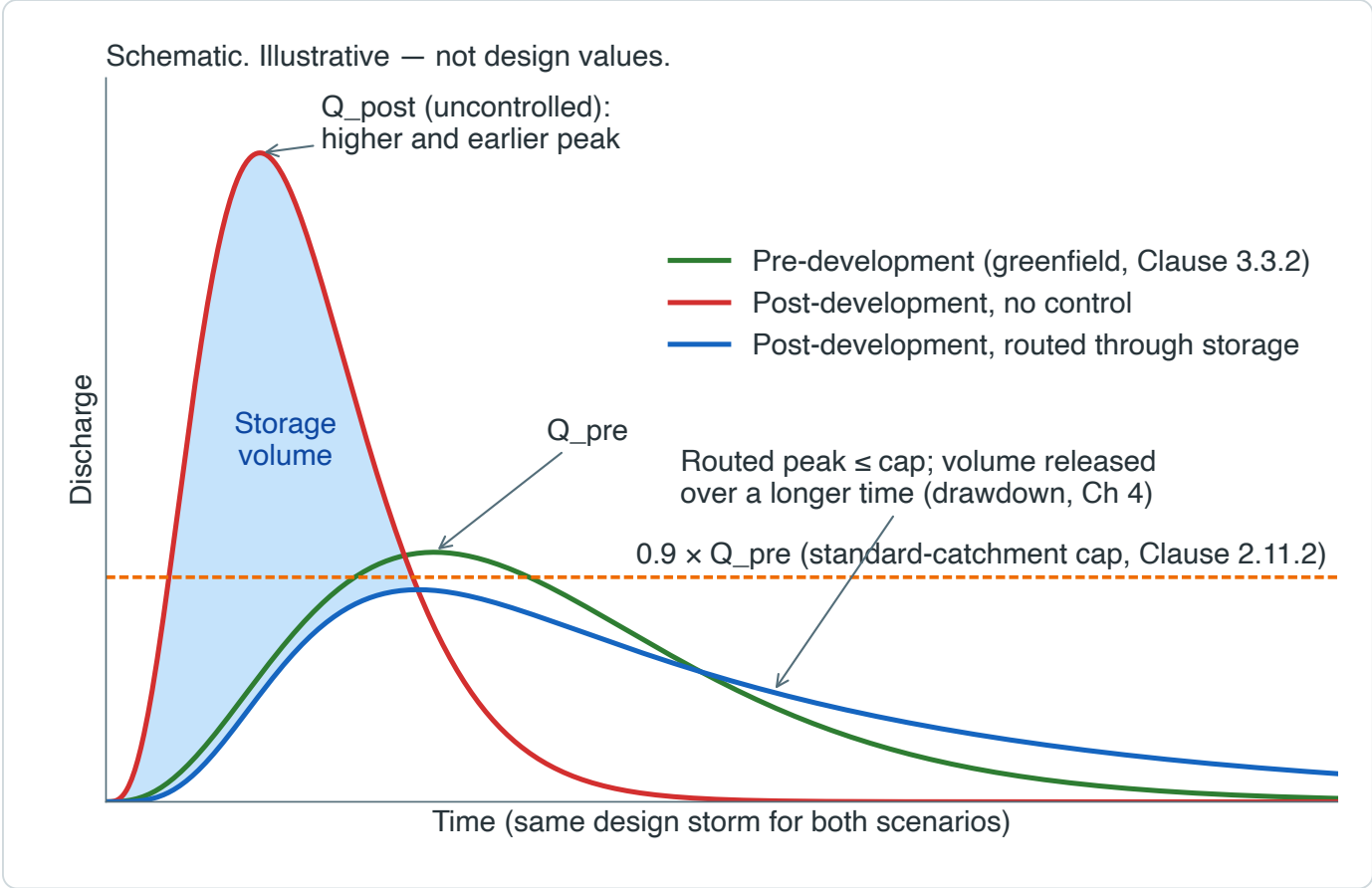

Figure 3.5 — Pre-development, uncontrolled post-development and routed post-development hydrographs for the same design storm. Original drawing for this Manual, adapted from the pre- vs post-development detention concept in CPHEEO, Manual on Storm Water Drainage Systems, Part A §8.5, 2019, and KC Metro APWA Section 5600, 2025.01. Schematic. Illustrative — not design values.

3.14.2 **Step 1 — Define the site, catchments and points of comparison.**

- (a) Delineate the site and every area that drains to it, from survey.
- (b) Identify each POC where runoff leaves the site. Each POC shall be tested separately. Runoff shall not be diverted from one natural catchment to another to meet the criterion.
- (c) Model off-site run-on identically in both runs, at its existing condition (Clause 3.3.5(b)). Where it passes through the site's storage, the criterion applies to the total outflow at the POC.

3.14.3 **Step 2 — Soils.** Map HSG (Clause 3.7), apply the high-water-table rule (Clause 3.10.1) and record the infiltration tests.

3.14.4 **Step 3 — Pre-development model.** Build the pre-development model per Clause 3.3.2: greenfield CN (Table 3.5), Tc (Clause 3.6, with n = 0.15), and existing waterbodies and channels. Compute CN at AMC II and AMC III.

3.14.5 **Step 4 — Post-development model.** Build the post-development model per Clause 3.3.3: measured impervious areas, connectivity (Clause 3.9), disturbed-soil HSG, CN, Tc, and the proposed retention, detention and outlets as storage (Clause 3.12.1).

3.14.6 **Step 5 — Design storms.** From Chapter 2, prepare for each required AEP (50%, 10% and 1%; 2-, 10- and 100-yr) and each duration in {1, 2, 3, 6, 12, 24, 48, 72 h}:

- the depth with the climate factor (Clause 2.8), ARF = 1.0 for the site (Clause 2.7.4);
- the hyetograph (Clause 2.9); and
- the AMC (Clause 2.11.4).

The same storms shall be used in both runs (Clause 2.11.1).

3.14.7 **Step 6 — Run the pre-development model** for every storm and tabulate Q_pre(T, d). For flood-sensitive catchments, identify the largest 10% AEP pre-development peak over all durations; that value is the cap of Clause 2.11.3.

3.14.8 **Step 7 — Run the post-development model without controls** and tabulate Q_post(T, d) and runoff volumes. This shows the size of the problem and is reported, not tested.

3.14.9 **Step 8 — Add retention and detention.**

- (a) Represent the retention volume of Chapter 4 as storage that is lost to infiltration or reuse (not released to the POC) within the period verified under Chapter 4.
- (b) Route the remaining hydrograph through the detention storage and outlets (Clause 3.12.1).
- (c) Apply the tailwater of Chapter 5, including the joint cases of Clause 2.12, where the outfall is tidal or under backwater.
- (d) Adjust storage and outlets until Step 9 is met.

3.14.10 **Step 9 — Test the criterion** at each POC, for every AEP and every duration:

- (a) standard catchments: Q_post(T) ≤ 0.9 × Q_pre(T) for the 50%, 10% and 1% AEP (Clause 2.11.2);
- (b) flood-sensitive catchments: Q_post(1% AEP) ≤ Q_pre(10% AEP), and Q_post(50% AEP) ≤ Q_pre(50% AEP) (Clause 2.11.3).

The governing duration for storage is the one that needs the largest storage or gives the highest water level; the 24, 48 and 72 h runs are always reported (Clause 2.5.2).

3.14.11 **Step 10 — Sensitivity runs.** Repeat Steps 6–9 for the governing storms with Ia = 0.05S (Clause 3.8.5) and, where a lower peak rate factor is used, with the standard factor (Clause 3.11.5). Report the change in peaks and required storage.

3.14.12 **Step 11 — Associated checks.** Using the final routed model, check the drawdown times, minimum orifice and emergency spillway of Chapter 4, the outfall-closed storage check of Chapter 5, and the downstream analysis of Chapter 5.

3.14.13 **Step 12 — Document** the results on Forms 3-1 and 3-2 (Clause 3.17).

> Commentary. The step sequence follows the standard event-based workflow: delineate; set pre-development CN and Tc; set post-development CN and shorter Tc; run identical storms through a unit hydrograph or kinematic model; compare peaks and volumes; and size storage by modified Puls routing. It adds the Jammu and Kashmir elements: the 48–72 h storms, AMC III, and tailwater. Figure 3.5 shows why the long-duration runs matter: the routed peak can meet the cap while the storage holds the volume difference between the post- and pre-development hydrographs, which must then drain within the Chapter 4 limits. The ban on diverting runoff between catchments in 3.14.2(b) stops a site meeting the rule at one POC by moving flow to a neighbour's drain.

3.15 Model calibration and validation

3.15.1 **When required.** Calibration and validation are required for:

- (a) catchment models of 25 km² or more;
- (b) regional facilities and continuous simulation under Clause 3.13;
- (c) city or basin drainage master plans; and

- (d) any model whose parameters differ from the defaults of this chapter (for example a Clark transform or a lower peak rate factor).

3.15.2 **Data.** Calibration shall use observed rainfall (gauges, and radar where available) and observed flows or water levels (I&FC gauging sites, SMC or J&K SDMA level sensors, tank gauges, or surveyed flood marks).

3.15.3 **Events.** At least three independent events shall be used for calibration and at least one further event for validation. At least one event shall be a long-duration SW monsoon or cyclone event (for example the storm of 3–6 September 2014 (599.8 mm at Qazigund over the four days and 698.6 mm in 72 hours at Katra; Ray et al., 2015) or the storm of 26–27 August 2025 (380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30 IST on 27 August; IMD), where data exist).

3.15.4 **Performance.** The submittal shall report, for each event, the observed and modelled peak, volume and time to peak, and for continuous models the Nash–Sutcliffe efficiency (NSE) and percent bias. As a guide, a calibrated model should reproduce event peaks and volumes within ±25%, and a continuous model should achieve NSE ≥ 0.5 and percent bias within ±25%.

3.15.5 **Limits on calibration.** Calibration shall not be used to justify design flows lower than those given by the default methods of this chapter, unless site-specific factors are thoroughly examined and documented and the authority agrees.

3.15.6 **Reasonableness check.** Design peak flows shall be plotted as discharge per unit area against catchment area and compared with the CWC SUH results, regional gauged estimates and known historical floods.

> Commentary. Clauses 3.15.5 and 3.15.6 follow APWA, which states that "model calibration shall not be used to justify discharge estimates that are lower than those provided by the baseline unit hydrograph method" and requires unit discharges to be plotted against tributary area and compared with regression, gauge and historical values (KC Metro APWA 5600, 2011, §5602.9). The event-count and performance values in 3.15.3 and 3.15.4 are set by this Manual. The NSE ≥ 0.5 and ±25% bias thresholds are the "satisfactory" streamflow ratings of Moriasi et al. (2007), which were developed for monthly continuous simulation; their use for event peaks and volumes here is an extension.

3.16 Software acceptance

3.16.1 **Accepted software.** The following are accepted without further demonstration, in a version current at the time of submittal:

- (a) EPA Storm Water Management Model (SWMM 5.x);
- (b) USACE HEC-HMS and HEC-RAS;
- (c) USDA NRCS WinTR-55 and WinTR-20; and
- (d) spreadsheets for the Rational Method and single-area SCS-CN calculations, where every formula and input is shown.

3.16.2 **Other software.** Commercial packages built on the SWMM or HEC engines are accepted if the engine and version are stated. Any other method or software is accepted only if the designer reports, for every sub-area, the peak flow, lag, runoff volume and equivalent CN from both that method and a baseline method of 3.16.1, identifies every difference greater than 5%, and justifies every difference that gives a less conservative result.

3.16.3 **Benchmark problems.** The authority shall publish benchmark test problems (Annex 3C). Software not listed in 3.16.1 shall reproduce them within the stated tolerance.

3.16.4 **Model files.** Native model input and output files shall be submitted with every hydrograph-based design.

> **Commentary.** The 5% equivalence test is the APWA rule for alternative methods (KC Metro APWA 5600, 2011, §5602.2D). APWA names TR-55, TR-20, HEC-1 and HEC-HMS as baseline methods (§5602.2B). CPHEEO names SWMM for hydrograph and continuous modelling (CPHEEO 2019, Part A §4.4.2). Submitting native model files lets the authority rerun the model and is the main safeguard against unreviewable black-box results.

3.17 Documentation

Every hydrologic submittal shall include:

1. **Form 3-1, Hydrologic Calculation Summary**, stating the method used and why (Table 3.1), the software and version, and the computation interval.
2. **Catchment maps** for the pre- and post-development conditions, showing sub-areas, flow paths used for Tc, POCs, and off-site run-on.
3. **Soils:** the HSG map and its source and scale (Clause 3.7), water-table data (Clause 3.10), and infiltration test results.
4. **Parameter tables** for each sub-area and condition: area, impervious area by type and connectivity, HSG, CN at AMC II and III (or C and Cf), Tc worksheets, and n values.
5. **Rainfall:** the Design Rainfall Sheet (Form 2-1) and the hyetographs used.
6. **Results:** hydrograph tables and plots for each storm; stage–storage and stage–discharge tables; routed outflows; and peak water levels.
7. **Form 3-2, Pre- vs Post-Development Comparison**, with Q_pre, Q_post (uncontrolled and routed) and the criterion for each POC, AEP and duration, and the sensitivity runs of Clause 3.14.11.
8. **Calibration report**, where Clause 3.15 applies.
9. **Model files** (Clause 3.16.4).
10. **A statement by the responsible engineer** that the methods and parameters of this chapter have been used, with any departures listed and justified.

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- US EPA. Storm Water Management Model (SWMM 5). US Army Corps of Engineers, Hydrologic Engineering Center. HEC-HMS and HEC-RAS.

Annexes and forms

Annex / Form	Content
3A	Jammu and Kashmir soil series to HSG lookup; seasonal high water table map
3B	Jammu and Kashmir CN calibration and supplementary land covers (valley-floor paddy, Karewa orchards, Kandi scrub, conifer and chir pine forest, slide scars, debris fans and muck dumps, bare rock and scree, alpine meadow and snow, boulder-bed khads, nambal reed beds, lake, talab and reservoir beds)
3C	Benchmark test problems for software acceptance
3D	Peak rate factor study for flat coastal land
3E	CWC SUH parameters for zone 7, with worked example
Form 3-1	Hydrologic Calculation Summary
Form 3-2	Pre- vs Post-Development Comparison

CHAPTER 4

Site Runoff Control: Retention and Detention

4.1 Purpose and scope

4.1.1 This chapter sets the performance standard that every regulated development shall meet for runoff leaving the site. It covers:

- (a) the order in which runoff-control measures are to be applied (Clause 4.3);
- (b) retention of frequent rainfall, and how retained volume is credited against detention (Clause 4.4);
- (c) release-rate criteria for standard and flood-sensitive catchments (Clause 4.5);
- (d) the procedure for sizing detention storage and outlets (Clauses 4.6 to 4.9);
- (e) facility types, rainwater harvesting (RWH) accounting, and high-groundwater sites (Clauses 4.10 to 4.12);
- (f) regional detention and fee-in-lieu (Clause 4.13);
- (g) simplified methods for small sites: the Tier B tables and the fixed-coefficient route (Clause 4.14); and
- (h) public safety (Clause 4.15).

4.1.2 This chapter applies to land disturbance of **0.1 ha or more**, or new or replaced impervious area of **500 m² or more**, as set in Chapter 1. Single dwellings below that threshold, and road resurfacing that adds no impervious area, are exempt. The existing RWH mandate of the building rules (the complete rainwater harvesting proposal that chapter 10 of UBBL-2021 makes mandatory for every building on a plot of 100 m² or more, with recharge for buildings on plots of more than 500 m² and inspection before a completion certificate or service connection is issued; the rules are discussed in the Commentary to Clause 4.11) continues to apply to every building it covers, whether or not this chapter applies.

4.1.3 Rainfall inputs come from Chapter 2. Hydrologic methods come from Chapter 3. Tailwater, downstream analysis and the outfall-closed check come from Chapter 5. Water quality volume (WQv) treatment comes from Chapter 8. Where this chapter and those chapters overlap, the more stringent requirement governs.

> **Commentary.** No Indian national rule or Jammu and Kashmir rule found during research for this Manual limits the rate of discharge from a site, and none requires on-site detention or "zero run-off". No Jammu and Kashmir document found sets a design storm, runoff coefficient, time of concentration, minimum size or freeboard for any drain: the drainage master plan and DPR for Srinagar prepared by Egis India covers "a 767-square-kilometer stormwater drainage system that is separate from the sewage system", modelled in SewerGEMS, but publishes no design basis (vendor case study, as reported); the World Bank's Jhelum and Tawi Flood Recovery Project designs its roads and bridges to the guidelines of the Indian Roads Congress and states no drainage return period (JTFRP project documents, 2015); and Jammu's storm-water DPR was to be prepared "immediately after the approval" of its master plan (Jammu Master Plan 2032, §11.1.3), and none was found. The building rules are the Jammu and Kashmir Unified Building Bye-Laws 2021 (UBBL-2021), published in the *J&K Official Gazette*, Extraordinary, Vol. 134, No. 39-4, on 24 December 2021 in the copy of the Jammu Municipal Corporation, and adopted body by body on a common text (the Doda Municipal Council's notification of 21 October 2021, as quoted); the original H&UDD notification was not found [TBC]. They have been amended by a JMC notification of 9 March 2022, by H&UDD's S.O. 304 of 1 December 2025, issued under section 395(d) of the Jammu and Kashmir Municipal Corporation Act 2000 and section 202 of the Jammu and Kashmir Municipal Act 2000, which brought in online auto-scrutiny of plans, including their rainwater harvesting, deemed rejection after 15 days, online NOCs

from departments that include Sewerage & Drainage, LCMA, the Pollution Control Board and I&FC, and a "WATERBODY USE_NEGATIVE LIST", and by S.O. 58 of 26 February 2026 (as listed); a further draft of 9 September 2026 was reported to be issued under section 397 of the Corporation Act (as reported). Neither S.O. 58 nor the 2026 draft was read [TBC]. The drainage provisions that can be found protect the building and the watercourse, not the catchment. The site plan shall show "the approximate location and size of any water body, flood affected areas and contours at an interval of 0.3m in case of the site which has a slope more than 1:20" (cl. 2.6(b)(xi)); the registered technical person certifies that the site is clear of drains and water bodies (cl. 2.18); "No development shall be permitted in area designated for water body, pond and Talav"; the green buffer along nallahs and rivers is "minimum 30 m from the highest water level" or wider where a plan or the water law provides (cl. 5.2.5); building in areas "vulnerable to floods/flash floods" is regulated by I&FC "or the flood zonation maps notified by the department from time to time" (cl. 7.12(a)), of which none was found; no development is allowed within 50 m of the edge of the bank of the major rivers and khads, 30 m of the listed lakes, among them Mansar, Surinsar, Wular, Nigeen and Manasbal, and 20 m of other rivulets and of the Ranbir and Sindh canals, "or as per building regulation whichever is more" (cl. 7.12(b)), with talabs and village tanks "as may be prescribed" by the building permit issuing authority (cl. 7.12(c)); and roofs slope in snowfall areas, the Authority "may require rainwater pipes to be connected to a drain", and "No rainwater from the roof shall be drained in the adjoining property" (cl. 6.20). For floor levels UBBL-2021 sets the plinth at not less than 45 cm (cl. 6.1) and the ground-floor finish 300 mm above the centre line of the road (Table 5-9); this Manual reads them as two minimums that both apply, and its own floor-level rule, based on the design flood level and freeboard (Clause 6.11), is stricter than either. Rooftop rainwater harvesting is mandatory under chapter 10 (Commentary to Clause 4.11). None of these sets a design storm, a release rate, a detention volume or an overflow path. The master plans go no further. The Srinagar Master Plan 2035 (Town Planning Organisation Kashmir, February 2019) "asserts to work as per the stormwater performance standards effectively with 100% coverage and zero incidence of waterlogging" and describes "source controls" that "store and slowly release stormwater" (detention) or "dispose of stormwater onsite" (retention), but gives no return period, runoff coefficient or intensity (§13.3). The Jammu Master Plan 2032 records that "the road side drains serve as storm water drains", that 20% of the roads have side drains covering about 40% of the city (§5.1.3), and that land recorded as "Gair Mumkin Khad" covers more than 30% of the JDA's land and is to be reduced to the "true Khad", the functional drainage channel fixed with I&FC, with "adequate buffer zones along all the drainage channels in accordance with the size, importance, and expected discharge" (§12.2.3). This Manual requires that no such land be released until a hydraulic study of the khad has mapped the 1% AEP flow, bulked for sediment and debris under Chapter 6, with the corridor of Chapter 7 (set by this Manual). The Union Territory has two statutory routes to flood zoning, and neither has been used. The Jammu and Kashmir Flood Plain Zones (Regulation and Development) Act 2005 comes into force only on a date the Government notifies (s.1(3)), and no such notification was found, so the Act is not in force; its "flood zone" is the area needed to carry "the maximum probable floods" (s.2(d)), which is not the 1% AEP line. Part VI of the Jammu and Kashmir Water Resources (Regulation and Management) Act 2010 lets the Government declare a flood basin after survey, objections and notification, and no flood basin has been declared; the Act places "the bed and banks of all water sources … city channels and flood spill channels" under I&FC, so every outfall to them needs I&FC's consent, and its rainwater harvesting provision is advice to the Government, not a rule that binds an owner (the section numbers of the copy read were assigned from an index and are to be confirmed against an official copy [TBC]). Where a flood basin is declared under Part VI, or a flood plain zone notified under the 2005 Act, its restrictions will govern; until then the mapped design flood line of Chapter 7 applies (set by this Manual). The drain sections of the Municipal Corporation Act and the Municipal Act 2000 were not read [TBC]. The High Court of Jammu and Kashmir and Ladakh, as "Custodia Legis of river Jhelum and other water bodies", has directed the removal of encroachments from the Jhelum's banks so that "the original width of the river Jhelum is restored" and that "no construction of any kind is raised near the water bodies" (PIL 8/2017 with PIL 2/2014 and PIL 18/2018, order of 29 May 2024, recalling the orders of 2014–2016); these are court directions, and Chapter 7 states the lake buffers the Court has set. Basements are regulated for their size, not for flooding: they lie within the building envelope, their height is limited and none may be put to habitable use (cl. 5.2.1.7); no rule found restricts basements in low-lying or flood-prone land, sets a level for a basement ramp or opening, or keeps surface water or groundwater out of a basement. This Manual therefore adds its own requirements for every basement: no detention storage in a habitable basement (Clause 4.10.1); the crest of every basement ramp and the sill of every basement opening at

least 0.5 m above the 1% AEP flood level, with basement drainage pumped to the surface drain through a non-return valve (Clauses 6.11.1 and 6.11.4); and no basement in Zone 2 (Clause 7.5.2). In the flood-sensitive catchments of Clause 4.5.3.2, in any catchment notified under Clause 4.5.4, and on the valley-floor, Sirowal, floodplain, lake-margin and reservoir-margin land of Clause 4.12.1, it recommends that no basement be permitted where the 1% AEP flood level stands above the surrounding ground. On the floor of the Kashmir valley a basement shall also be watertight and checked for flotation with groundwater at ground level (Clause 4.12.1), and where wells nearby flow, at the artesian head measured in the nearest flowing well; its pumps shall discharge above the level that the receiving drain reaches while the Jhelum holds its outfall shut, because in Srinagar that drain may itself drain only by pumps. In the hills a basement cut into a slope shall carry the geotechnical certificate of the hill infiltration rule of Clause 4.11, with the water behind its walls drained to a lined drain and not to the ground. For a sloping site, this chapter also supplies what the building rules leave open and what the GSI recommended at Pernote, "diverting the surface runoff away" from the slope and lining the drains on it (GSI note, 2024): runoff from the catchment above the site shall be intercepted and carried round the building in the design storms of Chapter 6, and every flow from the site shall discharge to a lined drain or a stable natural channel, never onto an unprotected slope or into the overburden. These are the Manual's proposals, not rules of UBBL-2021. This chapter is written so that it can supply, as a technical companion to UBBL-2021, the master plans and the Municipal Acts, the design storm, release rates and storage volumes that they leave open; it has not been adopted for either purpose. A competent authority, such as H&UDD for building approvals or the Jal Shakti Department for river and flood-basin matters, could adopt it. In practice many of the Union Territory's urban drains carry sewage: Srinagar generated about 193.34 MLD of sewage against 62.01 MLD of treatment capacity (32.07%) in 2024, untreated sewage "gets entry into the Dal Lake from areas like Telbal, Lalbazar", and about 910 houseboats discharge into Dal and Nigeen (JKPCC, 2024); in Jammu "Storm water drains carry considerable quantities of raw and untreated effluents" and the BOD of 90% of the city's drains is that of "weak to strong domestic sewage" (Jammu Master Plan 2032, §5.1.3); and the CPCB lists the Chunt Kol in Srinagar, the Jhelum below the Vishav confluence to Baramulla, the Tawi from Tawi Bridge to the Balol Nallah, the Basantar at Samba, the Devak at Udhampur, Gawkadal and the Lidder among the polluted river stretches (October 2025) (Clause 8.9). Retention and detention apply in full on every site whatever the drain carries: every litre a site releases at the peak of a storm takes up capacity in a drain that is already part-filled with sewage, and in Srinagar capacity at a pump that may already be running. The CPHEEO (2019) manual describes limiting outflow to the pre-development peak as typical practice, but it uses no "shall" and names no storm frequencies (CPHEEO Part A §8.5.1). This chapter turns that description into a development-control requirement.

4.2 Definitions

Term	Meaning in this Manual
Retention	Permanent removal of runoff from the surface drainage system by infiltration, evapotranspiration or reuse, so that the water never reaches the outfall.
Retention depth	The 90th percentile wet-day 24-hour rainfall depth for the site's zone (Clause 2.10, Annex 2E).
Required retention volume (RRV)	The runoff volume from the retention depth over the post-development site (Clause 4.4.2).
Detention	Temporary storage of runoff, released through a controlled outlet at a rate set by Clause 4.5.
Retention credit	The reduction in required detention storage that results from retention practices, determined by routing under Clause 4.4.6. It is **not** the same as the retained volume.
Permissible site discharge (PSD)	The maximum rate at which a site may discharge for a stated AEP, in L/s or L/s/ha.

Term	Meaning in this Manual
Site storage requirement (SSR)	The detention storage required per hectare of site under the simplified method of Clause 4.14.
Multi-stage outlet	An outlet structure with separate openings at different levels, each controlling a different AEP (Figure 4.2).
Drawdown time	Time from the peak stored volume until the stated fraction of that volume has been released.
Emergency spillway	A secondary overflow that passes flows above the primary outlet capacity, or all flow when the primary outlet is blocked, without overtopping the embankment.
Freeboard	Vertical distance between the maximum design water level and the embankment crest or other critical level.
Flood-sensitive catchment	A catchment listed in Clause 4.5.3 or notified under Clause 4.5.4.
Authority	The approving authority under Chapter 1 (the building permit issuing authority under UBBL-2021, that is the Srinagar or Jammu Municipal Corporation, a Municipal Council or Municipal Committee, or a Development Authority under the Jammu and Kashmir Development Act 1970, such as SDA or JDA, in its area, acting through the online building permission system of S.O. 304 of 1 December 2025, as applicable).
Tier A / Tier B	Adoption tiers defined in Chapter 1. Tier A: the Srinagar Municipal Corporation (SMC), with the Srinagar Development Authority (SDA), in the Srinagar Local Planning Area; and the Jammu Municipal Corporation (JMC), with the Jammu Development Authority (JDA), in the Jammu Local Planning Area. Tier B: Municipal Councils and Municipal Committees.

4.3 Order of measures

4.3.1 Every site runoff-control design shall apply measures in the following order, and shall document in the submittal why each earlier step could not do more:

1. **Preserve.** Keep existing waterbodies, talabs, natural drainage lines, wetlands, and permeable soils and vegetation. Avoid fill in flood storage (Chapter 7).
2. **Retain.** Retain the RRV on site by infiltration, reuse or evapotranspiration (Clause 4.4).
3. **Detain.** Detain the remaining runoff so that the release-rate criteria of Clause 4.5 are met for every design storm and duration (Clauses 4.6 to 4.9).
4. **Convey.** Convey the 1% AEP (100-yr) flow safely through the site to the receiving system on a defined overland path (Chapter 6), and check the receiving system downstream (Chapter 5).

4.3.2 Preservation and retention reduce the detention required (Clauses 4.4.6 and 4.4.7). They do not relieve the site of the release-rate criteria of Clause 4.5 or of the downstream analysis of Chapter 5.

> Commentary. This order follows the "layers of stormwater management" adopted in the Kansas City Metro APWA Section 5600 Version 2025.01: preserve or restore, retain, detain, convey, maintain (MARC factsheet; MARC Supplement, Nov 2025). Maintenance is the fifth layer and is set in Chapter 10. The 2025.01 manual credits retention and natural-area preservation against detention size (MARC Supplement, Nov 2025). Clause 4.4.6 adopts that credit, and defines it so that it cannot be claimed twice.

4.4 Retention

4.4.1 Requirement

The site shall retain the RRV. Retention shall be achieved by one or more of the following:

- infiltration practices (soakaways, infiltration trenches, permeable pavement with an infiltration base, bioretention);
- rainwater reuse that is drawn down by a demonstrated non-potable demand;
- green roofs and landscape areas that do not drain to the outfall in the retention-depth storm.

The limits of Clause 4.4.4 apply.

4.4.2 Computation of the RRV

> RRV (m³) = 10 × Q_R × A

where:

- Q_R (mm) is the runoff depth from the retention depth P_R (Annex 2E). It is computed with the SCS-CN method for the post-development cover of each sub-area, at AMC II, with Ia = 0.2S (Chapter 3); and
- A (ha) is the area of the site that drains to the outfall.

Q_R shall be computed for each sub-area separately and summed. An area-weighted CN shall not be used where impervious and pervious areas differ by more than 20 CN points.

The volumetric method RRV = 10 × P_R × Rv × A, with Rv = 0.05 + 0.009 × I (I = percent impervious), may be used for sites under 0.5 ha and under the Tier B method.

> Commentary. The Rv formula is the one used in the KC water quality volume (MARC BMP Manual 2012). It is simple to review for small sites. The SCS-CN form is required for larger sites so that the retention computation uses the same runoff model as the detention routing. That keeps the credit computation of Clause 4.4.6 consistent.

4.4.3 Verification

Retention by infiltration shall be supported by:

- (a) site infiltration tests at the location and depth of each practice, at the frequency set in Chapter 8;
- (b) a design infiltration rate of no more than **half** of the measured rate; and
- (c) groundwater evidence showing the seasonal high groundwater table at least **1.0 m** below the base of the practice (Chapter 8).

Retention by reuse shall be supported by a demand calculation showing that the RRV is drawn down within 72 hours by a continuous non-potable use, such as toilet flushing, cooling or irrigation.

> Commentary. The factor of 2 on measured infiltration rate has no direct precedent; this Manual sets it to allow for clogging and for the difference between a test pit and a full-scale practice. Chapter 8 may set a different factor; if

it does, Chapter 8 governs.

4.4.4 Limits on retention

4.4.4.1 Infiltration practices shall not be used:

- where the seasonal high groundwater table is less than 1.0 m below the base (Chapter 8);
- on contaminated land;
- within the setbacks from foundations, wells and septic systems set in Chapter 8; or
- on fill, unless tested after placement.

4.4.4.2 Where the RRV cannot be fully retained, the shortfall shall be stated in the submittal. The shortfall shall be treated as WQv under Chapter 8 and shall get no retention credit.

4.4.5 Drawdown of retention

Retention storage shall be emptied by infiltration or reuse within **72 hours** of the end of the retention-depth storm, verified by the tests of Clause 4.4.3.

4.4.6 Retention credit: definition and computation

4.4.6.1 **What the credit is.** The retention credit is the reduction in required detention storage that results when the retention practices are included in the post-development routing. It is computed. It is not assumed equal to the RRV.

4.4.6.2 **Tier A method (routing).** For each design storm and duration of Clause 4.6.3:

- (a) model each retention practice explicitly as a storage that is **empty at the start of the storm**, unless Clause 4.11 says otherwise;
- (b) let the practice fill from the front of the storm, and let it lose water during the storm only at the design infiltration or reuse rate of Clause 4.4.3;
- (c) once it is full, route its overflow to the detention facility; and
- (d) size the detention for the residual hydrograph.

The required detention storage is the largest storage over all storms and durations. The credit is the difference between that storage and the storage required with no retention. No further deduction shall be made.

4.4.6.3 **Tier B method (simplified).** The detention storage required by Clause 4.14 may be reduced by:

> $V_{credit} = C_R \times RRV_{provided}$

where C_R is the retention credit factor from Annex 4B for the zone, soil group and drawdown rate. Until Annex 4B is published, **$C_R = 0$**.

4.4.6.4 Retention that is not verified under Clause 4.4.3 gets no credit.

> **Commentary.** "Credited against detention" (APWA 5600 2025.01) can be read in two ways. One reading subtracts the retained volume from the detention volume, cubic metre for cubic metre. The other routes the storms with retention in place and sees what detention is still needed. The two readings give very different answers in Jammu

and Kashmir, because the mandatory 48- and 72-hour storms (Clause 2.5.2) fill any retention practice on the first day, long before the peak arrives on the last day (Clause 2.9.2). Unless the practice keeps infiltrating during the storm, it is full at the peak and does nothing to reduce the peak storage.

The illustrative example in Clause 4.6.7 shows the size of the effect. A 2 ha site with 552 m³ of retention (no infiltration during the storm) needs 138 m³ less detention for the 24-hour storm. That is a credit of about a quarter of the retained volume. For the 48- and 72-hour storms, which govern, the credit is close to zero. Subtracting the retained volume directly would have under-sized the detention by about 545 m³ (about 19%).

This Manual therefore defines the credit as the result of routing. Retention on fast-draining sandy soils, which keeps infiltrating through a multi-day storm, will earn a real credit. Retention that only fills will earn little. Both outcomes are physically correct. Setting C_R = 0 until Annex 4B exists is a safe default for Tier B, not a judgement that retention has no value: retention is still required for water quality and recharge (Chapter 8).

4.4.7 Preservation credit

Areas of the site that are permanently preserved in natural cover may be modelled at their pre-development CN in the post-development condition, provided that:

- they are protected by a registered covenant or dedication; and
- their runoff is not concentrated onto impervious surfaces.

This lowers both the RRV and the detention required. No other preservation credit applies.

4.5 Release-rate criteria

4.5.1 General

4.5.1.1 Peak discharge from the site shall be computed by a hydrograph method (Chapter 3) for the pre-development and post-development conditions with identical design storms (Clause 2.11.1). The Rational Method shall not be used for any part of storage sizing.

4.5.1.2 Pre-development is greenfield: open land in good condition for the mapped HSG. Existing impervious cover is not counted (Clause 2.11.5, Chapter 3). This applies to redevelopment as well, subject only to the constrained-redevelopment route of Clause 4.5.6.

4.5.1.3 The criteria apply at each point where runoff leaves the site. Where a site drains to more than one outfall, the criteria apply to each outfall for the area draining to it. Runoff shall not be diverted between catchments.

4.5.2 Standard catchments

For each of the 50%, 10% and 1% AEP (2-, 10- and 100-yr) storms, and for every duration in {1, 2, 3, 6, 12, 24, 48, 72 h}:

$$Q_{post}(T, d) \le 0.9 \times Q_{pre}(T, d)$$

4.5.3 Flood-sensitive catchments

4.5.3.1 In the catchments listed below, the **mixed-frequency rule** of Clause 2.11.3 applies, for every duration in Clause 2.5.2:

> Q_post(1% AEP, 100-yr) ≤ Q_pre(10% AEP, 10-yr), and Q_post(50% AEP, 2-yr) ≤ Q_pre(50% AEP, 2-yr).

Each cap is the pre-development peak at the duration that maximises it: the 10-yr peak for the 100-yr check, and the 2-yr peak for the 2-yr check. The cap applies to every post-development duration (Clause 2.11.3).

4.5.3.2 The flood-sensitive catchments are:

- (a) **Srinagar behind the Jhelum embankments**: the land of the SMC and SDA areas that drains to the Jhelum, the flood spill channel and the city channels through gated or pumped outfalls, including the catchment of Dal and Nigeen and the low land of the west-bank flood basins, from Lelhar and Lasjan to Rakh-e-Arth, Narkara and Hokersar;
- (b) **Anantnag–Bijbehara–Pampore on the upper Jhelum**: the land of Anantnag, Bijbehara and Pampore and of the other towns on the valley floor above Srinagar that drains to the Jhelum between Sangam and Srinagar and to the nallahs that join it there;
- (c) **Sopore–Baramulla–Sumbal–Bandipora on the lower Jhelum and Wular**: the land of Sopore, Baramulla, Sumbal and Bandipora that drains to the Jhelum below Srinagar, to Wular or to the flood spill channel;
- (d) **Jammu's khads and the Tawi**: the land of the JMC and JDA areas that drains to the Tawi and to its khads, among them the Balol, Thather and Bhalwal khads, including land recorded as Gair Mumkin Khad and the localities flooded in August 2025;
- (e) **Kathua–Hiranagar on the Ujh and the Ravi, and Samba on the Basantar**: the land of Kathua, Hiranagar and Samba that drains to the Ujh, the Ravi, the Basantar and their khads;
- (f) **R.S. Pura–Bishnah–Arnia in the Sirowal**: the land of R.S. Pura, Bishnah, Arnia and the other towns of the Sirowal that drains across waterlogged, flat land towards the international border;
- (g) **Akhnoor on the Chenab**: the land of Akhnoor that drains to the Chenab below the Salal reservoir;
- (h) **Udhampur on the Tawi and the Devak, and Katra**: the land of Udhampur that drains to the Tawi and the Devak, and of Katra that drains to the khads below it;
- (i) **Hill towns of the Chenab valley**: the land of Ramban, Batote, Banihal, Doda, Thathri and Kishtwar that drains to the Chenab and its tributaries or lies on the slopes of the subsidence and sliding zones of Pernote, Duksar and Thathri Nai Basti (Commentary to Clause 4.11); and
- (j) any catchment notified under Clause 4.5.4.

The boundaries shall be those mapped in Annex 4A.

4.5.4 Notification of further flood-sensitive catchments

4.5.4.1 The Authority may propose that a catchment be notified as flood-sensitive where one or more of the following is documented:

- (a) buildings or arterial roads flooded in an event of 1% AEP or more frequent, on at least two occasions in the previous 20 years;
- (b) receiving drains or channels with capacity below the 10% AEP flow under existing conditions;
- (c) an outfall that is held up by a river, lake or reservoir in flood, such as the Jhelum behind the embankments of Srinagar, Anantnag–Bijbehara, Pampore, Sopore and Baramulla, where the gravity outfalls are shut from flood-declaration stage and the town drains only by pumps, Wular below Sopore, Sumbal and Bandipora, Dal and

Anchar when the river shuts their outlets, the Tawi at Jammu and Udhampur, the Chenab at Akhnoor, or the Salal, Baglihar or Ranjit Sagar reservoir, or that is buried or blocked by the debris of a khad or nallah, for part of the SW monsoon or of the spring snowmelt (Chapter 5);

- (d) loss of more than a quarter of the mapped tank and talab storage in the catchment since the earliest available survey; or
- (e) a basin master plan that relies on limiting site discharge.

4.5.4.2 The procedure shall be:

1. The Authority prepares a technical note with the catchment boundary in GIS form and the evidence for 4.5.4.1.
2. The State-level technical committee constituted under Chapter 1 reviews the note.
3. The draft notification and map are published for public comment for at least 60 days.
4. The Government notifies the catchment and the map is added to Annex 4A.
5. The rule applies to applications received **6 months** or more after notification. Applications received earlier are assessed under Clause 4.5.2.

4.5.4.3 A notified catchment may be de-notified only by the same procedure, and only after a basin study shows that the downstream system meets Chapter 5 with all development under Clause 4.5.2.

> Commentary. The 0.9 factor is derived from the Denver (MHFD) analysis. In that analysis, ten basins each releasing 100% of the historic 100-yr peak still produced 106% of the historic peak at the outlet; releasing 90% at each gave 97% (UDFCD Full Spectrum Detention Release Rate Memorandum, 2012). The mixed-frequency rule has no direct precedent; the nearest is the Malaysian DID (2008) checklist, which required post-development 2-, 10-, 50- and 100-yr peaks below the pre-development 2-yr peak. The specific "100-yr post ≤ 10-yr pre" form appears in a New Berlin, Wisconsin planning discussion (not an adopted rule). The Srinagar entry follows the river and the pumps. In September 2014 about 34% of the Srinagar planning area, 262 km², was under water (Srinagar Master Plan 2035); the flood came down the Jhelum, which passed about 72,585 cusecs at Ram Munshi Bagh and set the CWC site's highest level of 1,588.99 m on 8 September, while the city's own gauges recorded only about 140–152 mm over the storm (Malik, 2021; CWC, as transcribed by SANDRP; Ray et al., 2015). The flood spill channel that carries the river round the city had been built for 17,000 cusecs after the flood of the early 1900s and had silted to 4,000 cusecs, and the CAG found that the impact of the floods "may have been mitigated" had two channel schemes been carried out as approved (CAG Report No. 4 of 2016). The city drains by pumps whenever the river is high: the master plan counts about 89 drainage pumping stations (38 lift, 21 gravity, 30 lift-cum-gravity) on about 119 km of primary and secondary drains (Srinagar Master Plan 2035, February 2019), and H&UDD told the Legislative Assembly in February 2026 of 104 permanent dewatering stations of about 2,300 cusecs, 281 mobile units and about 650 km of drains (as reported). About 2,300 cusecs, roughly 65 m³/s, over the 767 km² of the drainage master plan is about 0.3 mm of rain an hour (NEER's arithmetic), so when the river shuts the gravity outfalls the city drains only by storage and pumps. The city centre, Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds, was waterlogged after 26.4 mm on 1 August 2019 (as reported). The master plan sets "stormwater performance standards" of 100% coverage and zero waterlogging, and it records that the wetlands to the south, west and north-west of the city "have been acting as flood retention basins", while the plan of 1971–91 drew growth into "low lying areas, wetlands and flood absorption basins" (Srinagar Master Plan 2035). The Anantnag–Bijbehara–Pampore entry follows the upper Jhelum, whose CWC site at Sangam has a danger level of 1,590.88 m and a highest level of 1,595 m from 4 September 2014, and at Khanabal a highest level of 1,595.43 m set on 3 September 2025 (CWC, as transcribed by SANDRP); in 2014 the river at Sangam exceeded 115,000 cusecs (Romshoo et al., 2018), and Qazigund recorded 206 mm in a day and 599.8 mm over 3–6 September (IMD; Ray et al., 2015); wells flow over much of Anantnag district (NAQUIM, Kashmir Valley). The Sopore–Baramulla–Sumbal–Bandipora entry follows the lower Jhelum and Wular: the CWC site at Safapora has a danger level of 1,579.66 m and a highest level of 1,582.1 m (2014), Wular's danger level is reported as 1,578 m, and the lake has shrunk from 157.74 km² in 1911 to 86.71 km² in 2007 (as reported), with less room for the floods it absorbs; 81.8% of Baramulla's observation wells stood within 2 m of the surface in May 2021 (CGWB). The Jammu entry follows the Tawi and its khads, which the master plan says are "transformed into gushing torrents" in the rains; Jammu recorded 380 mm in the 24 hours to 08:30 IST on 27 August 2025 (IMD), the

Tawi at Sidhra rose to a new highest level of 321.1 m on 26 August 2025 (CWC, as transcribed by SANDRP), and land recorded as "Gair Mumkin Khad", more than 30% of the JDA's land, is proposed for release once the "true Khad" is fixed with I&FC (Jammu Master Plan 2032, §12.2.3). Roadside drains serve as the city's storm drains and cover only about 40% of it, and its storm-water DPR was still to be prepared (same plan, §§5.1.3 and 11.1.3). The Kathua–Hiranagar–Samba entry follows the Ujh, the Ravi and the Basantar: I&FC's levels for the Ujh at Panjtirthi are reported as 48,000 and 88,000 cusecs (as reported), the Basantar at Samba is in the most polluted priority of the CPCB list (October 2025), and more than half of Kathua's wells flow (NAQUIM, Outer Plains of Jammu Province). The R.S. Pura–Bishnah–Arnia entry follows the Sirowal, where water stands two to five metres below ground, waterlogging occurs towards its south-western extremity and the drains run towards the international border, beyond which their tailwater is not monitored (NAQUIM; Chapter 5). The Akhnoor entry follows the Chenab, whose CWC site at Akhnoor holds its highest level of 324.29 m from 10 September 1992; I&FC reported its gauge at 43 ft on 3 September 2025 against a danger level of 35 ft and a peak of 61 ft in 1992 (as reported), and the river below Salal carries the reservoir's desilting and flood releases (Chapter 5). The Udhampur and Katra entry follows the outer-hill front, where the plates of the CWC report are most exceeded: Udhampur IAF recorded 630 mm in the 24 hours to 08:30 IST on 27 August 2025 (IMD), and Katra 292.4 mm on 25 September 1988 and 698.6 mm in 72 hours in September 2014 (IMD; Ray et al., 2015); the Devak at Udhampur is in the most polluted priority of the CPCB list (October 2025), and the landslide of 26 August 2025 on the route above Katra was reported to have killed 30–35 people (as reported). The hill-town entry follows the Chenab valley, where the GSI found that "ingress of surface runoff through these cracks may have developed the pore pressure" at Pernote in April 2024 (GSI note, 2024), the NGT's committee at Thathri Nai Basti in 2023 found "unplanned PVC pipes for the purpose of sewerage disposal to the road side drainage downslope" (as reported), and JKPCC lists Duksar in Ramban as prone to land sinking (JKPCC, 2024). Kupwara, Ganderbal, Pulwama, Shopian, Kulgam, Rajouri, Poonch, Reasi, Bhaderwah and Bani are candidates for notification under Clause 4.5.4. No flood basin has been declared under Part VI of the Jammu and Kashmir Water Resources (Regulation and Management) Act 2010, and no flood plain zone under the Jammu and Kashmir Flood Plain Zones (Regulation and Development) Act 2005, which is not in force (Commentary to Clause 4.1), so the list has no entry for notified floodplain reaches. The notification triggers in 4.5.4.1 have no direct precedent and are set by this Manual. The 6-month lead time follows the update rule of Clause 2.14.2. Clause 4.16 explains why releases below pre-development are needed at all.

4.5.5 Minimum outlet and short-duration 2-yr checks

4.5.5.1 Where the PSD for any AEP and duration is less than the discharge of a **50 mm** orifice (Clause 4.8.2) at the corresponding stage, the 50 mm orifice is deemed to comply for that AEP and duration.

4.5.5.2 Where meeting the 2-yr criterion at a duration of 3 hours or less would require a low-flow orifice so small that the drawdown requirement of Clause 4.7 cannot be met, the designer shall:

- size the low-flow orifice as the smallest opening that meets Clause 4.7; and
- report the resulting 2-yr exceedance for those durations.

The Authority may accept the design if the exceedance is below the discharge of the 50 mm orifice at the 2-yr stage, or if the downstream analysis of Chapter 5 shows no adverse effect.

Commentary. Under AMC II, a greenfield site produces almost no runoff in a 1- or 2-hour, 2-yr storm, because most of the rain is lost to initial abstraction. A pre-development peak of a few litres per second, compared duration by duration, then forces a very small low-flow orifice. That orifice cannot release the 10-yr volume within 48 hours. Checked as if it were outside a flood-sensitive catchment, the illustrative example of Clause 4.6.7 would need a low-flow orifice of about 75 mm to match the 1-hour, 2-yr pre-development peak. 90% drawdown of the 10-yr volume would then take about 84 hours even with a clean orifice, against the 48-hour limit. The 170 mm orifice that meets drawdown with 50% blockage exceeds the 1-hour, 2-yr pre-development peak by about 11 L/s. Clause

4.5.5.2 resolves that conflict in favour of drawdown, because a basin that is still partly full when the next SW monsoon storm arrives fails in the event that matters more. KC APWA 5600 (2006) used a 75 mm (3 in) minimum orifice with trash racks. This Manual sets a 50 mm minimum (Clause 4.8.2).

4.5.6 Constrained redevelopment sites

4.5.6.1 **Eligibility.** The relief route of this clause is available only for **redevelopment** where all of the following hold:

- (a) the existing site is at least **60% impervious**, as surveyed before demolition;
- (b) the site is **1 ha or less**; and
- (c) the designer shows, in a Constraint Statement submitted with Form 4-1, that the greenfield criteria of Clauses 4.5.2 or 4.5.3 cannot be met on the site. The statement must show that every storage option of Clause 4.10 has been assessed: rooftop and podium storage, tanks under parking or landscape, permeable paving with sub-base storage, and landscape depressions. It must also give the storage each option can provide.

New development on undeveloped land is never eligible.

4.5.6.2 **Minimum on-site performance.** An eligible site shall provide all of the following on site:

- (a) the full retention volume (Clause 4.4) and the WQv treatment (Chapter 8), with no relief;
- (b) post-development peak discharge no more than **50% of the existing-condition peak** for the 50%, 10% and 1% AEP storms, at each duration of Clause 2.5.2. The existing condition is modelled under Clause 3.3.4; and
- (c) no increase in the 1% AEP water level at any building or road downstream (Chapter 5).

4.5.6.3 **Shortfall.** The shortfall is the detention storage required to meet the greenfield criteria (Clause 4.6) minus the storage provided on site under 4.5.6.2. The applicant shall pay for the shortfall as a fee-in-lieu at the unit rate of Clause 4.13.3. The fee shall be:

- (a) paid into the ring-fenced account of the basin in which the site lies;
- (b) spent only on regional detention or on restoring talab or tank flood storage identified in the basin stormwater master plan (Chapter 11); and
- (c) recorded in the public ledger of Clause 4.13.4, which shall show the volume owed and the volume delivered in each basin.

Where no basin master plan has yet been approved, the fee shall be held for up to **5 years**. If no plan is approved in that time, it shall be spent on restoring tank flood storage in the same basin, with I&FC agreement.

4.5.6.4 **Flood-sensitive catchments.** In the catchments of Clause 4.5.3, the route is available under the same conditions. The Authority may, however, refuse it where the downstream analysis of Chapter 5 shows existing flooding of buildings in the 10% AEP event within the analysis extent.

Commentary. Greenfield is the target for all redevelopment, because a dense city only reduces its runoff as it rebuilds. On small, fully built plots in areas such as Lal Chowk, Budshah Chowk and the old city of Srinagar, the old city of Jammu round Lakhdata Bazar, or the old towns of Anantnag, Baramulla and Sopore, there is often no space for the full greenfield storage. A rule that cannot be met invites variances and non-compliance, which help no one downstream. This clause follows the approach of the UK Non-statutory Technical Standards for Sustainable Drainage (Defra, 2015, S2–S3). For previously developed sites, those standards require peak runoff "as close as reasonably practicable to the greenfield runoff rate" and never above the pre-redevelopment rate. The fixed 50% minimum reduction has no direct precedent; this Manual sets it to give reviewers a clear number in place of a "reasonably practicable" judgement. The fee-in-lieu turns the shortfall into regional storage in the same basin, so the basin still receives greenfield-equivalent control in total. Retention and water quality get no relief, because they are small volumes that almost every site can hold.

4.6 Detention sizing procedure

4.6.1 Method

Detention shall be sized by hydrograph routing through the stage–storage–discharge relationship of the facility, by level-pool (Modified Puls) or an equivalent numerical method (SWMM, HEC-HMS). Fixed-ratio and Rational-based storage formulae shall not be used. The simplified methods of Clause 4.14 (the Tier B tables and the fixed-coefficient route) are the only exceptions.

4.6.2 Steps

1. Delineate the site and sub-areas. Map HSG and confirm by testing (Chapter 3).
2. Extract design rainfall for 50%, 10% and 1% AEP and every duration in Clause 2.5.2, with the climate factor (Chapter 2, Form 2-1).
3. Build design hyetographs: alternating block for ≤ 24 h; the "peak day last" pattern for 48 and 72 h (Clause 2.9).
4. Compute pre-development hydrographs (greenfield CN; AMC III for storms of every duration from 1 March to 31 May on the Kashmir valley floor (sub-area JK-C) and there whenever the Jhelum is at or above flood-declaration level, from 1 July to 30 September on the Sirowal and valley-floor alluvium of sub-area JK-A and in sub-areas JK-B and JK-B1, at all times in sub-area JK-D and in catchments draining to a reservoir, barrage pond or backwater or to a lake whose outlet the river can close (Dal, Anchar, Wular), and at other sites and times, including the Kandi and the Karewas, after a 5-day total of more than 53 mm, AMC II otherwise).
5. Compute the release caps for each AEP and duration under Clause 4.5.2 or 4.5.3.
6. Compute post-development hydrographs with the same storms and AMC, including retention practices (Clause 4.4.6).
7. Choose a trial facility geometry (stage–storage) and a multi-stage outlet (Clause 4.6.5).
8. Route every storm and duration. Use a time step of no more than **5 minutes**, and no more than Tc/3 of the post-development catchment.
9. Check every release against its cap, and check drawdown (Clause 4.7). Adjust the outlet and storage and repeat.
10. Check the tailwater condition of Clause 4.6.6 and the downstream analysis of Chapter 5.
11. Size the emergency spillway and set freeboard (Clause 4.9).
12. Report the governing storm for storage, for each outlet stage, and for the spillway (Clause 4.17).

4.6.3 Storms to be routed

Every facility shall be routed for the full matrix:

Table 4.1 — Design storms to be routed for detention sizing

AEP	Durations (h)	AMC
50% (2-yr)	1, 2, 3, 6, 12, 24, 48, 72	II for ≤ 6 h; III for ≥ 12 h
10% (10-yr)	1, 2, 3, 6, 12, 24, 48, 72	II for ≤ 6 h; III for ≥ 12 h
1% (100-yr)	1, 2, 3, 6, 12, 24, 48, 72	II for ≤ 6 h; III for ≥ 12 h

The 24-, 48- and 72-hour runs are mandatory whatever the critical-duration result (Clause 2.5.2). Where Ia = 0.05S sensitivity is required by Chapter 3, it shall be run for the governing storage case.

4.6.4 Initial conditions

Each run shall start with:

- detention storage empty, down to the invert of the lowest outlet;
- any permanent pool full;
- retention practices empty, except as limited by Clause 4.11; and
- RWH storage full (Clause 4.11).

The 48- and 72-hour storms already contain their antecedent rain, so no further pre-filling is applied.

4.6.5 Multi-stage outlet design

4.6.5.1 The outlet shall have a separate control for each criterion, normally stacked as in Figure 4.2:

- **Stage 1**, at the invert: the low-flow orifice. It releases the WQv over 24–48 h (Chapter 8) and controls the 2-yr release.
- **Stage 2**: an orifice or slot set at or near the maximum 2-yr level. It controls the 10-yr release.
- **Stage 3**: a weir, riser crest or larger orifice set at or near the maximum 10-yr level. It controls the 100-yr release.
- **Emergency spillway**: separate from the primary outlet (Clause 4.9).

Stages may be combined where routing shows that every cap is met.

4.6.5.2 Orifices shall be computed with a discharge coefficient of 0.60 unless a rated device is used. Weirs shall use a coefficient appropriate to their shape. Submerged-outlet and tailwater effects shall be included (Clause 4.6.6).

4.6.5.3 Vortex flow controls and other proprietary devices may be used where the supplier provides a certified head–discharge curve and the minimum clear opening is at least 50 mm.

4.6.6 Tailwater on the outlet

The outlet shall be routed against the tailwater of the receiving system, not free outfall, wherever the receiving water level can rise above the outlet invert. The tailwater shall be:

- for a receiving drain: its water level in the same storm, from the Chapter 5 analysis or, for Tier B, the drain obvert;
- for tidal or backwater-affected outfalls: the levels and joint cases of Clause 2.12 and Chapter 5, including the outfall-closed check (Clause 5.10).

Where tailwater governs, a flap gate shall be fitted to the outlet (Clause 5.11). The storage below the tailwater level shall not be counted as available unless the routing includes the gate closure.

4.6.7 Illustrative example

Illustrative — not design values. This example shows the procedure and the sizes it produces. The inputs are invented to be plausible for a colony draining to a khad in Jammu. They are not NIH-DHAARA values and must not be used for design.

Inputs:

- Site: 2.0 ha, flood-sensitive catchment (Clause 4.5.3).
- Land cover: pre-development all pervious, CN 70. Post-development as two sub-areas (Clause 3.9.2): 1.57 ha of directly connected impervious surface at CN 98, never converted for AMC, and 0.43 ha of pervious open space at CN 70, on the same soil as pre-development; the area-weighted CN at AMC II is 92. For storms of 12 h and longer the pervious CN only is converted to AMC III: $CN_{III} = 23 \cdot CN / (10 + 0.13 \cdot CN) = 84.3$ (Clause 3.8.4).

- Time of concentration (Tc): 45 min pre-development, 15 min post-development (used for both sub-areas). SCS triangular unit hydrograph; 5-minute time step.
- 24-h depths: 110, 200 and 350 mm for 2-, 10- and 100-yr (the same 10- and 100-yr values as Clause 2.11).
- Shorter durations: P(t) = P24·(t/24)^0.40, an assumed ratio set and not Annex 2B.
- Longer durations: 48-h and 72-h depths taken as 1.25 and 1.40 × P24, laid out per Clause 2.9.2.
- Storage: vertical-walled, 2,500 m² plan area.
- Outlet, sized so that drawdown is met with the low-flow orifice 50% blocked (Clause 4.8.3). Annex 4C shows the trial outlet that failed this check.
    - Stage 1: 170 mm orifice at the invert.
    - Stage 2: 460 mm orifice with its invert 0.53 m above the floor.
    - Stage 3: none needed, because the 100-yr cap is met by Stages 1 and 2.

Results (discharges in L/s; storage in m³):

Table 4.2 — Illustrative example: peak discharges and storage used, by duration (Illustrative — not design values)

Duration (h)	2-yr pre	2-yr post, detained	10-yr pre	10-yr post, detained	100-yr post, uncontrolled	100-yr post, detained	100-yr storage used	10-yr drawdown, 50% blocked (h)
1	4	15	51	28	922	42	1,426	31.3
2	14	20	84	34	961	79	1,911	32.1
3	19	22	104	37	981	139	1,999	32.8
6	32	25	150	41	1,010	194	2,154	34.2
12	127	30	302	46	1,074	276	2,512	39.0
24	149	32	327	49	1,081	320	2,766	**45.3**
48	173	34	349	82	1,087	343	**2,913**	44.8
72	180	34	356	84	1,089	343	2,911	44.7

How to read it:

- **100-yr cap.** The cap is the largest pre-development 10-yr peak, 356 L/s (72 h). Every 100-yr detained peak is at or below it; the largest is 343 L/s.
- **2-yr cap.** The site is flood-sensitive, so the 2-yr cap is the largest pre-development 2-yr peak, 180 L/s (72 h; Clause 4.5.3.1). The largest 2-yr detained peak is 34 L/s. At 1, 2 and 3 hours the detained 2-yr peak is above the pre-development peak of the same duration (15 against 4 L/s, 20 against 14 L/s, and 22 against 19 L/s). That comparison is not required here. It would be for a site under Clause 4.5.2, and Clause 4.5.5.2 would then apply.
- **Governing storage.** Storage is governed by the **48- and 72-hour** storms: 2,913 m³, which is 0.146 m³ per m² of site, at a maximum depth of 1.17 m. A design that checked only the critical-duration peak storm (1–3 h here) would have provided about 2,000 m³, roughly two-thirds of what is needed.
- **Drawdown.** With the low-flow orifice 50% blocked (Clause 4.8.3), 90% of the 10-yr storage drains in at most 45.3 h (the 24-hour storm), within the 48 hours of Clause 4.7. A 120 mm orifice would drain it in about 42 h when clean but 54 to 75 h when half blocked, so it fails. Annex 4C shows that trial and the routing step by step.
- **Retention credit.** With an illustrative retention depth of 40 mm, RRV = 552 m³, computed for each sub-area (Clause 3.9.4). Modelled as filling from the start of the storm with no infiltration during it, the retention reduces the 24-hour storage by 138 m³ and the 48- and 72-hour storage by 7 m³ or less. The credit under Clause 4.4.6 is therefore effectively zero for this site.

The order of magnitude, about 0.15 m³ per m² of site, is consistent with the indication in Clause 2.11.

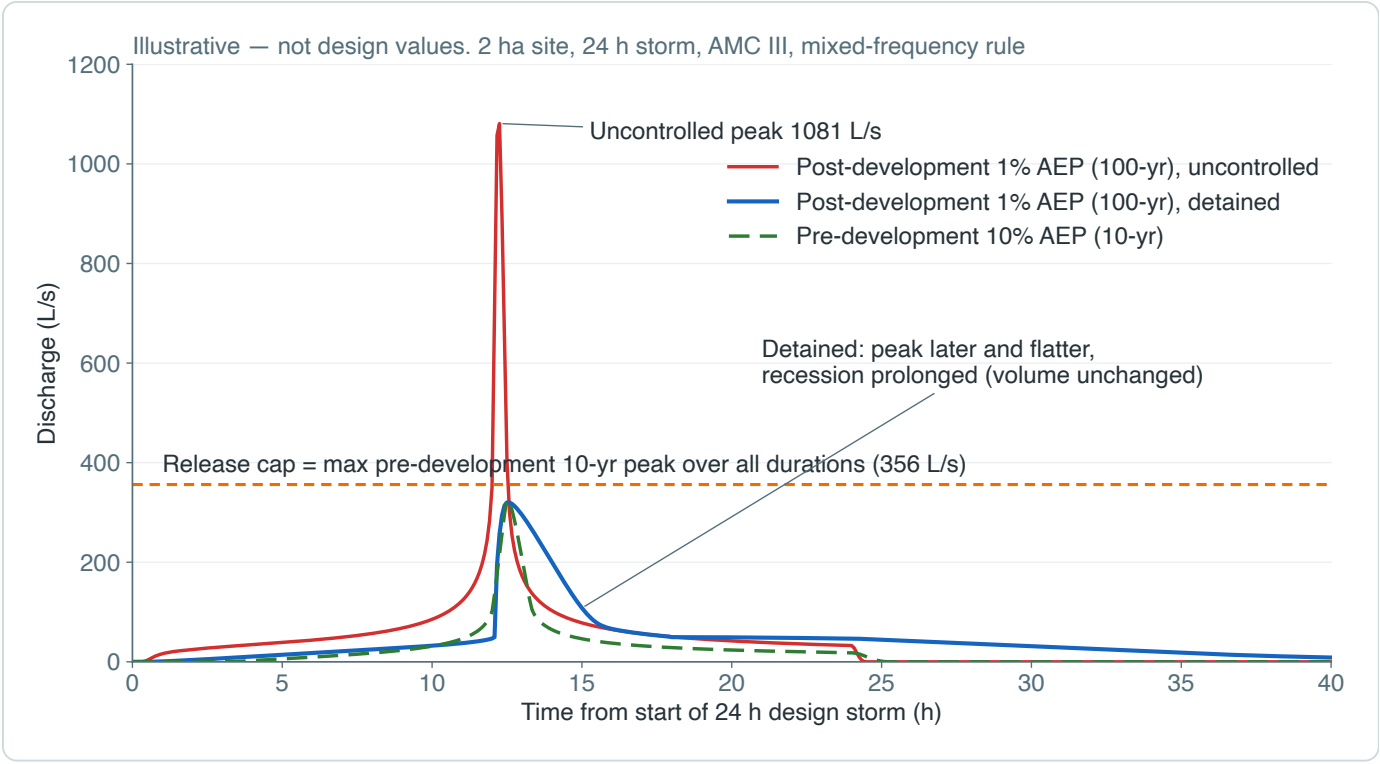


Figure 4.1 — Pre-development 10-yr, post-development 100-yr uncontrolled and detained hydrographs for the 24-hour storm of the illustrative example (Clause 4.6.7). Illustrative — not design values. Original drawing for this Manual, adapted from the pre/post-development hydrograph concept in MARC/KC APWA Section 5600 and the Georgia Stormwater Management Manual (2016).

> **Commentary.** Figure 4.1 shows what detention does and does not do. It cuts and delays the peak. It does not reduce the volume: the area under the detained curve equals the area under the uncontrolled curve, more than twice the pre-development 10-yr volume. The extra volume leaves the site over many hours after the storm. That prolonged release can coincide with the peak of the larger catchment downstream (Clause 4.16), and it must still drain when the outfall is tide-locked (Chapter 5).

4.7 Drawdown

4.7.1 **Detention.** At least **90%** of the maximum volume stored in the 10% AEP (10-yr) storm of each duration shall be released within **48 hours** of the time of maximum storage, by gravity, with the tailwater of Clause 4.6.6.

4.7.2 **Water quality volume.** The WQv shall be released over not less than 24 hours and not more than 48 hours (Chapter 8).

4.7.3 **Retention.** Retention storage shall be emptied within 72 hours by infiltration or reuse (Clause 4.4.5).

4.7.4 **Tidal outfalls.** Where gravity drawdown is prevented by tide for part of each cycle, the 48-hour limit applies with the tidal tailwater modelled. Where it cannot be met by gravity, pumped drawdown shall be provided under Clause 5.12.

> **Commentary.** KC APWA 5600 (2006) required dry basins to release at least 80% of storage within 24 hours of the inflow peak and to empty within 72 hours. Singapore PUB requires detention to be restored within 4 hours. The 48-hour, 90% rule is longer than PUB's because Jammu and Kashmir storage must hold multi-day volumes. It is still short enough that a basin filled by one SW monsoon depression will have most of its volume back before the

next, which in late August and early September 2014, when heavy rain fell between 28 August and 10 September (CAG Report No. 4 of 2016), and August 2025, when the storms of 14, 16–17 and 26–27 August struck the Jammu division within two weeks (IMD; as reported) followed within days.

4.8 Outlet structures

4.8.1 **General.** Primary outlets shall be:

- unattended, with no moving parts, valves or pumps, except where Clause 5.12 permits pumped drawdown;
- accessible for inspection and cleaning from the surface without confined-space entry, where practicable; and
- built of durable materials. In coastal areas these shall be corrosion-resistant (Clause 4.12.5).

4.8.2 **Minimum orifice.** No control orifice shall be smaller than **50 mm** in diameter, or 50 mm in least dimension for a slot.

4.8.3 **Trash racks and screens.** Every orifice and weir shall be protected by a trash rack or screen. The rack shall:

- have a clear bar spacing no greater than half the smallest opening it protects, and not less than 25 mm;
- have a clear open area at least **10 times** the area of the opening it protects;
- be inclined, or set as a cage around the riser, so that debris rises with the water and does not pin against the bars;
- be removable or hinged for cleaning; and
- for routing, be assumed **50% blocked** at the low-flow orifice when checking drawdown.

4.8.4 **Anti-vortex devices.** Riser crests and orifices that may run under more than 1.5 times their diameter of head shall have an anti-vortex plate or hood (Figure 4.2).

4.8.5 **Outlet barrels.** Outlet barrels through embankments shall:

- be at least 300 mm in diameter (Chapter 6);
- have watertight joints;
- have a filter diaphragm or seepage collars over the length within the embankment; and
- have an energy-dissipating outfall (Chapter 9).

4.8.6 **Isolation.** Facilities serving more than 1 ha shall have a means of isolating the outlet for maintenance, such as a stop-log slot or penstock. In normal service it shall be left fully open.

> Commentary. The 50 mm minimum is smaller than the 75 mm (3 in) of KC APWA 5600 (2006), so the trash-rack requirements are correspondingly stricter. The ratios in 4.8.3 (bar spacing at half the opening, open area 10 times the opening, 50% blockage for the drawdown check) have no direct precedent and are set by this Manual. The blockage factor matches the 50% grate clogging factor for sag inlets in Chapter 6. Indian urban drains carry heavy loads of solid waste, so a low-flow orifice without an effective rack will block within one season.

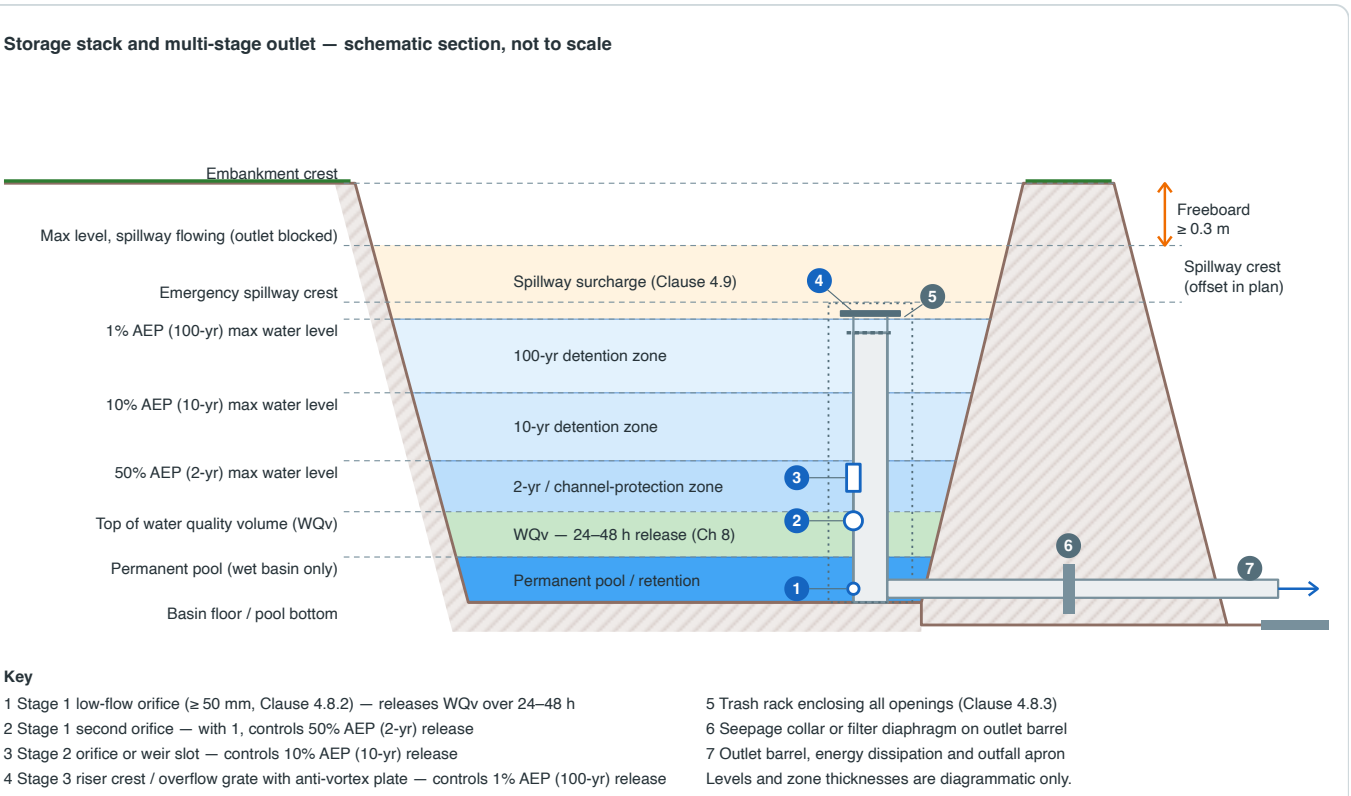


Figure 4.2 — Detention storage stack (permanent pool, WQv, 2-yr, 10-yr and 100-yr zones, spillway surcharge and freeboard) and multi-stage riser outlet. Schematic, not to scale. Original drawing for this Manual, adapted from the multi-stage outlet and storage-zone concepts in MARC/KC APWA Section 5600 (2006, 2025.01) and the Mile High Flood District Urban Storm Drainage Criteria Manual, Volume 2 (full-spectrum detention).

4.9 Emergency spillway, freeboard and embankment safety

4.9.1 **Spillway capacity.** Every detention facility formed wholly or partly by an embankment, or whose overflow would reach buildings, shall have an emergency spillway that passes the **1% AEP (100-yr) peak inflow**:

- with the primary outlet assumed fully blocked;
- with the facility full to the spillway crest at the start of the storm; and
- with at least **0.3 m freeboard** from the maximum water level to the embankment crest.

4.9.2 **High-hazard facilities.** A facility is high-hazard if its failure or overflow could:

- endanger life;
- flood a habitable building or critical facility; or
- close an arterial road.

High-hazard facilities shall also be checked for the **0.2% AEP (500-yr)** peak inflow under the conditions of 4.9.1, with the embankment not overtopped.

4.9.3 **Spillway crest.** The spillway crest shall be at or above the 1% AEP maximum water level from routing with the primary outlet working. The recommended clearance is 0.15 m.

4.9.4 **Spillway location.** The spillway shall be:

- on natural ground or a reinforced section, not on fill, unless protected against erosion for the full design flow;
- discharging to the 1% AEP overland flow path of Chapter 6; and

- placed so that its flow does not reach a building.

4.9.5 **Underground and enclosed facilities.** Tanks, vaults and podium storage shall have an overflow route that operates when the outlet is blocked. The route shall carry the 1% AEP inflow to the overland path without surcharging any building, basement or lift pit.

4.9.6 **Embankments.**

- (a) Embankments more than **2 m** high (measured from the downstream toe to the crest) shall be designed by a qualified geotechnical engineer. The design shall include stability, seepage and settlement analysis.
- (b) Side slopes shall be no steeper than 3H:1V on any face that is mown or accessible to the public. Slopes shall be flatter where Clause 4.15 requires.
- (c) Embankments shall have:
  - a crest width of at least 3 m;
  - compacted, engineered fill with a core or cut-off where required by the seepage analysis; and
  - no trees or large shrubs.
- (d) An embankment structure that falls within the Dam Safety Act, 2021 is subject to that Act in addition to this Manual.

4.9.7 **Excavated facilities.** Facilities wholly below the surrounding ground, with no embankment, need not meet 4.9.6. They shall still meet 4.9.1, with the overflow route treated as the spillway.

> Commentary. The spillway criterion (1% inflow, outlet blocked, basin full, 0.3 m freeboard; 0.2% for high hazard) follows the KC APWA 5600 (2006) rule: the spillway passes the 1% storm with 1 ft (0.3 m) freeboard to the top of the dam, assuming zero storage and a clogged primary outlet, with the crest at least 0.5 ft (0.15 m) above the 1% maximum water surface. KC designed dams above 10 ft (3 m) to SCS TR-60 Class C. The 2 m embankment trigger, the 3H:1V slope (KC wet ponds), and the 3 m crest width have no direct precedent and are set by this Manual.

4.10 Facility types

4.10.1 **General.** Any storage that meets Clauses 4.5 to 4.9 may be used. Surface storage that is visible and can be inspected without confined-space entry is preferred. Storage shall not be placed in a habitable basement or in any space whose flooding would endanger life.

4.10.2 **Underground tanks and vaults.**

- (a) Gravity outlet is required where the receiving drain allows it. Pumped outlets are permitted only under Clause 5.12, with a registered maintenance declaration (Chapter 10).
- (b) Access openings shall be provided over the outlet chamber and over every inlet. In tanks over 500 m², they shall be no more than 30 m apart.
- (c) The floor shall fall at least 1% to a sump at the outlet, with a sediment pocket below the low-flow orifice invert.
- (d) The tank shall be ventilated.
- (e) Inlets shall pass through a silt trap or gross pollutant trap (Chapter 8).
- (f) Flotation and groundwater ingress shall be checked under Clause 4.12.

4.10.3 **Rooftop detention.**

- (a) It is permitted on flat roofs designed for the full ponded load with the outlet blocked. The ponding depth shall not exceed **150 mm** unless a structural engineer certifies a greater depth.
- (b) Each roof outlet shall have a flow-control ring or weir with a certified rating, and every roof area shall have at least one overflow scupper, independent of the controlled outlets, that passes the 1% AEP inflow.

- (c) Roofs used for RWH collection may also provide rooftop detention. The detained volume is released through the control, not into the RWH sump.

4.10.4 **Podium and landscape-deck detention.**

- (a) It is permitted above ground level or above a basement car park, provided the structure is designed for full saturation and ponding, and waterproofed.
- (b) The release, overflow and safety rules for rooftop detention (4.10.3) apply.

4.10.5 **Parking-lot detention.**

- (a) It is permitted only on surface parking. Ponding depth shall not exceed:
  - **200 mm** in the 10% AEP storm and **300 mm** in the 1% AEP storm at any parking bay;
  - zero on accessible routes, ramps and pedestrian crossings; and
  - zero in the 10% AEP storm on fire-tender access routes.
- (b) Signs shall warn that the area floods.
- (c) Ponding shall not reach a building wall unless the wall is waterproofed above the 1% level plus freeboard (Chapter 6).

4.10.6 **Multi-use detention (parks, playfields, open space reservation).**

- (a) Open space land may be used for detention, provided its primary use remains available in at least the 50% AEP storm.
- (b) The storage areas shall be graded to drain fully within the times of Clause 4.7.
- (c) A low-flow channel or underdrain shall carry dry-weather and frequent flows, so that the park is not waterlogged.
- (d) The depth and slope limits of Clause 4.15 apply.
- (e) Play equipment and seating shall be placed above the 10% AEP level.

4.10.7 **Ponds and wet basins.**

- (a) A permanent pool shall be at least 1.2 m deep over most of its area to discourage weed growth and mosquito breeding, with a vegetated safety bench at the edge (Clause 4.15).
- (b) Only storage above the permanent pool counts as detention.

> Commentary.
>
> - The rooftop depth (150 mm) and parking depths (200 and 300 mm) have no direct precedent. This Manual sets them so that a blocked outlet is noticed before it becomes dangerous.
> - The 1.2 m pool depth equals the 4 ft minimum permanent pool of KC APWA 5600 (2006). This Manual adopts it mainly for weed and mosquito control.
> - Pumped detention tanks need maintenance declarations in Singapore (PUB Addendum No. 3, April 2025). This Manual adopts the same approach through Chapter 10.
> - Using open space for multi-use detention fits UBBL-2021, under which public open spaces of more than 500 m² shall have "arrangements for complete utilization and capture of storm water" and "Artificial or natural Storage of storm water runoff from larger sites" (cl. 10.4), group housing shall use permeable materials for its open parking (Table 10-1), and the Conservation Green Zone along nallahs and rivers allows only roads, parking, plantation and sit-outs (cl. 5.2.5). On the Kandi fans, a detention area graded into the open space below the level of the road keeps it pervious and usable, which is what 4.10.6 requires, and can also infiltrate under the Kandi recharge rule of Clause 4.11. On the floor of the Kashmir valley and on the Sirowal the position is different. Ground there is wet, the water table may stand within a metre of the surface in spring, and the town's outfalls may be shut by the river for days; a depressed open space stays wet, cannot infiltrate (valley-floor rule, Clause 4.11) and may hold groundwater as well as storm water, so its storage below the design groundwater level is not counted (Clause 4.12.2), and its outlet is designed for

> the outfall-closed case of Chapter 5. On a hill site, ground on a natural slope of more than 10°, a terrace held up by a retaining wall, land within twice the height of a cut or wall downslope of it, and land in a subsidence or sliding zone are not to be used for ponding, because water held there soaks into the slope (hill infiltration rule, Clause 4.11). On such sites, detention is provided in lined tanks, open or closed, with an orifice outlet and an overflow to a lined drain, on rooftops and podiums under 4.10.3 and 4.10.4, or on a level open space only where it stands on rock or on ground that the geotechnical certificate of Clause 4.11 covers; an excavated pond or basin on a slope is not accepted. Four kinds of land are not open space for this purpose. A lake, nambal, talab, spring or kuhl on the land is preserved under step 1 of Clause 4.3.1; a lake or talab is modelled as a water surface (Clause 3.3.2(e)) that starts at its outlet or spill level (Clause 3.12.5), so only its flood storage above that level can count, and only as Chapter 7 allows, and a kuhl or other irrigation channel is a hydraulic work under the Jammu and Kashmir Water Resources (Regulation and Management) Act 2010 that may not be obstructed or fouled. The buffers of clauses 5.2.5 and 7.12 of UBBL-2021, of the Srinagar Master Plan 2035 (Tables 8-2 and 8-3) and of the Jammu Master Plan 2032 (§7.3.3), the 200 m round Dal and Wular that the High Court has held (Chapter 7), and land that the I&FC flood zonation of the Srinagar Master Plan treats as undevelopable are flood or waterbody land already. Land in the hydraulic corridor of a khad, nallah, lake or river under Chapter 7, and land recorded as Gair Mumkin Khad until the functional khad has been mapped (Commentary to Clause 4.1), is corridor or flood land: water reaches it first, so it is not counted as detention for the development beside it (Chapter 7). And land kept open on purpose, such as the wetland reserves, the proposed flood-absorption basin from Lelhar to Lasjan, the green Zabarwan hills above Srinagar or a mapped spring-recharge area, is not graded or paved for detention.

4.11 Rainwater harvesting versus detention accounting

4.11.1 **No double counting.** RWH storage (sumps, tanks, recharge pits and wells provided under the RWH mandate) shall **not** be counted as detention.

4.11.2 **RWH sumps assumed full.** For all routing under this chapter, RWH sumps and tanks shall be assumed **full at the start of every storm**, in every season. Their overflow shall be routed to the detention facility, or directly to the outfall if it bypasses detention. In the latter case the bypass flow counts against the PSD.

4.11.3 **Combined tanks.** A single tank may provide both RWH and detention only if:

- (a) the detention zone lies wholly **above** the RWH overflow level;
- (b) the detention zone is drained by its own gravity control orifice set at the RWH overflow level, meeting Clauses 4.7 and 4.8;
- (c) no pump, valve or user action can hold water in the detention zone; and
- (d) the two zones and the orifice level are shown on the drawings and in the maintenance declaration.

Only the volume between the RWH overflow level and the detention overflow level counts as detention.

4.11.4 **Recharge structures.** Recharge pits, trenches, shafts and wells may count as **retention** (not detention) if they meet Clauses 4.4.3 to 4.4.5. In particular, the seasonal high groundwater table shall be at least 1.0 m below their base. In the routing they are treated under Clause 4.4.6 with the groundwater level for the SW monsoon season.

4.11.5 **RWH remains mandatory.** Nothing in this chapter reduces the RWH requirement of chapter 10 of UBBL-2021 (as amended), regulation 1-7-13 of the Srinagar Master Plan 2035 where it applies, any measure notified on the advice of the Authority under the Jammu and Kashmir Water Resources (Regulation and Management) Act 2010, the guidelines of the Central Ground Water Authority where they apply, any condition of a building permission, or any rainwater harvesting rule or direction of an approving authority.

Commentary. RWH in Jammu and Kashmir rests on chapter 10 of UBBL-2021, which "gives the mandatory requirements of water conservation", with methods "adopted from NBC, 2016". "All buildings having a plot size of 100 sq.m. Or more, while submitting the building plans for sanction, shall mandatorily include the complete proposal of rainwater harvesting", whose components include storm-water drains, a filter chamber, storage and "Ground Water recharge structures like pit, trench, tube well" (cl. 10.1); plotted houses place the "emphasis on both storage and reuse", group housing shall use permeable materials "for all open parking spaces" and show its storm drainage, harvesting structure and recharge well, and in industrial areas contaminated water shall not be injected into recharge structures (Table 10-1); public open spaces of more than 500 m² shall capture their storm water (cl. 10.4); recharge is mandatory for buildings and group housing on plots of more than 500 m² (cl. 10.5); and an RWH Cell inspects the structures "before issuing Completion Certificates or NOCs for service connections" and verifies every building above 1,000 m² each year (cl. 10.6). Since S.O. 304 of 1 December 2025 the online scrutiny of plans checks rainwater harvesting. The chapter sets no storage volume: its only figure, that "Rainwater can be harvested to the extent of 55,000 litres per 100 sq. m. area per Year from rooftops", is a description, about 550 mm a year (NEER's arithmetic), not a size. The Srinagar Master Plan 2035 makes "storage of rainwater" mandatory only for plots of 1,000 m² and above and for all group housing (reg. 1-7-13). The two conflict; this Manual cites both and applies the stricter, the 100 m² threshold of UBBL-2021, which is the later rule and applies throughout the Union Territory, and never the master plan's figure alone. The Jammu and Kashmir Water Resources (Regulation and Management) Act 2010 adds only an advisory power: the Authority "may advise the Government" to identify areas where rooftop rainwater harvesting should be made mandatory, and no such area was found to have been notified [TBC]. To give the UBBL proposal a size against which credit can be given, **this Manual sets a minimum RWH storage of 20 litres per m² of roof, about 20 mm of rain over the roof** (set by this Manual, on the precedent of Appendix 6 of the Himachal Pradesh Town and Country Planning Rules 2014, which requires that volume for every roof in that State's planning areas), with a filter and first-flush diverter ahead of it and its overflow taken to the site's detention facility or drain. The figure is a floor for credit, not a cap on what an owner may store. This Manual credits these structures against its own retention requirement (Clause 4.4) as follows:

- An RWH tank is RWH storage. It is not detention (Clause 4.11.1), and it is assumed full at the start of every storm (Clause 4.11.2), because in the SW monsoon it is full after the first heavy rain, and in the Kashmir valley it is full through the wet spring. A tank may also provide detention only if it is built as a combined tank under Clause 4.11.3, with a detention zone above its RWH overflow level that drains through its own orifice; only that zone counts.
- An RWH tank counts toward the **retention** requirement of Clause 4.4 only to the extent that it is emptied within 72 hours by a continuous non-potable use, such as toilet flushing or washing, demonstrated under Clause 4.4.3; watering a garden is not a continuous use in the SW monsoon or in the Kashmir spring. The tank is then modelled under Clause 4.4.6 like any other retention practice. Where infiltration is barred, as on the valley floor and on hill sites, this storage and reuse is the way retention is provided.
- Recharge pits, trenches, shafts and wells count as retention only where they meet Clause 4.11.4: they are credited only to the extent that they drain within 72 hours at half the rate measured in a site test (Clauses 4.4.3 and 4.4.5), with their base at least 1.0 m above the seasonal high water table, and the credit is found by routing under Clause 4.4.6, not by deducting their volume. They are also subject to the three rules below, which decide where an infiltration practice may be built at all.
- **Valley-floor rule.** No deliberate infiltration practice (soakaway, soak pit, recharge pit, shaft or well, infiltration trench, or permeable paving with an exfiltrating base) shall be built or credited, and no infiltration credit shall be given, on the alluvium, Gurti clay and Nambal peat of the floor of the Kashmir valley in sub-area JK-C, whatever depth to water a single reading shows, or on the Sirowal, the river terraces and floodplains and the lake, nambal, talab and reservoir margins anywhere in the Union Territory wherever the seasonal high water table is within 2 m of the surface or wells nearby flow; such ground is HSG D (Clause 3.7.2). There the rainwater harvesting of UBBL-2021 is storage and reuse, not recharge, and the recharge structures listed in its chapter 10 are not built; detention is lined and sized for the outfall-closed case and the pump capacity of Chapter 5; and the flotation check takes the design groundwater level at ground level (Clause 4.12.1) and, where wells nearby flow, at the artesian head. Permeable paving required by Table 10-1 of

UBBL-2021 for open parking is built there with a lined or impermeable base and an underdrain to the detention facility. On the Upper Karewa tablelands of Budgam, Pulwama, Pampore and the airport plateau, small infiltration practices may be built only after a site test, and only where the hill infiltration rule does not apply, and outlets that run down a Karewa scarp shall be lined or stepped and protected against erosion; on the Lower Karewa infiltration is decided case by case on a site test.

- **Kandi recharge rule.** The boulder-gravel fans and khad beds of the Kandi belt, north of Jammu, round Nagrota and Samba and in the north of Kathua and Hiranagar, are the preferred recharge zone of the Union Territory. There retention shall be provided by recharge before reuse or detention wherever site tests allow, through a silt trap, a filter and a first-flush diverter ahead of the recharge structure, with the base of every practice at least 0.6 m above the post-monsoon water level and at least 1.0 m above the seasonal high water table (Clauses 4.4.3 and 4.11.4). Every recharge bore or shaft requires a hydrogeologist's check of the target zone that reports its nitrate before it is credited; no recharge bore or shaft shall be built within the protection zone of a public supply well, for which no Jammu and Kashmir distance was found [TBC]; and road, parking, industrial and sewage-carrying runoff shall not be put into a bore or shaft. The Kandi ponds are kept and, where they have been lost or silted, revived as recharge talabs, as the Jammu Master Plan 2032 proposes. The rule stops at the spring line: the Sirowal below it falls under the valley-floor rule.
- **Hill infiltration rule.** No deliberate infiltration practice (soakaway, soak pit, recharge pit, shaft or well, infiltration trench, or permeable paving with an exfiltrating base) shall be built or credited: on natural ground sloping more than 10°; on the Murree and Siwalik sequences of sandstone and clay of the hills; in a mapped subsidence or sliding zone, including Thathri Nai Basti in Doda, Pernote and Duksar in Ramban and any area that JKPCC lists as prone to land sinking, such as those of Budgam district; on colluvium, slide debris or moraine, whatever its slope; or upslope of a cut slope or retaining wall within a distance of twice the height of the cut or wall — unless a geotechnical certificate by a qualified geotechnical engineer or engineering geologist shows that the added water will not destabilise the slope. On such sites roof runoff goes to the rainwater storage of this Commentary (at least 20 L per m² of roof), with overflow to a lined drain that discharges through a sediment trap to a stable natural channel, never onto an unprotected slope, and sewage is never discharged to a roadside drain or onto a slope. The rule applies in sub-areas JK-B, JK-B1 and JK-D and on the slopes of sub-areas JK-A and JK-C, such as the Siwalik hills above the Kandi, the Karewa scarps and the hills round Srinagar. On these sites retention is provided by storage and reuse, and detention by lined tanks, not by ponds or basins on the slope (Commentary to Clause 4.10). The 1.0 m groundwater separation of Clause 4.4.3 does not make an infiltration practice acceptable on a slope: perched water and pore pressure in a slope are the hazard, not the depth to the water table.
- **Springs.** Kashmir's springs, the nāg and cashma, feed lakes and towns, and Dal has springs within its own basin (JKPCC, 2024); the Water Resources Act 2010 counts springs as water sources and "spring ponds, spring channels" as hydraulic works, but no Jammu and Kashmir rule found keeps construction or infiltration back from a spring [TBC]. In the recharge area of a spring, where it has been mapped, only clean roof runoff, passed through a filter, may be infiltrated, and only where the three rules allow; road and parking runoff shall not be infiltrated, the area shall not be paved, and no runoff that may be polluted shall be infiltrated upslope of a spring.
- **Industrial and polluted runoff.** UBBL-2021 bars contaminated water from recharge structures in industrial areas (Table 10-1). Runoff from industrial premises, fuel stations, workshops and the like, as in the industrial estates of Jammu, Samba and Kathua, shall not be recharged, and untreated runoff shall not be put into a bore or shaft anywhere (Chapter 8).
- **Everywhere,** road and parking runoff shall be recharged only through a surface infiltration practice with a filter, such as a vegetated basin or trench, never directly into a bore or well, and runoff from a nallah or khad that carries sewage, as many of Jammu's and Srinagar's drains do (Commentary to Clause 4.1), shall not be recharged at all.

The three rules follow the ground. On the floor of the Kashmir valley water stands 0–2 m below ground over the central and south-western parts and wells flow on both sides of the Jhelum, with piezometric levels "between 2 m agl and 12 m bgl" (NAQUIM, Kashmir Valley), and the CGWB says of Srinagar district that "As depth to water level in the district is shallow there is no scope for artificial recharge to ground water" (CGWB, Srinagar district booklet). A recharge pit there sits in the water table for much of the year. The 2 m threshold of the valley-floor rule,

wider than the 1 m used for some valley floors elsewhere in the series, is set by this Manual because a practice whose base must stand 1.0 m above the seasonal high water table (Clause 4.4.3) has no working depth where that level is within 2 m, and because artesian heads up to 2 m above ground make a shallow reading unsafe as a guide. Groundwater is not short in the Union Territory: all 149 assessment units were safe in 2024, with a stage of extraction of 22.28% (CGWB, GWRA 2024), and Jammu, Samba and Kathua districts have been safe in every assessment from 2017 to 2024, so recharge is preferred on the Kandi because the ground takes it, not because the aquifer is stressed. The Kandi is "underlain by boulder, gravel, which acts as a very good medium for the recharge", with water 7–30 m below ground over most of the belt (NAQUIM, Outer Plains of Jammu Province), and the water supply of Jammu city is drawn from groundwater, for which the CGWB asks for "proper well head protection measures"; nitrate above 45 mg/L was found in 9.2% of the samples of 2024, among them samples from Jammu, Kathua and Samba districts (CGWB, Ground Water Year Book 2021–22; CGWB leaflet on the ground water resources and quality of Jammu and Kashmir, 2024). In the hills water put into the ground does not stay where it is put. At Pernote in Ramban, where about 35 houses were damaged in April 2024, the GSI found that "During rains the ingress of surface runoff through these cracks may have developed the pore pressure, thus inducing the instability in the slope", in "alternating layers of permeable sandstone and weak impermeable clay", and recommended "Proper measures for diverting the surface runoff away from the affected/active part of the slope", that "Drains present in the affected slope should be lined/trained" and "No new construction" (GSI note, 2024); the district committee asked that drains be "properly lined and maintained and the domestic sewage be channelised" (JKPCC, 2024). At Thathri Nai Basti in Doda, where houses cracked in early 2023 after heavy rain in late January, the NGT's committee found "no retaining wall with weep holes, or planned drainage or sewage disposal structures" and sewage piped "to the road side drainage downslope" (as reported). Treating RWH as detention would credit storage that does not exist when it is needed, which is why this Manual assumes RWH tanks are full at the start of every storm, in every season. The combined-tank provision (4.11.3) lets an owner build one structure, as long as the detention part is empty when the storm arrives. The 20 L per m² storage, the valley-floor rule, the Kandi recharge rule, the hill infiltration rule, the spring rules, the industrial-runoff and pre-treatment rules and the road-runoff rule are set by this Manual. No Jammu and Kashmir source sets a slope or distance threshold for infiltration; the 10° limit is set by this Manual, as in the other mountain editions of the series, because a slope that can carry a building can still be destabilised by water put into it, and the distance of twice the height of a cut or wall is set as a precaution, pending guidance from a geotechnical study for the Union Territory [TBC].

4.12 High-groundwater and sandy coastal sites

4.12.1 **Design groundwater level.** Each site in the floor of the Kashmir valley, on its alluvium, Gurti clay and Nambal peat, in and around Srinagar, Anantnag–Bijbehara, Pampore, Sopore, Baramulla, Sumbal and Bandipora, the Sirowal of the Jammu plains round R.S. Pura, Bishnah, Arnia and Hiranagar, the floodplains and low terraces of the Jhelum, the Tawi, the Chenab, the Ujh, the Basantar, the Ravi and the khads, the margins of Dal, Nigeen, Anchar, Wular, Manasbal, Hokersar and the other lakes and nambals, of Mansar and Surinsar and of the Kandi ponds and talabs, the margins and backwaters of the Salal, Baglihar and Dul Hasti reservoirs and of the Tawi barrage pond, and hill sites with perched water, such as Thathri Nai Basti, Pernote and Duksar, or any area where the groundwater table lies within 3 m of the surface at any time of year shall establish a design groundwater level (DGWL) for the facility. The DGWL is the seasonal high level during or after the SW monsoon, from:

- (a) site piezometer readings over at least one full March–November season; or
- (b) where (a) is not available, the higher of the CGWB or Jal Shakti Department (PHE) record for the nearest observation well, plus **0.5 m**, and the design flood level of any adjacent river, khad, nallah, lake, nambal, talab or reservoir.

For the flotation check of 4.12.3 at sites in the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, the Sirowal belt of the Jammu plains, the river terraces and floodplains, and the lake, nambal and reservoir margins, where (a) is not available, the DGWL shall be taken as existing ground level.

4.12.2 **Lined storage.** Where the DGWL is less than 1.0 m below the base of a storage facility:

- (a) the facility shall be watertight (lined or of watertight concrete), and no infiltration credit applies (Clause 4.4.4); or
- (b) if unlined, the volume below the DGWL shall not be counted as detention, and groundwater inflow shall be added to the routed inflow.

4.12.3 **Uplift and flotation.** Every below-ground tank, vault, lined pond or chamber shall be checked for flotation:

- with the facility empty;
- with groundwater at the DGWL; and
- for coastal sites, with groundwater also at the major-system tailwater level of Chapter 5, where that is higher.

The factor of safety against uplift, counting only permanent dead loads and ignoring wall friction unless supported by geotechnical design, shall be at least **1.2**. Anchoring by ballast, toe extensions or tension piles may be used.

4.12.4 **Shallow and above-ground storage preferred.** On sites where the DGWL is within 1.5 m of ground, storage should be provided above ground where possible: rooftop, podium, landscape or surface storage. Deep tanks should be avoided.

4.12.5 **Durability.** Concrete and metal parts in contact with saline or brackish groundwater or tidal water shall be designed for the exposure class appropriate to coastal conditions under IS 456:2000. Outlet fittings, trash racks and gates shall be of stainless steel, HDPE, FRP or another corrosion-resistant material.

4.12.6 **Sandy soils with deep groundwater.** Where the DGWL is 1.0 m or more below the base, infiltration retention in sandy soils is encouraged. The design infiltration rate of Clause 4.4.3 applies, and the Chapter 8 requirements on pollution of shallow aquifers shall be met.

> Commentary. Jammu and Kashmir is landlocked, so the coastal provisions of this clause, the tidal water levels of 4.12.1 and 4.12.3, do not apply in the Union Territory, and no saline groundwater was reported in the assessments read for this Manual [TBC], so the exposure provisions of 4.12.5 apply only where a test at the site shows it. Groundwater lies at three kinds of depth. On the Kandi fans of the Jammu plains it is deep: 7–30 m below ground over most of the belt and up to 84 m in the deeper aquifers, 5.24 m at Supwal to 65.0 m at Pangiari in Jammu district, and in Kathua district generally more than 18 m (NAQUIM, Outer Plains of Jammu Province). On the floor of the Kashmir valley, on the Sirowal and near the trunk streams it is shallow: 0–2 m below ground over the central and south-western valley in November 2014 (NAQUIM, Kashmir Valley), within 2 m in 81.8% of Baramulla's observation wells in May 2021 (CGWB, Ground Water Year Book 2021–22), 1.50–2.50 m after the monsoon in Srinagar district (CGWB, Srinagar district booklet), and mostly two to five metres in the Sirowal; and it stands above ground in the wells that flow under artesian pressure on both sides of the Jhelum, at heads up to 2 m above ground and 2.50 m at Charsoo in Anantnag district, and in the Sirowal of Kathua district, where more than half the wells flow at heads from a metre to more than 9 m above ground (NAQUIM, Kashmir Valley; CGWB, Anantnag district booklet; NAQUIM, Outer Plains of Jammu Province). In the hills it occurs in fractures, weathered rock and debris and is perched in places, as at Pernote, where "the water table is shallow" and springs flow from the slope (GSI note, 2024), and on the Upper Karewa, where "Perched water bodies are encountered" (NAQUIM, Kashmir Valley). The valley floor, the Sirowal, the floodplains and low terraces of the rivers and khads, the margins of the lakes, nambals, talabs and reservoirs, and hill sites with perched water are the wet cases. There an unlined tank fills with groundwater before the storm, and an empty lined tank can float, especially when the Jhelum in flood, a lake whose gate the river has shut, a reservoir at its full level or a talab at its spill level raises the water table beside it. The design groundwater level of 4.12.1(b) therefore takes the design flood level of the adjacent river, khad, nallah, lake, nambal, talab or reservoir where that is higher than the well record, and on the valley floor,

the Sirowal, the river terraces and floodplains and the lake, nambal and reservoir margins it is taken as existing ground level for the flotation check unless piezometers show otherwise. Where wells near the site flow under artesian pressure, as along the Jhelum and in the Sirowal of Kathua district, the tank shall also be checked for uplift with the groundwater at the artesian head measured in the nearest flowing well, which may stand several metres above ground; a deep tank shall not be built there at all unless that check is met. On a hill site a deep tank is not preferred even where groundwater is deep, because a leaking tank on a slope is an infiltration practice by another name: storage on a slope shall be lined and watertight, and its leakage and overflow taken to a lined drain (hill infiltration rule, Clause 4.11). The March–November monitoring season of 4.12.1(a) is set by this Manual to cover both groundwater years of the Union Territory: on the floor of the Kashmir valley levels are shallowest in May, after winter rain, snowfall and snowmelt (NAQUIM, Kashmir Valley), and in the Jammu division they rise with the SW monsoon of June–September and its after-flow; a reading taken only in the SW monsoon understates the design level in the valley, and one taken only in spring understates it in the plains. No water-table depths for individual town sites in Srinagar, Anantnag, Sopore, Baramulla, R.S. Pura or Kathua, and no map of the seasonal high water table of the valley floor or the Sirowal, were obtained [TBC]; the only Srinagar well in the 2021–22 year book is at Regal Chowk. The factor of 1.2, the 0.5 m allowance, the "ground level" default for the valley floor, the Sirowal, the river terraces and floodplains and the lake, nambal and reservoir margins, and the artesian-head check have no direct precedent; this Manual sets them because no published site-scale seasonal groundwater depths for Jammu and Kashmir were found during research.

4.13 Regional detention and fee-in-lieu

4.13.1 **Where permitted.** In a basin covered by a Basin Stormwater Master Plan approved under Chapter 11, a development may meet all or part of its detention requirement through:

- (a) a regional detention facility identified in the plan; or
- (b) a fee-in-lieu paid toward restoration of talab or tank storage identified in the plan.

4.13.2 **Conditions.** Regional detention or fee-in-lieu shall be accepted only where:

- (a) the regional facility or restored tank is operational, or is funded and scheduled to be operational within **3 years**. Until then, interim on-site detention is required.
- (b) the conveyance from the site to the facility carries the 1% AEP post-development flow without increasing water levels at buildings or roads between them (Chapter 5);
- (c) the storage credited at a tank is the **flood storage** only. This is the volume between full tank level (FTL) and the maximum water level the bund and surplus weir can safely hold, plus any volume below FTL that a notified operating rule commits to empty before the SW monsoon. Storage below FTL that is held for irrigation or supply through June to September shall not be credited.
- (d) the tank meets Chapter 7: surveyed FTL, a documented operating rule, and a maintained surplus weir;
- (e) the site still provides **retention** (Clause 4.4) and **WQv** treatment (Chapter 8) on site; and
- (f) in flood-sensitive catchments, the regional facility meets the mixed-frequency rule for its whole contributing area.

4.13.3 **Fee.** The fee-in-lieu shall be computed as:

> Fee = (detention volume required on site under Clause 4.6, m³) × (unit rate, ₹/m³, notified by the Authority)

The unit rate shall include land, construction and 10 years of maintenance. Fees shall be held in a ring-fenced basin account and spent only on the facilities named in the plan.

4.13.4 **Ledger.** The Authority shall keep a public ledger of:

- detention volume credited to each regional facility;
- volume delivered; and
- fees received and spent.

Commentary. The Malaysian DID (2008) checklist favoured community ponds over on-site detention for sites above 0.1 ha. Studies of on-site detention show that its benefit depends on location and fades with distance downstream (Colorado State University thesis; McEnroe for Kansas City), and that a pond low in the catchment can synchronise with the main-stem peak (*Water* 2016). Regional storage therefore has to be sited by basin modelling, not simply aggregated.

Jammu and Kashmir has no tank or lake Act. Its lakes are managed by authorities set up under the Jammu and Kashmir Development Act 1970: Dal and Nigeen by the Lake Conservation and Management Authority (LCMA, formerly LAWDA; renamed in November 2021, as reported) and Wular and its feeder channels by the Wular Conservation and Management Authority (WUCMA, 2012). The Jammu and Kashmir Wetland Authority was constituted on 25 November 2020 under the Wetlands (Conservation and Management) Rules 2017, but as of September 2024 no wetland had been notified under rule 4 of those Rules, although the Authority had approved the brief document of Wular "for Notification" (Forest, Ecology and Environment Department, report of 9 September 2024 in NGT O.A. 239/2024). Seven wetlands, Hokersar, Shallabugh, Hygam, Freshkoori, Kranchoo, Chatlam and Manibugh, are wildlife conservation reserves under orders of 1945 (same report). The Union Territory has five Ramsar sites: Wular (18,900 ha, 1990), Surinsar–Mansar (350 ha) and Hokera (Hokersar, 1,375 ha) (both 2005), and Hygam (802 ha) and Shallabugh (1,675 ha) (both 2022) (MoEFCC, list of Ramsar sites, 31 January 2024). No lake, nambal or reservoir in the towns was found to be operated for flood control under a documented rule for the towns' benefit. The Union Territory's regional storage is of six kinds: the lakes, Dal and Nigeen behind the Dal Gate, Anchar, Manasbal and Wular in the Kashmir valley and Mansar and Surinsar near Jammu; the nambals and flood basins of the Jhelum, Hokersar, Narkara, Shallabugh, Rakh-e-Arth, Haran and the low land from Lelhar to Lasjan, which hold the river's floods; the reservoirs, Salal and Dul Hasti (NHPC), Baglihar (JKSPDC), Ranjit Sagar on the Ravi and the new barrage pond on the Tawi at Jammu; the Kandi ponds and the talabs of Jammu, most of which survive only as names; the springs; and the kuhls and canals, from the Ranbir canal to the zamindari khuls. Five points follow:

- A lake or nambal on the record may not be a working one, and a nambal is the river's storage, not the town's. Hokersar has shrunk from 18.75 km² to about 13 km² and is reported to have "lost nearly half of its flood storage capacity", Wular from 157.74 km² in 1911 to 86.71 km² in 2007, and 37% of Narkara has been built over (as reported); no flood-storage volume was found for any valley wetland [TBC]. A lake or nambal is credited only after a survey shows its bed, rim and outlet, and only for the storage above its outlet or spill level (Clause 3.12.5). The flood basins that fill from the Jhelum are not credited to any site, because they are full when the river is high, which is when the town's outfalls are shut; a site that drains to them provides its full detention on site.
- Dal and Nigeen are not spare capacity for their catchment. Their outlets are shut when the Jhelum rises (Commentary to Clause 3.10), untreated sewage "gets entry into the Dal Lake from areas like Telbal, Lalbazar", and about 910 houseboats discharge into Dal and Nigeen (JKPCC, 2024). Storm water may be discharged to them only with LCMA's consent, through a sediment trap and with the dry-weather flow intercepted (Clause 8.9), and no credit is given for their storage.
- The reservoirs are not spare capacity either. They are held for power through the SW monsoon and the snowmelt, Salal's gates are opened at least once a month in the monsoon for desilting (as reported), their releases are set by their operators for the whole river and, since April 2025, may not be announced (as reported); their storage below full level is not credited (Clause 4.13.2(c)), and storm water spilled to a reservoir, or to a river below one, can be relied on only with the written agreement of the operator, NHPC, JKSPDC, the operator of Ranjit Sagar or I&FC for the Tawi barrage, for a stated flow and level.

- A pond or check dam in the bed of a khad or nallah is not regional detention unless it is designed for debris. The khads of the Kandi and the hills carry boulders, sediment and muck in every large storm, and muck dumping was reported to have worsened the floods of August 2025 on the Chenab and the Tawi (SANDRP, as reported); such a facility is credited only for the storage left after the sediment and debris volume of Chapter 6, with a debris rack or trap at its inlet, a geotechnical check of its bund and abutments, its failure path mapped, and a maintenance budget for clearing it after each large storm (Chapters 9 and 10). A Kandi pond revived as a recharge talab under Clause 4.11 is credited as retention only to the extent that it drains within 72 hours under Clause 4.4. A regional facility on a hill slope is also subject to the hill infiltration rule of Clause 4.11. A kuhl, canal or city channel is not regional detention: a storm drain that crosses or discharges to one does so only with the consent of I&FC, through a screen and a sediment trap, because the control of "the bed and banks of all water sources … city channels and flood spill channels" lies with I&FC and depositing waste in a channel is barred by the Water Resources Act 2010 (section numbers to be confirmed [TBC]).
- No rule dividing natural streams from municipal drains was found [TBC]. Until one is made, this Manual follows the working assignment of Chapter 1: the rivers, nallahs and khads, with their beds, banks and embankments, the flood spill channel, the city channels, canals and khuls as I&FC's, with the municipal body desilting and clearing within its limits the nallahs it cleans now; in Srinagar, the drainage schemes, drains and dewatering stations as UEED's to plan, design and build and as the Town Drainage wings' of SMC and of the Directorate of Urban Local Bodies Kashmir to run; in Jammu, the drains within JMC's limits as JMC's and the UEED Sewerage and Drainage Division (West) Jammu's; in the other towns, the Municipal Council's or Municipal Committee's; road drains and culverts as PW (R&B)'s, and on national highways NHAI's; Dal, Nigeen and the drains in LCMA's area as LCMA's, Wular and its feeder channels as WUCMA's, and the wetland conservation reserves as the Wildlife Department's; drains built by SDA, JDA, the Housing Board, a Smart City company or a colony developer as the builder's until handed over in writing; the reservoirs and their drawdown land as their operators'; and sewers as UEED's (Commentary to Clause 6.9). This is the Manual's working assignment, not a statutory one.

The first point is the basis of condition 4.13.2(c) in Jammu and Kashmir. A lake, nambal or talab gives flood storage only above its outlet or spill level, unless a notified operating rule commits it to be lowered before the SW monsoon or, in the Kashmir valley, before the spring snowmelt. The 3-year operational limit and the 10-year maintenance allowance have no direct precedent and are set by this Manual.

4.14 Simplified methods for small sites

4.14.1 **Applicability.** Tier B local bodies may permit the simplified method for sites of **2 ha or less** outside flood-sensitive catchments. In flood-sensitive catchments, it may be used for sites of **0.5 ha or less**. All other sites shall use Clause 4.6. Until Table 4.3 (Annex 4B) is published, all Tier B sites shall also use Clause 4.6.

4.14.2 **Method.**

1. Read the PSD (L/s/ha) and SSR (m³/ha) for the site's zone, HSG and post-development imperviousness from **Table 4.3** (Annex 4B).
2. Required storage: V = SSR × A − V_credit (Clause 4.4.6.3).
3. Permissible discharges: Q_PSD,T = PSD_T × A for the 2-yr and 100-yr stages.
4. Select the low-flow orifice and upper control from the standard outlet table in Annex 4B (orifice sizes for the PSD at the stated depths), subject to the 50 mm minimum.
5. Provide a spillway or overflow under Clause 4.9, the RWH accounting of Clause 4.11, and the safety provisions of Clause 4.15.
6. Complete Form 4-2 (Tier B site sheet).

Table 4.3 — Tier B permissible site discharge and site storage requirement (template)

Zone (Annex 2A)	HSG	Imperviousness	PSD 2-yr (L/s/ha)	PSD 100-yr (L/s/ha), standard	PSD 100-yr (L/s/ha), flood-sensitive	SSR (m³/ha), standard	SSR (m³/ha), flood-sensitive
JK-Z1 Jammu plains: JK-A Jammu plains, Kandi and Sirowal (Jammu–R.S. Pura–Akhnoor–Samba–Kathua)	A / B / C / D	50% / 70% / 90%	[TBC]	[TBC]	[TBC]	[TBC]	[TBC]
JK-Z2 Pir Panjal–Chenab hills: JK-B Outer and middle hills (Udhampur–Katra–Reasi–Rajouri–Poonch–Ramban–Banihal)	B / C / D	50% / 70% / 90%	[TBC]	[TBC]	[TBC]	[TBC]	[TBC]
JK-Z2 Pir Panjal–Chenab hills: JK-B1 Inner Chenab hills (Doda–Kishtwar–Bhaderwah)	B / C / D	50% / 70% / 90%	[TBC]	[TBC]	[TBC]	[TBC]	[TBC]
JK-Z3 Kashmir valley: JK-C Kashmir valley floor and Karewas (Srinagar–Anantnag–Pampore–Sopore–Baramulla–Kupwara)	B / C / D	50% / 70% / 90%	[TBC]	[TBC]	[TBC]	[TBC]	[TBC]
JK-Z4 High mountains: JK-D High mountains and snow-fed catchments (Gulmarg–Pahalgam–Sonamarg–Gurez–Paddar; hazard-first)	—	—	Not tabulated: Clause 4.6 applies (Clause 2.3.6(i))	—	—	—	—

Worked example (illustrative — not design values).

A 0.4 ha residential layout in a Tier B Municipality, in a flood-sensitive catchment, with about 80% directly connected impervious area (area-weighted post-development CN about 92). Suppose Table 4.3 had been computed and gave the per-hectare equivalent of the Clause 4.6.7 example:

- PSD 100-yr = 356 / 2.0 = 178 L/s/ha
- SSR = 2,913 / 2.0 ≈ 1,460 m³/ha
- PSD 2-yr ≈ 17 L/s/ha

Then:

- Storage: V = 1,460 × 0.4 = **584 m³**. C_R = 0, so there is no retention credit.
- 100-yr release: 178 × 0.4 = **71 L/s**.
- 2-yr release: 17 × 0.4 = **7 L/s**. At about 1 m head this needs a low-flow orifice of about 60 mm, above the 50 mm minimum (Clause 4.8.2).
- Layout options:
  - a 400 m² underground tank 1.5 m deep; or
  - 250 m² of podium storage at 0.3 m (75 m³) plus a 350 m² tank 1.5 m deep (525 m³).
  - Rooftop storage at 150 mm over 1,200 m² of roof (180 m³) could replace part of the tank.
- RWH sumps are additional, and are assumed full (Clause 4.11).

> **Commentary.** Australian councils use permissible site discharge and site storage requirement tables in the same way (Sydney Water OSD guide; the Upper Parramatta River Catchment Trust handbook listed SSR of about 455 m³/ha). The illustrative SSR here, about 1,460 m³/ha, is much larger. That is the expected effect of combining a

> mixed-frequency cap with mandatory 48–72-hour storms at AMC III. MSMA 2 in Malaysia offers a similar simplified OSD method for sites under 5 ha. The MARC policy supplement offers smaller Kansas City municipalities adoptable alternatives within the regional standard; Clause 4.14 follows that model for Tier B.

4.14.3 **Fixed-coefficient route.** As an alternative to Clauses 4.6 and 4.14.2, the designer of any site of **1 ha or less**, under any Approving Authority and in any catchment, may size detention by Clauses 4.14.4 to 4.14.7. The route shall not be used where:

- (a) the site counts tank or waterbody storage in its design (Chapter 7);
- (b) any part of the site lies within a waterbody setback (Chapter 7); or
- (c) the site drains to a tank cascade whose storage is counted in a downstream design.

The route sets the release caps by fixed coefficients and does not need Table 4.3. It may therefore be used before Annex 4B is published. Retention (Clause 4.4), drawdown (Clause 4.7), outlets (Clause 4.8), the spillway (Clause 4.9), the downstream and tailwater checks (Chapter 5) and water quality (Chapter 8) still apply.

4.14.4 **Release caps.** Two caps apply at each point where runoff leaves the site:

$Q_{cap,10} = 2.78 \times C_{10} \times i_{10} \times A$ and $Q_{cap,2} = 2.78 \times C_2 \times i_2 \times A$

where Q_{cap} is in L/s; A is the site area (ha); i_{10} and i_2 are the 10% AEP (10-yr) and 50% AEP (2-yr) rainfall intensities (mm/h) for a **15-minute** duration at the site, from the sources of Chapter 2, with the climate factor of Clause 2.8; and C_{10} and C_2 are the fixed coefficients of Table 4.3A for the site's hydrologic soil group (Clause 3.7). For a site with more than one soil group, the coefficients are area-weighted.

Table 4.3A — Fixed release coefficients (provisional)

Hydrologic soil group	C_{10}	C_2
A (sandy, well drained)	0.05	0.02
B	0.08	0.03
C	0.15	0.08
D (clay, poorly drained)	0.25	0.15

$Q_{cap,10}$ is the maximum release for **every storm up to and including the 1% AEP (100-yr) storm**, in every catchment. $Q_{cap,2}$ is the maximum release for the 50% AEP (2-yr) storm. Where a cap is smaller than the discharge of a 50 mm orifice at the corresponding stage, the 50 mm orifice is deemed to comply (Clause 4.5.5.1).

4.14.5 **Storage.** The detention storage V (m^3) is the larger of V_{100} and V_2, each the largest over the durations d of Clause 2.5.2 (1 to 72 hours):

$V_{100} = \max_d [\, 10 \times C_v \times P_{100}(d) \times A - 1.8 \times Q_{cap,10} \times d \,]$

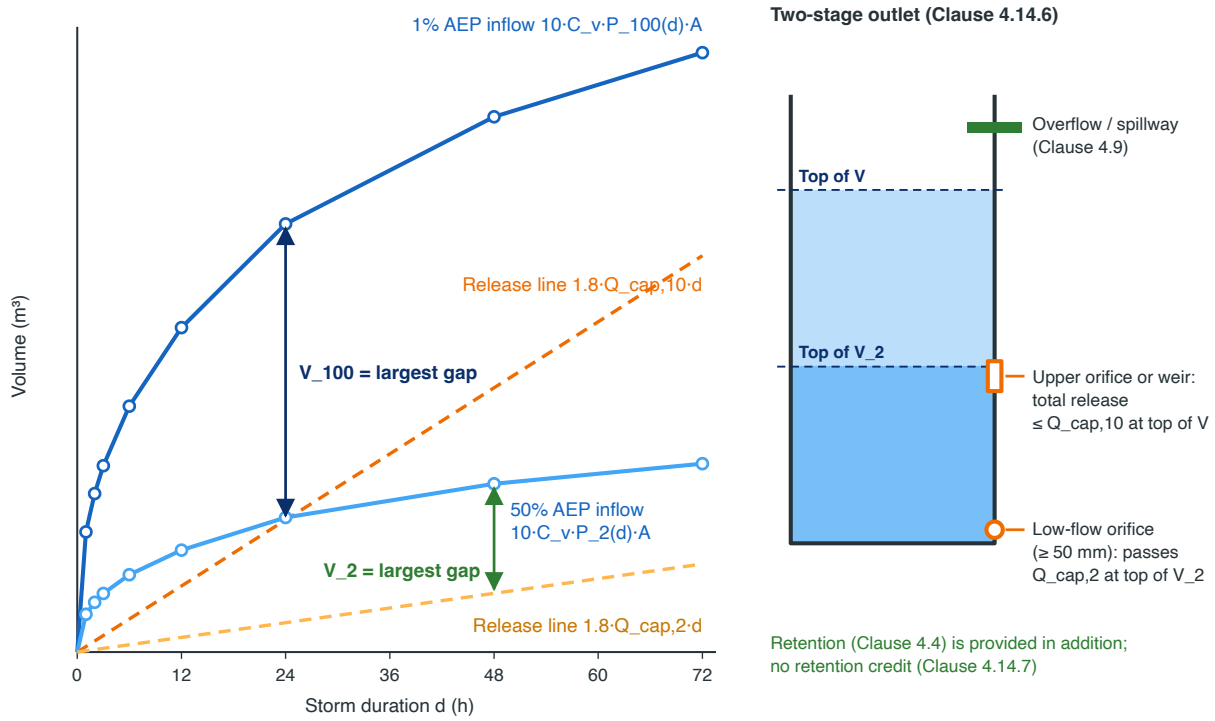
$V_2 = \max_d [\, 10 \times C_v \times P_2(d) \times A - 1.8 \times Q_{cap,2} \times d \,]$

where $P_{100}(d)$ and $P_2(d)$ are the 1% and 50% AEP rainfall depths (mm) for duration d (hours), with the climate factor; and C_v is the post-development volumetric coefficient: the composite C of Table 3.2 (upper half of each range), multiplied by Cf of Table 3.3 for the 1% AEP. For durations of 12 hours or more, C for every pervious surface shall be taken as not less than **0.50**. The factor 1.8 assumes an average release of half the cap over the storm (3.6×0.5).

4.14.6 **Outlet.** The outlet shall be a two-stage control: a low-flow orifice that passes $Q_{cap,2}$ when the storage holding V_2 is full, and an upper orifice or weir that limits the total release to $Q_{cap,10}$ at the top of V. The outlet table of Annex 4B may be used once it is published.

4.14.7 **Retention.** The retention volume of Clause 4.4 is provided in addition to V. No retention credit (Clause 4.4.6) is taken under this route.

Fixed-coefficient route for sites of 1 ha or less (Clauses 4.14.3–4.14.7) — schematic, not to scale



Dots: durations of Clause 2.5.2 (1, 2, 3, 6, 12, 24, 48, 72 h). Pervious C ≥ 0.50 for d ≥ 12 h.

$Q_{cap,10} = 2.78 \times C_{10} \times i_{10} \times A$; $Q_{cap,2} = 2.78 \times C_2 \times i_2 \times A$; (L/s; A in ha; i in mm/h)

C_{10}, C_2 from Table 4.3A by soil group; i_{10}, i_2 for a 15-minute duration with the climate factor (Clause 2.8)

$V = \max(V_{100}, V_2)$; $V_T = \max$ over d of $[\, 10 \times C_v \times P_T(d) \times A - 1.8 \times Q_{cap} \times d \,]$ (m^3) ; 1.8 = 3.6 × 0.5 (average release of half the cap)

Figure 4.3 — Fixed-coefficient route for sites of 1 ha or less (Clauses 4.14.3 to 4.14.7): the release caps Q_cap,10 and Q_cap,2 from Table 4.3A; the storage V as the largest gap, over the durations of Clause 2.5.2, between the cumulative inflow 10·C_v·P(d)·A and the release line 1.8·Q_cap·d, for the 1% and 50% AEP storms; and the two-stage outlet that passes Q_cap,2 at the top of V_2 and Q_cap,10 at the top of V. Schematic, not to scale. Original drawing for this Manual, adapted from the rainfall mass-curve (inflow minus outflow) storage concept and the single-coefficient peak cap of the PUB Code of Practice on Surface Water Drainage, 7th ed. (cl. 7.1.5).

Commentary. The fixed-coefficient route follows Singapore, which caps the peak runoff from every development of 0.2 ha or more with one runoff coefficient, C = 0.55, applied to the 10-yr storm (PUB Code of Practice on Surface Water Drainage, 7th ed., cl. 7.1.5, Addendum No. 3, 2025). It is quick to apply and quick to check: the cap needs only the site area, the soil group and two intensities. PUB's 0.55 is not used here, because Singapore's baseline is the existing urban drainage system, while this Manual's baseline is greenfield land (Clause 4.5.1.2). The coefficients of Table 4.3A are set by this Manual from the greenfield curve numbers of Clause 3.3 (CN 39, 61, 74 and 80 for soil groups A to D). They are the ratios of runoff to rainfall that those curve numbers give for 1-hour depths typical of the Jammu plains and the Kandi belt, rounded down. They are therefore **provisional**. The State Stormwater Technical Committee shall confirm or revise them against NIH-DHAARA values for each zone when it issues Annex 4B.

> The route is deliberately **stricter** than the full method, so that simplicity costs the developer storage rather than costing the people downstream. The 100-yr release is held to about the greenfield 10-yr peak everywhere, which is the flood-sensitive rule of Clause 4.5.3; the storage assumes the outlet releases only half the cap on average; pervious ground is assumed wet in long storms; and no retention credit is taken. A designer who wants a smaller tank can use the full method of Clause 4.6. The storage formula is the rainfall-mass (inflow minus outflow) method. Clause 3.4.2 otherwise forbids rainfall-based peak methods for storage, because they ignore the shape of the hydrograph; this route is a stated exception because its conservative assumptions cover that error for small sites, and the 24- to 72-hour durations are always checked.

4.15 Safety, fencing and multi-use

4.15.1 **Depth limits for publicly accessible storage.** Where the public has access to a storage area (parks, playfields, open space, school grounds):

- (a) maximum depth in the 10% AEP storm: **0.45 m**;
- (b) maximum depth in the 1% AEP storm: **1.2 m**, except in a fenced zone under 4.15.3;
- (c) side slopes: no steeper than **4H:1V**, with at least a quarter of the perimeter at **6H:1V** or flatter for escape; and
- (d) no vertical drop greater than **0.3 m** within the storage area or at its edge.

4.15.2 **Wet basins.** Permanent pools shall have:

- a safety bench at least 3 m wide, no more than 0.3 m below the normal water level; and
- an emergent planting fringe that deters entry.

4.15.3 **Fencing.** A fence at least **1.2 m** high, of a non-climbable design with a lockable gate, is required around any part of a storage that:

- has a vertical wall or headwall drop greater than **0.6 m**;
- exceeds 1.2 m depth in the 1% AEP storm with slopes steeper than 4H:1V; or
- contains an outlet structure with an opening larger than 300 mm that is not grated.

4.15.4 **Outlets.** Every inlet and outlet opening larger than 300 mm accessible to the public shall be fitted with a grate or rack. The grate shall be designed so that a person pinned against it can escape: low approach velocity, inclined, with a large open area.

4.15.5 **Signs and depth markers.** Every publicly accessible storage shall have signs in Urdu and English stating that the area floods during rain, and a depth marker at the deepest point.

4.15.6 **Confined spaces.** Underground tanks shall have lockable covers. They shall be marked as confined spaces, and the maintenance declaration (Chapter 10) shall state the entry procedure.

4.15.7 **Vector control.** Dry storage shall drain completely (Clause 4.7) and have no low points that pond for more than 72 hours. Wet basins shall meet Clause 4.10.7.

> Commentary. The numeric limits in Clause 4.15 have no single direct precedent. They are drawn from common international practice, for example KC APWA 5600 (2006), which required at least a quarter of a dry-pond perimeter at 5:1 or flatter, a 20 ft (6 m) clearance from property lines and a 15 ft (4.6 m) maintenance strip. They are made somewhat stricter here because multi-use storage on open space land and in schools will be used by children during the monsoon. Standing water in dry basins is a mosquito-breeding risk, so complete drainage (Clause 4.15.7) is a public-health requirement, not an amenity.

4.16 Basis: why peak matching alone fails

Commentary. This section has no requirements. It records why this chapter requires release **below** pre-development rates, retention, long-duration checks and a downstream analysis, rather than simple peak matching.

1. **Timing.** Detention lowers a site's peak but stretches its hydrograph (Figure 4.1). Downstream, the stretched releases from many sites overlap with each other and with the main-stem peak. In Denver's study, ten basins each releasing 100% of the historic 100-yr peak produced 106% of the historic peak at the outlet. Only releasing 90% at each site brought it to 97% (UDFCD memo, 2012). A Colorado State University thesis found that location-blind on-site detention "can actually increase peak flows above post-development peaks". An optimisation study found that a downstream pond performed worse than upstream ponds because its outflow synchronised with the main stem (Water 2016, 8(7):290).
2. **Volume.** Detention does not remove volume. In the illustrative example, the post-development 100-yr storm produces about three times the runoff volume of the pre-development 10-yr storm (Clause 2.11). Only retention, or storage that empties to somewhere other than the receiving drain, reduces volume.
3. **Scale.** Kansas City modelling (McEnroe, 2005) found that uniform 3 cfs/ac control reduced Q100 by 36% in a 200-ac watershed. With the same control everywhere, Q100 still rose by 40% at 14 sq mi, and the benefit faded beyond about 1–2 sq mi. The KC committee concluded that "'match existing' can harm streams" (MARC Evolution deck). Georgia makes a ten-percent downstream analysis mandatory for the same reason: "Due to peak flow timing and runoff volume effects, some structural practices fail to reduce discharge peaks to pre-development levels downstream" (GSMM 2016).
4. **Design-storm dependence.** An Australian study of 20 real on-site detention systems found that designs using even ten temporal patterns "cannot reliably produce an OSD system design that will always be effective" under real rainfall (Water Science and Engineering, 2019). This is why Clause 4.6.3 routes the full duration matrix rather than one critical storm.
5. **Closed outfalls.** In Jammu and Kashmir, the governing failure takes two forms. On the floor of the Kashmir valley it is volume with no outlet while the Jhelum is high. Srinagar, Anantnag–Bijbehara, Pampore, Sopore and Baramulla lie behind the river's embankments, and their gravity outfalls are shut from the time the river reaches flood-declaration stage, 18 ft on the I&FC gauge at Ram Munshi Bagh (as reported); in September 2014 the CWC site there rose to 1,588.99 m on 8 September, 3.51 m above its danger level of 1,585.48 m (CWC, as transcribed by SANDRP from the 2022 list; the 2018 list gives 1,589.65 m), the river broke its embankments and parts of the city stayed under water for up to 25 days (Malik, 2021). Whenever the river shuts the outfalls the city drains only by its pumps, about 2,300 cusecs from 104 permanent dewatering stations in 2026 (as reported), or about 0.3 mm an hour over the 767 km² of the drainage master plan (NEER's arithmetic), and by the storage in its drains, low land and lakes; Dal and Nigeen are shut off from the river by the same rise. Even a small storm floods the city centre, as 26.4 mm did on 1 August 2019 (as reported). In the hills and on the Kandi the outfall is closed in a different way: by debris. The khads and nallahs rise fast after a burst and carry boulders, sediment, wood and muck that bury outfalls, block culverts and choke the drains behind them; muck dumping was reported to have worsened the floods of August 2025 on the Chenab and the Tawi (SANDRP, as reported), and at Thathri Nai Basti sewage pipes discharged to the roadside drains downslope (as reported). No hourly record of how long the Jhelum stays above a town's outfalls was obtained [TBC], the I&FC gauges read in feet on zeros that are not published, and no document was found that sets a design river level for an outfall; Chapter 5 sets the design level, the closure to be assumed and its duration, and Chapters 6 and 9 the debris and blockage allowances. A perfectly orificed basin behind a closed outfall simply fills. No release-rate rule can fix that; it is handled by the outfall-closed check of Chapter 5.

The response in this Manual is layered:

- release below pre-development (Clause 4.5);
- retain the frequent storms (Clause 4.4);
- route long SW monsoon storms (Clause 4.6.3);

- prefer regional storage in the talab system (Clause 4.13); and
- check downstream and at the outfall (Chapter 5).

Kansas City's own history shows the price. On a test site, peak matching needed 3.0 ac-ft of storage and the 2011 comprehensive criteria needed 4.9 ac-ft (MARC Evolution deck). Over-detention costs more storage. That is the cost of protecting the catchment rather than only the site boundary.

4.17 Submittal requirements

Every site runoff-control submittal shall include a **Site Runoff Control Report** (Form 4-1) containing:

1. the Design Rainfall Sheet (Form 2-1) and the hydrology inputs (Chapter 3);
2. the evidence for the order of measures under Clause 4.3.1;
3. the RRV computation, infiltration tests, groundwater evidence and drawdown calculation (Clause 4.4);
4. the retention credit computation (Clause 4.4.6);
5. the release-rate criterion applied, standard or flood-sensitive, with the Annex 4A map extract (Clause 4.5);
6. a results table in the format of Clause 4.6.7 for every AEP and duration, with the governing case highlighted;
7. stage–storage and stage–discharge tables and plots, and inflow/outflow hydrographs for the governing cases;
8. the drawdown calculation (Clause 4.7);
9. outlet details, including orifice sizes and levels, trash racks and anti-vortex devices (Clause 4.8);
10. the spillway or overflow calculation, freeboard and hazard classification, and the geotechnical report where required (Clause 4.9);
11. the RWH and detention accounting, with tank sections showing zone levels (Clause 4.11);
12. the design groundwater level and flotation check (Clause 4.12);
13. the downstream and tailwater report (Chapter 5, Form 5-1); and
14. the safety provisions (Clause 4.15) and the draft maintenance declaration (Chapter 10).

Tier B sites using Clause 4.14.2 shall submit Form 4-2 in place of items 6 and 7. Sites using the fixed-coefficient route (Clause 4.14.3) shall submit Form 4-3 in place of items 6 and 7.

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Annexes and forms

Annex / Form	Content
4A	Flood-sensitive catchment boundaries (GIS); shallow-groundwater zone map
4B	Tier B tables: PSD and SSR (Table 4.3), retention credit factor C_R, standard outlet sizes; confirmed fixed release coefficients (Table 4.3A)
4C	Worked example (Tier A) with full routing tables
Form 4-1	Site Runoff Control Report
Form 4-2	Tier B Site Sheet
Form 4-3	Fixed-coefficient Route Sheet (Clauses 4.14.3 to 4.14.7)

CHAPTER 5

Downstream and Tailwater Analysis

5.1 Purpose and scope

5.1.1 This chapter sets two checks that every regulated development and every public drainage project must pass.

- **The downstream analysis** (Clauses 5.3 to 5.5) confirms that the project does not make flooding worse below its outfall.
- **The tailwater analysis** (Clauses 5.6 to 5.13) sets the water level the system discharges into, including tide, storm surge, sea-level rise, river backwater and sand-bar closure. It also requires the system to cope when its outfall is closed.

5.1.2 This chapter applies to:

- (a) every site to which Chapter 4 applies;
- (b) every minor- and major-system drainage project under Chapter 6; and
- (c) every regional detention or tank restoration project under Clause 4.13 and Chapter 7.

5.1.3 Rainfall and joint-occurrence inputs come from Chapter 2, in particular Clauses 2.5.3 and 2.12. Hydrologic methods come from Chapter 3. Site release criteria come from Chapter 4. Hydraulic design of gates, culverts and pumps follows Chapter 9.

5.1.4 **No tidal outfalls in Jammu and Kashmir.** Jammu and Kashmir is landlocked and mountainous: it has no coast, no tide and no Coastal Regulation Zone, and the south-west monsoon and the western disturbances reach it only as rainfall and snow, which are dealt with in Chapter 2, not as a tidal or surge level. No outfall in the Union Territory discharges to the sea, a tidal creek or an estuary, so the provisions of this chapter that depend on tide, storm surge, sea-level rise or a river mouth do not apply in Jammu and Kashmir: Clause 5.7 and Annex 5A, cases J1 to J3 of Table 5.2, the tidal lock windows of Clause 5.10.3, the seawater requirement of Clause 5.11.3(a) (gates and seats shall still be of corrosion-resistant materials, and shall resist abrasion by gravel and boulders and the action of ice), and Clause 5.13. They are kept so that the clause numbers of this Manual match its other editions. In Jammu and Kashmir the receiving water is one of six kinds: the Jhelum on the floor of the Kashmir valley, held above Srinagar and the other valley towns by its embankments, which the towns reach through gates and dewatering stations and which shuts their gravity outfalls for days once it rises; another river, such as the Tawi at Jammu, the Chenab at Akhnoor, the Ujh at Kathua or the Basantar at Samba, reached directly or through a gate; a khad (खड्ड; a seasonal hill torrent or ravine stream) or a nallah (नाला; نالہ; a natural or artificial drainage channel), ungauged, seasonal and laden with boulders, whose bed rises and falls in a single flood; a reservoir or barrage pond, such as Salal, Baglihar, Ranjit Sagar or the pond of the Tawi barrage; a sar (सर; a lake), a nambal (नंबल; a marsh or shallow lake choked by vegetation) or a talab, such as the Dal, whose outlet the river shuts, the flood-absorption marshes of Hokersar and Anchar, the Wular, or Mansar and Surinsar; or a canal, a city channel or a khul (a village irrigation channel), such as the Ranbir Canal, the Tsunth Kol or the flood spill channel; and:

- (a) its tailwater is set by Clauses 5.6 and 5.8, including Clause 5.8.5;
- (b) where Clauses 5.10 to 5.12, Form 5-1 or Chapter 6 refer to the J1 tailwater or the J1 tidal curve, the minor-system tailwater of Clause 5.6.2 or 5.8.5 applies, as a time series where the receiving level varies; where they refer to the J2 tailwater or to HAT + surge + SLA, the major-system tailwater applies: the design-AEP river level of

Clause 5.8.4(b), or the major-system tailwater of Clause 5.8.5, whichever is higher at the outfall; and

- (c) the outfall-closed check of Clause 5.10 applies where an outfall is closed by the Jhelum or another river, a khad or nallah, a reservoir or barrage pond, a lake or nambal, a canal, city channel or khul, or a receiving drain, with the river lock of Clause 5.8.5(a) and the closures of Clause 5.8.5(b) to (f) in place of the tidal lock windows.

Commentary. The drains of Jammu and Kashmir's towns fail in places that site design does not see, and in six different ways. The first is the Jhelum. Srinagar lies on the floor of the Kashmir valley beside a river that its embankments hold above parts of the city in flood, and its drains reach the river through gates and pumping stations, about 89 of them in 2019 (Srinagar Master Plan 2035) and 104 permanent dewatering stations in 2026 (as reported). In September 2014, 34% of the Srinagar planning area, 262 km², was flooded (Srinagar Master Plan 2035, §4.2), and the floods of that month killed 304 people in the State, 217 in the Jammu division and 87 in Kashmir (CAG, Report No. 4 of 2016); the flood spill channel that is meant to carry the Jhelum round the city had been reduced by sediment from a design capacity of 17,000 cusecs to 4,000, and the audit found that the impact of the floods "may have been mitigated" had the schemes to restore it been carried out as approved (CAG, Report No. 4 of 2016). Srinagar's own rain in that flood was modest, about 140 to 152 mm in four days at its gauges, against 400 to 600 mm on the catchments of south Kashmir (Ray et al., 2015): the city flooded from the river. The second is the other rivers. The Tawi at Jammu set a new highest level of 321.1 m at Sidhra on 26 August 2025, 2.25 m above the level of 2014, on the day Jammu recorded 380 mm in 24 hours (IMD; CWC data, as copied by SANDRP); and the Chenab at Akhnoor rose to 43 ft on 3 September 2025 against 61 ft in 1992 (as reported). The third is the khad and the nallah. Jammu's Kandi belt has "more than 100 small and big dry khads which have flash floods during the rainy season" (Jammu Master Plan 2032, §7.3.2), none of them gauged, and much of its drainage land is recorded as Gair Mumkin Khad, which the master plan proposes to reduce to the "true Khad" (§12.2.3). The fourth is the reservoir: the Chenab's dams at Dul Hasti, Baglihar and Salal and the Ranjit Sagar dam on the Ravi pass floods and flush silt into the rivers below, and since April 2025 their releases are reported to go unannounced downstream (as reported). The fifth is the lake and the nambal: the Dal drains to the Jhelum through the Dal Gate, whose flood-gates close when the river rises (Grierson, *A Dictionary of the Kashmiri Language*, p. 210), and the marshes that absorbed the Jhelum's floods west and north of Srinagar have been built over and silted, Hokersar losing "nearly half of its flood storage" (as reported). The sixth is the canal and the city channel: the Tsunth Kol, the Padshahi Canal and the flood spill channel are under I&FC by statute (Water Resources Act 2010, s.81 [TBC on the section number]). The outfalls also belong to one body while the drains above them belong to others: the rivers, nallahs, khads, embankments and channels are I&FC's, the reservoirs NHPC's, JKSPDC's or Punjab's, the Dal LCMA's and the Wular WUCMA's, and the drains and pumping stations UEED's, the municipal bodies' and the Public Works (R&B) Department's, and no rule divides them (Chapter 6, Clause 6.9). No document found during research sets a design level for any river, khad, reservoir, lake or canal outfall in the Union Territory, or a design standard for any town drain. A detention basin that meets every release rate in Chapter 4 still fails if the Jhelum has shut its outfall, if the khad has buried its outlet in boulders, or if the lake or reservoir is full. This chapter makes these failure modes part of the design. Jammu and Kashmir has no tidal outfall, so Clause 5.1.4 says which of the chapter's coastal provisions fall away and what takes their place.

5.2 Definitions

Term	Meaning in this Manual
Analysis point	A location on the downstream system where pre- and post-project conditions are compared (Clause 5.3.3).
Contributing catchment	The whole area draining to an analysis point, on and off site.

Term	Meaning in this Manual
Major drain	A channel listed as a major drain in the basin plan or Annex 5B, or any river, I&FC canal, the flood spill channel of the Jhelum from Padshahi Bagh to the Wular, the Tsunth Kol, the Padshahi Canal and the other city channels of Srinagar, the Dal's outlets at Dal Gate and Nallah Amir Khan, the Telbal, Doodhganga, Sukhnag and Sind nallahs and the other nallahs that feed the lakes and marshes of the Kashmir valley, the Devak and the Basantar, the Balol, Thather and Bhalwal khads and the other khads of Jammu and the Kandi belt, the Ranbir and Sindh canals and any other canal or zamindari khul that receives storm water, any drain built or held by SMC, JMC, a Municipal Council or Municipal Committee, UEED, SDA, JDA, LCMA, a Smart City company or the Public Works (R&B) Department with an internal width of 1.0 m or more, and every khad or nallah that drains 8 ha or more, or a tidal creek.
Chart datum (CD)	The datum of the published tide tables and nautical charts, to which tidal heights are referred.
Mean sea level (MSL)	Average sea level over a long period at a tide gauge.
MHWS	Mean high water springs: the average of high waters at spring tides.
HAT	Highest astronomical tide: the highest level predicted under average meteorological conditions over a full tidal cycle (18.6 years).
Storm surge	The rise in sea level above the astronomical tide caused by wind and low pressure, mainly during cyclones.
Still-water level	Astronomical tide plus surge, excluding individual waves.
Sea-level allowance (SLA)	The allowance added to present-day tidal levels for sea-level rise over the design life (Clause 5.7.4).
Tailwater	The water level at the downstream end of a drain, outlet or storage.
Tide-lock	The condition in which the tailwater is at or above the upstream water level, so a gravity outfall cannot discharge.
Lock window	A period during which the outfall-closed check of Clause 5.10 sets gravity discharge to zero.
Sand bar	A bar of beach sand that partly or fully closes a river mouth or creek inlet.
Project datum	The levelling datum used on the project drawings. It must be tied to a Survey of India benchmark (Clause 5.7.2).

5.3 Extent of the downstream analysis

5.3.1 The downstream analysis shall start at each site or project outfall. It shall continue downstream to the **first** of:

- (a) the point at which the project area is **10% or less** of the contributing catchment;
- (b) the next **tank, talab** or other waterbody with a surplus weir or controlled outlet; or
- (c) the next **major drain**, or the sea.

The end point itself shall be analysed (Figure 5.1).

5.3.2 Where the analysis ends at a tank or talab under 5.3.1(b), it shall report:

- the change in the tank's maximum water level; and
- the change in surplus-weir discharge, for the AEPs and durations of Clause 5.4.3.

If the maximum water level rises, the analysis shall continue below the surplus weir to the next end point.

5.3.3 Analysis points shall be set at least at:

- (a) each site outfall;
- (b) each confluence with a drain or channel whose contributing catchment is at least half that of the receiving drain at that point;
- (c) each culvert, bridge or road crossing;
- (d) each location recorded as flood-prone by the local body, SMC, J&K SDMA or I&FC; and
- (e) each building or road segment lying within the 1% AEP flood extent along the route. Representative points may be used where buildings are closely spaced.

5.3.4 **Small sites.** For sites of less than **0.5 ha**, the Authority may accept a simplified downstream statement (Form 5-2) in place of the full analysis, where all of the following hold:

- the receiving public drain has documented capacity for its minor-system design flow (Chapter 6);
- no flood-prone location is recorded within 500 m downstream; and
- the site does not drain to a tidal or backwater-affected outfall.

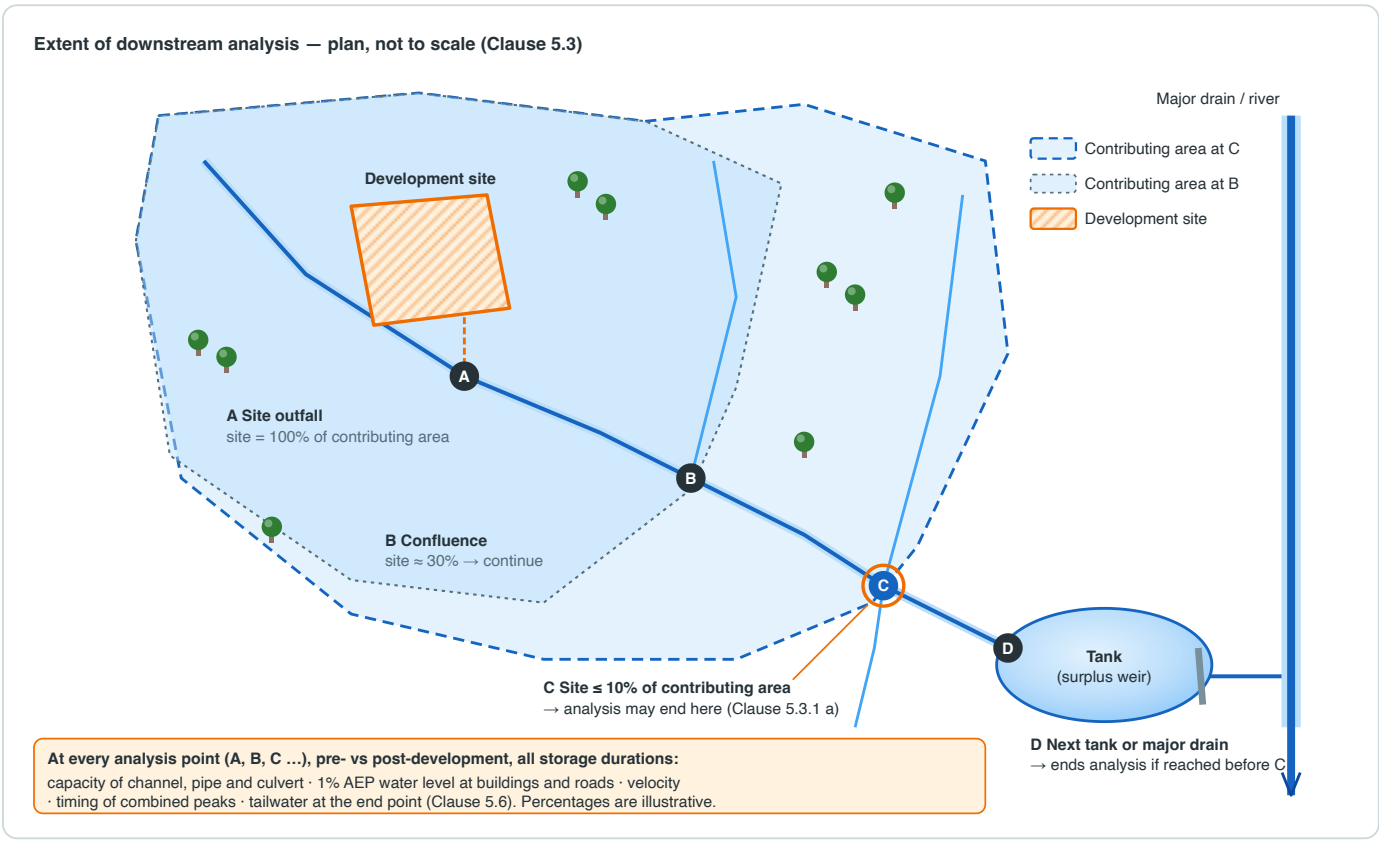

Figure 5.1 — Extent of downstream analysis: analysis points A–D, the contributing area at each point, the 10% point, and the next talab or major drain as an alternative end point. Schematic; percentages are illustrative. Original drawing for this Manual, adapted from the ten-percent rule in the Georgia Stormwater Management Manual (2016, Vol. 2 §3.1.9) and KC APWA Section 5600 (2006, 5601.5).

> **Commentary.** The 10% rule has established precedent. KC APWA 5600 (2006) required the downstream system to be analysed "to the point the development's land mass is less than 10% of the total watershed". The Georgia manual makes the ten-percent analysis a mandatory standard (GSMM 2016, Standard #8). The tank or major-drain end point has no direct precedent; this Manual adds it for Jammu and Kashmir. In the Kashmir valley, where a colony's drain runs to a dewatering station that lifts it over the embankment into the Jhelum, which carries it through Srinagar, or round the city by the flood spill channel, to the Wular many kilometres below, and in the Jammu plains and hills, where a colony's drain runs down a khad across the Kandi belt to the Tawi, the Ujh, the Basantar or the Chenab, the 10% point can lie many kilometres downstream, across several tanks. A tank with a

working surplus weir changes the hydrograph completely, so the analysis is better ended there and the tank level reported. Clause 5.3.2 prevents that end point from hiding a rise in the tank level. The small-site statement (5.3.4) and its 500 m distance have no direct precedent and are set by this Manual.

5.4 What the analysis must check

5.4.1 **Scenarios.** Each analysis shall compare:

- (a) **Existing**: the present downstream system and present land use of the whole contributing catchment, with the project site at its pre-project state; and
- (b) **With project**: the same, with the project and all its controls (Chapter 4) in place.

Where the Authority's basin plan defines future land use, the Authority may also require:

- (c) **Future**: the catchment fully developed under the plan, all to Chapter 4 standards, with and without the project.

5.4.2 **Quantities to be checked at every analysis point:**

- (a) **Capacity**: peak flow against the capacity of every channel, pipe, culvert and crossing, for the minor-system AEP of that element (Chapter 6) and for 1% AEP;
- (b) **Flood levels**: 1% AEP maximum water level at buildings (at the lowest opening) and on roads (at the crown and at the deepest point);
- (c) **Velocities**: peak velocity for 50%, 10% and 1% AEP;
- (d) **Timing of combined peaks**: the hydrograph at each confluence, showing the time to peak of the project outflow and of the receiving drain; and
- (e) **Duration of inundation**: on roads and at buildings, the time above the Chapter 6 depth limits.

5.4.3 **Storms.** The analysis shall use:

- 50%, 10% and 1% AEP;
- the duration set of Clause 2.5.2, at least the durations that give the highest level at each analysis point (these will usually be longer than at the site); and
- the 24-, 48- and 72-hour storms in every case.

The AMC rule of Clause 2.11.4 applies. Areal reduction follows Clause 2.7, applied to the contributing catchment at each analysis point and never to the site storage.

5.4.4 **Method.** The analysis shall:

- use a hydrograph method that combines hydrographs at confluences (SWMM, HEC-HMS, or an equivalent);
- include a hydraulic model with backwater (SWMM dynamic wave, HEC-RAS, or equivalent) wherever tailwater or backwater affects any analysis point; and
- not use the Rational Method at any analysis point, because it cannot represent timing.

Off-site areas shall be modelled at their present land use. Upstream detention shall be included only where it is built, maintained and documented.

5.4.5 **Tailwater.** The downstream end of the model shall use the tailwater of Clauses 5.6 to 5.9 and the sand-bar condition of Clause 5.13 where applicable.

> **Commentary.** Clause 5.4.2(d) exists because detention changes when the site's water arrives, not only how much arrives (Clause 4.16). A Colorado State University thesis and a *Water* (2016) optimisation study both found that delayed site releases can coincide with the main-stem peak and raise it. Georgia's manual states the result

directly: some structural practices "fail to reduce discharge peaks to pre-development levels downstream" because of "peak flow timing and runoff volume effects" (GSMM 2016). The duration-of-inundation check (5.4.2(e)) matters in the Kashmir valley, whose towns drain to a Jhelum held above them by its embankments: in September 2014 water stood up to 16 ft deep in parts of Srinagar, and for up to 25 days in places (Alam et al., 2018, as cited by Malik, 2021), and 34% of the Srinagar planning area, 262 km², was under water (Srinagar Master Plan 2035, §4.2); once the river shuts the gravity outfalls, the city's dewatering stations, reported at about 2,300 cusecs in 2026, can lift only about 0.3 mm of rain an hour from the 767 km² of its drainage master plan (a NEER reading of figures as reported). Detention that prolongs releases can lengthen that time even when it lowers the peak.

5.5 Acceptance criteria

5.5.1 The project is acceptable if, at every analysis point and for every AEP and duration of Clause 5.4.3, comparing "with project" to "existing":

- (a) the 1% AEP maximum water level does not rise by more than **10 mm** at any habitable building, at any building's lowest opening, or on any road carriageway;
- (b) no building that is not flooded in the existing case is flooded with the project, and no building or road that meets the Chapter 6 freeboard or depth limits in the existing case fails them;
- (c) peak flow does not exceed the existing peak at the minor-system AEP of each element, or at 1% AEP;
- (d) peak velocity in lined channels stays within the permissible velocity for the lining (Chapter 6: 3.0 m/s maximum); and
- (e) in unlined or natural channels, peak velocity for 50% and 10% AEP does not increase by more than **10%**, unless protection is provided under Chapter 9.

5.5.2 The duration of inundation under 5.4.2(e) shall be reported. The Authority may refuse a project that increases the duration of road closure on an arterial or emergency route.

5.5.3 **Where the criteria are not met**, the project shall do one or more of the following:

- (a) reduce release rates or increase storage (Chapter 4);
- (b) build downstream improvements, with the consent of the owner of the downstream system. These shall not transfer the problem further downstream, and shall be re-analysed under this chapter;
- (c) contribute to a regional facility under Clause 4.13; or
- (d) under Clause 5.5.4, change the release strategy.

5.5.4 **Timing exception.** Where the analysis shows that detention raises downstream levels because of timing, the Authority may vary the site release-rate criteria of Clause 4.5. This applies only where the site discharges within the lower tenth of the contributing catchment, directly to a major drain, tidal creek or the sea, and only on the following conditions:

- (a) the varied strategy meets 5.5.1;
- (b) the retention requirement (Clause 4.4) and WQv treatment (Chapter 8) are met in full; and
- (c) the outfall-closed check (Clause 5.10) is met.

Commentary. The 10 mm tolerance (5.5.1(a)) has no direct precedent. It is meant to be at or below the numerical precision of a typical one-dimensional model, so that "no increase" can be tested without arguing over rounding. The 10% velocity tolerance is likewise set by this Manual. The timing exception in 5.5.4 follows the Georgia manual, where the downstream analysis can show "that peak controls are not needed" and allow them to be

waived (GSMM 2016, Standard #8). It is limited here to sites low in the catchment, which is where synchronisation with the main-stem peak is most likely (*Water* 2016, 8(7):290). It is not available above that, because the evidence on scale (Clause 4.16) shows that early release from many upstream sites raises peaks.

5.6 Tailwater: general and non-tidal outfalls

5.6.1 Every drain, outlet and storage shall be designed against a stated tailwater. A free outfall shall be assumed only where the outlet invert is above the maximum receiving water level for the case being checked.

5.6.2 **Minor-system tailwater, non-tidal.** The tailwater is the receiving system's water level at the time of the minor-system peak, from the downstream model. Where no model exists, use:

- for a receiving pipe, its obvert; or
- for a receiving open drain, its full-bank level less freeboard (Chapter 6).

5.6.3 **Major-system tailwater, non-tidal.** The tailwater is the receiving system's 1% AEP water level, unless Clause 5.8 allows a coincident lower level.

5.6.4 **Tidal and backwater outfalls.** Clauses 5.7 to 5.13 apply in addition.

5.6.5 **Storage elements.** Detention, tanks and pumped sumps shall be routed with a time-varying tailwater (Clause 4.6.6), not a constant level, wherever the tailwater varies with tide or with the receiving system's hydrograph.

5.7 Tidal tailwater: datums, surge and sea-level allowance

5.7.1 **Design tailwater levels.** For outfalls to the sea, tidal creeks, estuaries, backwaters and tidal reaches of rivers and canals:

Table 5.1 — Design tailwater levels for tidal outfalls

Design case	Tailwater
Minor-system design (Chapter 6)	**MHWS + SLA**
Major-system design and storage design	**HAT + surge + SLA**, with the surge term defined in Clause 5.7.3
Joint case (Clause 2.12(b))	1% AEP still-water level + SLA

The SLA is **+0.3 m minimum** (Clause 5.7.4). The cases to be run are listed in Clause 5.9.

5.7.2 **Sources and datums.**

- (a) **Tidal levels.** MHWS, HAT and MSL shall be taken from the current edition of the Indian tide tables published by the National Hydrographic Office (NHO) or by the Survey of India, for the nearest standard or secondary port, or from the port authority's published tidal levels. The edition and port shall be stated.
- (b) **Datum conversion.** Tide-table heights are referred to chart datum. They shall be converted to the project datum through a documented connection between chart datum, the tide gauge zero and a Survey of India benchmark. The offset and its source shall be stated on Form 5-1.
- (c) **Estuaries, creeks and canals.** For outfalls inside estuaries, creeks, backwaters or tidal canals (for example the estuaries of the coastal States; there is none in Jammu and Kashmir, Clause 5.1.4), tidal levels may differ from the open coast. Open-coast levels shall be used unless measured levels over at least one spring–neap cycle, or a

calibrated hydrodynamic model, justify a different value. No reduction below open-coast levels shall be taken without such evidence.

- (d) **Interim.** Until Annex 5A is published, the designer shall obtain the values directly from the sources in (a) and record them.

5.7.3 **Storm surge.**

- (a) **Major-system and storage design.** The surge term in "HAT + surge" is the **10% AEP (10-yr) storm surge** for the coastal segment, given in Annex 5A. The 1% AEP surge is used only in the joint case of Clause 2.12(b), with the 10-yr 48-hour storm. That keeps the two cases symmetric, so that a rare rainfall is never paired with a rare surge.
- (b) **Joint case.** The 1% AEP still-water level for Clause 2.12(b) is taken from Annex 5A.
- (c) Until Annex 5A is published, both values shall be taken from a site-specific study using INCOIS, IMD or NCCR surge hindcasts or return-level analyses. The study shall state its source, method and record length.
- (d) Wave set-up shall be added where the outfall faces the open sea without a protected entrance.

5.7.4 **Sea-level allowance.** The SLA shall be:

- (a) **+0.3 m** minimum for every element;
- (b) greater than 0.3 m where the State, a Development Authority or the Authority adopts a higher projection for the planning area; and
- (c) assessed for the design life of the element. For elements with a design life of more than 50 years, the designer shall report the effect of a sea-level rise of twice the SLA as a sensitivity run.

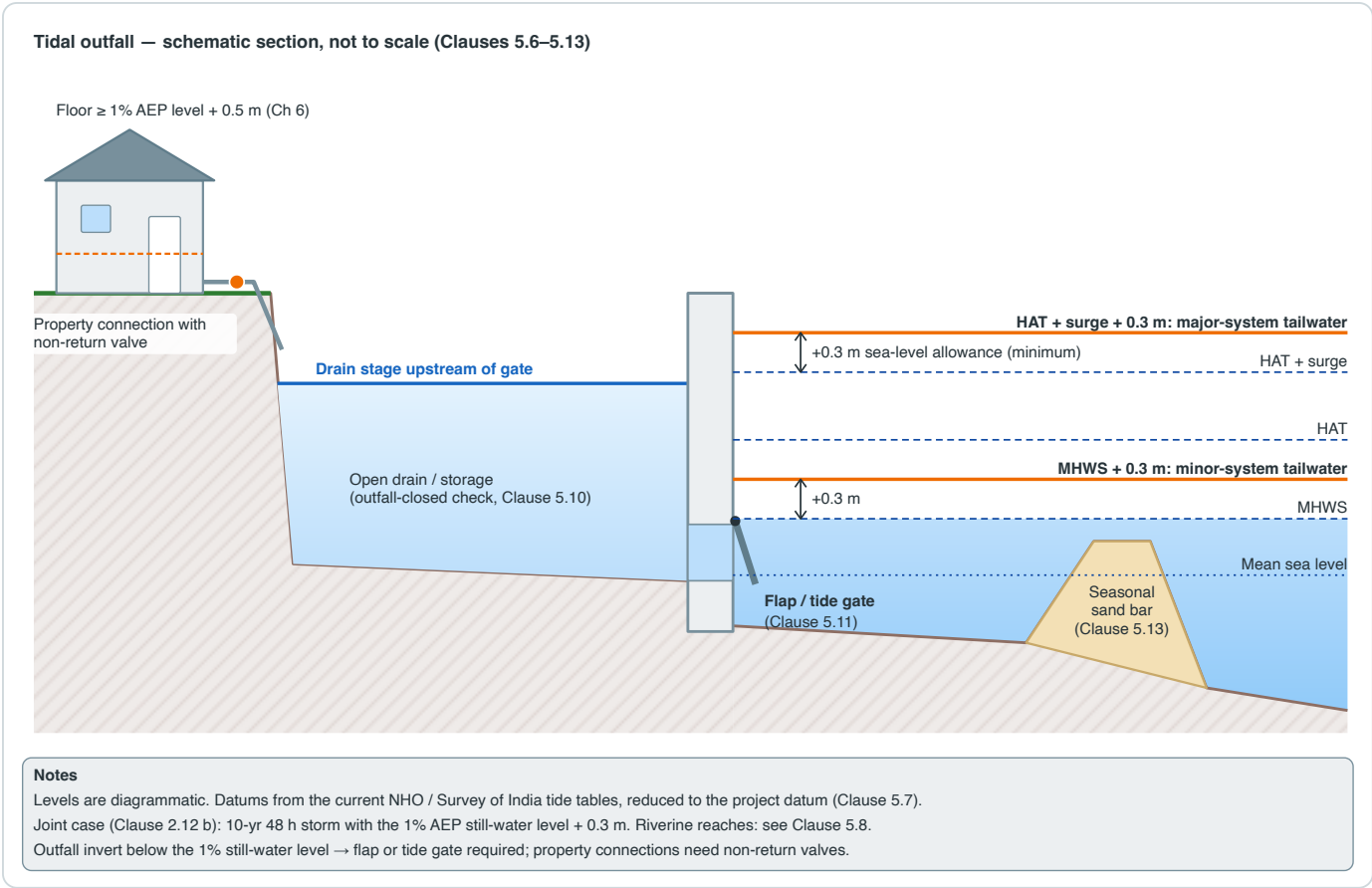

Figure 5.2 — Tidal outfall: flap gate, property non-return valve, and the design tailwater levels (MHWS + 0.3 m for the minor system; HAT + surge + 0.3 m for the major system), with a seasonal sand bar at the mouth. Schematic, not to scale. Original drawing for this Manual, adapted from the tidal tailwater table in MoHUA/CPHEEO Manual on Storm Water Drainage Systems (2019), Part A, Table 6.2.

Commentary. CPHEEO (2019) Table 6.2 sets the design tailwater for coastal outfalls as:

- MHWN to MHWS for a minor storm (more frequent than 1 in 5 years);
- MHWS to HAT for a major storm; and
- "Effect of climate change: additional 0.3 m".

CPHEEO also says the joint probability of storm, tide and surge "should" be considered, with the state maritime board consulted. This Manual takes the upper end of each CPHEEO range, adds surge for the major system, and makes the joint case explicit (Clause 2.12). CPHEEO does not require surge to be added; this Manual adds it because the surge records of the coastal States showed why it is needed there; Jammu and Kashmir has no coast, and the surge term does not arise in the Union Territory, whose largest floods come from long storms over the hills, as in September 2014, when monsoon moisture met a western trough (Chapter 2).

Indian tide tables have been published by the Survey of India since the nineteenth century (Survey of India, Tidal Predictions). Current Indian tidal predictions also appear in the NHO's tide tables. One port document describes the current edition as covering 95 Indian ports, based on NHO observations and on data from civil ports, NIO and INCOIS (Adani Ports, Dahej tide table 2025, citing NHO INP-12). INCOIS runs coastal tide gauges and issues storm-surge and swell-surge warnings. None of these is used for design in Jammu and Kashmir, which has no coast, and Annex 5A is not prepared for the Union Territory (Clause 5.1.4).

5.8 Riverine backwater

5.8.1 **Where it applies.** Outfalls to rivers and canals whose water level in a storm can exceed the outfall invert shall be designed with riverine backwater. This includes:

- the **Jhelum** through **Srinagar**, past the **Ram Munshi Bagh** gauge, with the **flood spill channel** from Padshahi Bagh to the Wular and every drain, nallah, lake and nambal behind the embankments that drains to them by gate or by pumping (Clause 5.8.5(a), (e) and (f));
- the **Jhelum** above Srinagar, past **Khanabal** and **Sangam**, at **Anantnag**, **Bijbehara** and **Pampore** (Clause 5.8.5(a));
- the **Jhelum** below Srinagar, past **Safapora**, at **Sumbal** and **Bandipora**, the **Wular**, and the outlet reach at **Ningli**, **Sopore** and **Baramulla** (Clause 5.8.5(a) and (e));
- the **Tawi** at **Jammu**, past the **Jammu Tawi (Sidhra)** gauge, with the **Tawi barrage**, and at **Udhampur**, past **Kishanpur Manwal** (Clause 5.8.5(b) and (d));
- the **Chenab** at **Akhnoor**, below the **Salal** dam, and at **Doda** (Prem Nagar), **Ramban**, **Reasi** and **Kishtwar**, with the **Dul Hasti**, **Baglihar** and **Salal** reservoirs (Clause 5.8.5(b) and (d));
- the **Ujh** at **Kathua**, the **Basantar** at **Samba**, the **Devak** at **Udhampur**, and the **Ravi** at **Basantpur** and along the **Ranjit Sagar** reservoir (Clause 5.8.5(b) and (d));
- the tributaries of the Jhelum above the valley floor, among them the **Lidder**, the **Rambiara**, the **Romushi**, the **Doodhganga**, the **Vishow** and the **Sind** (Clause 5.8.5(b));
- the khads and nallahs of the towns, among them the **Balol**, **Thather** and **Bhalwal** khads and the other khads of the Kandi belt at Jammu, Samba, Kathua and Hiranagar, the nallahs and khads of the hill towns of the Pir Panjal and the Chenab valley, and the **Telbal**, **Sukhnag** and other nallahs that feed the lakes and marshes of the Kashmir valley (Clause 5.8.5(c));
- the **Dal**, **Nigeen**, **Brari Nambal**, **Khushalsar**, **Gilsar**, **Anchar**, **Hokersar**, **Nambal Narkur**, **Shallabugh**, **Hygam**, **Manasbal** and **Mansar–Surinsar**, and the other lakes, nambals and talabs (Clause 5.8.5(e));
- the **Ranbir** and **Sindh** canals, the **Tsunth Kol**, the **Padshahi Canal** and the other city channels, the zamindari khuls, and any drain or channel of another body that receives storm water (Clause 5.8.5(f)); and
- elsewhere: any river or I&FC channel listed in Annex 5B.

5.8.2 **River levels.** River water levels shall be taken from:

- (a) I&FC design flood levels or recorded highest flood levels for the reach, where published; or
- (b) a hydraulic model (HEC-RAS or equivalent) of the river reach. The model shall use:
  - the river design flood from a hydrograph method (Chapter 3), with continuous simulation where Chapter 3 requires it;
  - the tidal boundary of Clause 5.7 at the mouth; and
  - the sand-bar condition of Clause 5.13.

5.8.3 **Reservoir and tank releases.** Where a reservoir or tank upstream can release to the river (for example on the Chenab, the Dul Hasti and Baglihar dams in Kishtwar and Ramban districts and the Salal dam in Reasi district above Akhnoor; the Ranjit Sagar dam on the Ravi, on the Punjab border of Kathua district; and the Tawi barrage at Jammu), the river level shall include the release given by the reservoir's operating rule for the storm being checked. Where there is no published rule, it shall include the largest recorded release.

5.8.4 **Coincidence of site storm and river flood.** Unless a joint-probability study is accepted by the Authority, the more severe of the following governs:

- (a) the site design storm (AEP as required), with the river at its **10% AEP (10-yr)** level; and
- (b) the site **10% AEP** storm, with the river at its design-AEP level (1% AEP for the major system).

The two storms in each pair shall have the same duration and timing where they are generated by the same rainfall event.

5.8.5 **The Jhelum and its embankments, other rivers, khads and nallahs, reservoirs and barrages, lakes and wetlands, canals, city channels and khuls, and I&FC consent.**

- (a) **The Jhelum in the Kashmir valley: embanked, gated and pumped.** For an outfall in Srinagar or another town of the Kashmir valley floor, among them Anantnag, Bijbehara, Pampore, Sopore, Baramulla, Sumbal and Bandipora, to the Jhelum directly, through a gate in its embankments or in a bund, through a dewatering or drainage pumping station, or to the flood spill channel, or into a drain, nallah, lake or nambal that itself discharges in one of those ways, the designer shall identify the body that operates each gate and pumping station, and obtain from its written records the sill of each gate, the crest of the embankment or bund, the installed permanent pumping capacity of each station and its duty point, its sump levels, and the river stage at which its gravity gate is shut. No list of Srinagar's stations with these values was found during research [TBC]. Every level shall state its datum and its connection to a Survey of India benchmark, and shall name the gauge with which it is compared.
  - **Two gauge systems.** The Jhelum is gauged by CWC in metres, with no datum stated in the lists found (taken as metres above mean sea level [TBC]), and by I&FC on staff gauges read in feet from a gauge zero that is not published, so that a reading can be negative. No I&FC reading in feet shall be converted to metres, or compared with a CWC level, until I&FC gives the reduced level of that gauge's zero tied to a Survey of India benchmark (set by this Manual). The two systems do not describe the same levels: at Ram Munshi Bagh the CWC highest flood level stands 3.20 m (10.5 ft) above the CWC danger level of the list of 2018, while the I&FC peak of September 2014 is reported as about 29.5 ft against a danger stage of 21 ft, 8.5 ft above it (a NEER reading of figures as reported).
  - **Design river level.** The river level of Clause 5.8.2 at the outfall shall be, for the major-system and storage cases (Clause 5.8.4(b)), the **1% AEP river level at the outfall**, from a hydraulic model under Clause 5.8.2(b) of the Jhelum, the flood spill channel and the Wular together. Neither the Flood Plain Zones Act 2005 nor Part VI of the Water Resources Act 2010 has been used to fix a flood level for any reach (Chapter 7), so no level is available from a floodplain study. The level shall in no case be less than the **highest recorded level** at the nearest CWC gauge on the river, transferred to the outfall. The levels found during research (Table 5B.1), all from SANDRP's copies of the CWC lists, with no datum stated and none read in a CWC site sheet [TBC], are: at **Ram Munshi Bagh** in Srinagar, a warning level of 1,584.87 m, a danger level of **1,585.48 m** and a highest flood level of **1,588.99 m** (8 September 2014) in the list of 2022, against 1,585.53 m, 1,586.45 m and **1,589.65 m** for the same gauge and the same flood in the list of 2018; at **Sangam** near Anantnag, a

warning level of 1,589.96 m, a danger level of **1,590.88 m** and a highest level of **1,595 m** (4 September 2014) in 2022, against **1,595.7 m** in 2018; at **Khanabal** near Anantnag, a danger level of 1,592.5 m and a highest level of **1,595.43 m**, set on 3 September 2025; and at **Safapora**, above the Wular, a warning level of 1,579.36 m, a danger level of **1,579.66 m** and a highest level of **1,582.1 m** (9 September 2014). Where two highest levels are given for the same gauge and flood, the higher applies until CWC confirms the level in its site sheet: **1,589.65 m** at Ram Munshi Bagh and **1,595.7 m** at Sangam [TBC]. The danger levels are thresholds that CWC lowered by 0.3 to 0.7 m between the two lists, and the values of 2022 apply. For an outfall on the shore of the Wular, or to a drain or channel that ends in it, the tailwater shall not be less than the Wular's danger level of **1,578 m** given by I&FC (as reported; datum taken as metres above mean sea level [TBC]) nor than the level at Safapora transferred; for Sopore and Baramulla, below the Wular's outlet at Ningli, the level shall be taken from a model of the outlet reach or from flood marks of September 2014 surveyed at the outfall, and not less than the Wular's danger level, until CWC publishes a level for a gauge on that reach [TBC]. Where a later flood has exceeded a listed level, the later level governs. The recorded level shall be transferred along the river with the water-surface slope of the flood that set it, from the CWC gauge records or from the model; until either is available, the recorded level of the nearest gauge upstream applies unchanged at the outfall, except that between two gauges on the same river with no tributary joining between them, as at Pampore between Sangam and Ram Munshi Bagh, the level may be interpolated linearly by river distance between their highest recorded levels (set by this Manual).

- **10% AEP level.** For the cases with the river at its 10% AEP level (Clause 5.8.4(a)), and for the minor-system tailwater of Clause 5.1.4(b), the level shall be taken from the same model or a frequency analysis of the gauge record, and not less than the CWC **danger level** at the nearest gauge, transferred in the same way: **1,585.48 m** at Ram Munshi Bagh, **1,590.88 m** at Sangam, **1,592.5 m** at Khanabal and **1,579.66 m** at Safapora (SANDRP's copy of the CWC list of 2022) (set by this Manual). I&FC gives its own stages: at Ram Munshi Bagh, **flood declaration at 18 ft** and **danger at 21 ft**; at Sangam, flood declaration at 21 ft and danger at 25 ft; and at Asham, 14 ft and 16.5 ft; at Sangam and Asham the two labels are reported the other way round in some accounts, and a danger stage of 23 ft is also reported at Sangam (as reported) [TBC]. They are used for the closure of the next item, and where I&FC gives the reduced level of a gauge's zero, the 10% AEP level at that gauge shall also be not less than its danger stage converted with it.
- **Gravity outfalls closed.** Every gravity outfall to the Jhelum, to the flood spill channel or to a lake, nambal or channel that the Jhelum backs up shall be taken as **closed from the time the river reaches the I&FC flood-declaration stage** at the governing gauge, 18 ft at Ram Munshi Bagh for Srinagar and 21 ft at Sangam for Anantnag, Bijbehara and Pampore until I&FC confirms its labels [TBC], or from the time the river level beyond the gate reaches the outfall invert or the level at which its gate is shut, if that is earlier, and shall stay closed for the whole of the river lock of this item. While the gates are shut, the town drains only by storage and pumping (set by this Manual).
- **Tailwater.** The tailwater at the outfall shall be the higher of the river level beyond the gate, embankment or bund and the maximum level in the drain behind it, computed by routing the drain, with every lake, nambal and low ground that it fills, as a closed storage for as long as the gates are shut, with the inflow of the whole catchment that drains to it, its storage as surveyed in its present condition, net of silt, solid waste, weed and encroachment, and an outflow of no more than the pumping capacity that the operator confirms in writing is available in a storm, and in no case more than the installed capacity of the permanent pumps less the largest pump (set by this Manual). Pumps shall deliver against the design river level of this item, and every pump, panel, generator and control shall remain operable with the river at that level beyond the bund (Clause 5.12.5).
- **River lock.** Mobile and portable dewatering pumps, among them the mobile units that Srinagar keeps for events (281 in 2026, as reported), and capacity that has been sanctioned or proposed but not commissioned, shall not be counted; they are a reserve for the failure of a station and for a breach. The outfall-closed check of Clause 5.10 applies with a single lock that lasts for as long as the river stays above the closing stage of the item before last, taken from the river model or from the stage record of the nearest CWC gauge in the flood that set the highest recorded level (September 2014 at Ram Munshi Bagh, Sangam and Safapora; September 2025 at Khanabal) or in a comparable flood, and **not less than 7 days (168 hours)** (set by this Manual). The lock starts no later than the start of the storm and covers the whole of the

48- and 72-hour storms of Clause 5.10.2, so that storage and pumping handle the full storm volume (Clause 5.9.4), and the drawdown of Clause 5.10.5 is met by pumping until the lock ends. The check shall be run for both design cases of the valley floor in Clause 2.3.6(g)(ii), the summer convective storm and the long western-disturbance or snowmelt event of March and April, at AMC III (Clause 2.11.4), because the river can stand above flood-declaration stage in either season. A shorter lock may be used only where the outfall invert is above the 1% AEP river level of this item, or where an analysis of the stage record of a CWC gauge under Clause 5.10.6 shows it and the Authority approves it.

    - **Pumped capacity and the joint analysis.** Every pumping station credited shall be stated by name, with its installed permanent capacity in cusecs and in m³/s, its largest pump, its duty point at the design river level, its sump levels, the river stage at which its gravity gate is shut, its standby power and its operator, on Form 5-1 and on the GIS drainage asset register (Clause 10.14.3). Station counts shall be cited with their dates and sources and never added together: about 56 storm-water pumping stations in Srinagar in 2015 (JTFRP environmental and social management framework); 89 drainage pumping stations, 38 lift, 21 gravity and 30 lift-cum-gravity, in February 2019 (Srinagar Master Plan 2035, Table 12-5); and 104 permanent dewatering stations of about 2,300 cusecs with 281 mobile units in February 2026 (H&UDD in the Legislative Assembly, as reported). Every DPR for drainage in Srinagar, or in another embanked town of the valley floor, shall include a joint drain–pump–river analysis: the drains and storages of the whole drainage zone, every pumping station with its pump curves and its sump and gate levels, and the Jhelum and the flood spill channel as a time-varying stage boundary, run for the lock of this item with the coincident cases of Clause 5.8.4; a project inside a zone may take its tailwater from that analysis once the Authority has accepted it (set by this Manual).
    - **Breach and gate failure.** A breach of the Jhelum's embankments, as in September 2014, when water stood up to 16 ft deep in parts of Srinagar and for up to 25 days in places (Alam et al., 2018, as cited by Malik, 2021), is a residual risk and not a design case for drains, storage or pumps, which cannot be sized for it. The designer shall report on Form 5-1, for every pumping station and for the buildings of every flood-sensitive catchment behind the embankment (Clause 4.5.3.2(a) to (c)), the depth with the land behind it filled to the highest recorded river level beyond it, and the means of evacuation and of restarting the station (set by this Manual). Floor levels and pumped outfalls behind a gate shall also be checked for the failure of the gate open, with the drain behind it filled to the river level beyond it.
- (b) **Other rivers.** For an outfall to the Tawi, the Chenab, the Ujh, the Basantar, the Devak, the Ravi or another river, or to a tributary of the Jhelum above the valley floor, such as the Lidder, the Rambiara, the Romushi, the Doodhganga, the Vishow or the Sind, directly, through a gate or a pumping station, or into a drain that ends in one, the operator's data, tailwater routing, pump credit and gate-failure check of item (a) apply, with these levels:
    - **Design river level.** For the major-system cases, the 1% AEP river level at the outfall from a hydraulic model under Clause 5.8.2(b), with the releases of item (d), and not less than the highest recorded level at the nearest CWC gauge on the same river, transferred to the outfall. The levels found, all from SANDRP's copies of CWC data, with no datum stated [TBC], are: the Tawi at **Jammu Tawi (Sidhra)**, a level-monitoring site, **321.1 m** at 17:00 on 26 August 2025, above the 318.85 m of 6 September 2014; the Tawi at **Kishanpur Manwal** in Udhampur district, **442.65 m** on 26 August 2025, above an undated 436.75 m; the Chenab at **Akhnoor**, a level-monitoring site, **324.29 m** (10 September 1992); the Chenab at **Prem Nagar** in Doda district, **902.56 m** (2025); the Neeru Nallah, **1,075.33 m**, and the Kalnai, **932.7 m** (2025); the Ravi at **Basantpur**, **318.35 m** on 26 August 2025; the Lidder at **Ganeshpura**, **1,871.78 m** (28 August 2016); and, in the Kashmir valley, **Rumshi** on the Romushi, **1,589.91 m** (27 August 2025), the Rambiara at **Watchi**, **1,595.29 m** (3 September 2025), and the Doodhganga at **Kralpora**, **1,594.3 m** (2025). SANDRP counted fifteen breaches of a highest flood level in the Union Territory in the monsoon of 2025 and could not obtain the data of six sites (as reported), so a later level shall be sought from CWC for every gauge before design [TBC]. The level shall be transferred as item (a) provides, and on a mountain river, whose bed falls several metres in a kilometre, a profile of the flood marks of the same flood, surveyed between the gauge and the outfall and tied to a Survey of India benchmark, may be used in place of the unchanged level (set by this Manual).

    - **Rivers and reaches with no gauge level.** No CWC level was found for the Ujh at Kathua, the Basantar at Samba, the Devak at Udhampur, the Tawi in Udhampur town, or the Chenab at Kishtwar, Ramban or Reasi [TBC]. I&FC reports the Ujh at Panjtirthi in Kathua district by flow, with an alert at 48,000 cusecs and a danger mark at 88,000 cusecs against 59,750 cusecs in late August 2025, and the Tawi at Udhampur with an alert at 15 ft and a danger mark at 20 ft (also reported as 17 ft) against 24.975 ft on 26 August 2025 (as reported); no threshold was found for the Basantar. On such a reach, and for an outfall upstream of every gauge on its reach, the river level shall be the higher of the level from a model under Clause 5.8.2(b) and the highest flood level surveyed at the outfall from flood marks, including those of September 2014 and of August and September 2025, and from the records of I&FC, the local body or the Deputy Commissioner, with its source stated. Where a level is known only as a gauge reading, the designer shall tie the gauge zero to the project datum and a Survey of India benchmark by levelling. No outfall shall be designed on such a reach without one of these levels (set by this Manual).
    - **10% AEP level.** For the cases with the river at its 10% AEP level (Clause 5.8.4(a)), the level shall be taken from the same model or a frequency analysis of the gauge record. The CWC sites in the Jammu division are level-monitoring sites with no danger level; there, the 10% AEP case shall use the design river level of this item until a frequency analysis is accepted (set by this Manual). The I&FC stages at Akhnoor, an alert at 32 ft and a danger mark at 35 ft, against 43 ft at 19:00 on 3 September 2025 and 61 ft in September 1992 (as reported), are named for the record and not converted to metres (item (a)).
    - **The Tawi barrage.** The pond level, the gates, the design flood and the operator of the Tawi barrage at Jammu, whose first phase was dedicated on 14 April 2026, were not found (as reported) [TBC]. An outfall to its pond is an outfall to a barrage pond under item (d); an outfall to the Tawi below it takes the releases of item (d).
    - **Rivers that cross the border.** The Tawi, the Basantar, the Ujh and the Chenab cross into Pakistan within about 10 to 30 km of Jammu, R.S. Pura, Samba and Akhnoor. No lowering of the river at an outfall shall be assumed on the ground of the channel below the border, whose levels are not available to the designer, and the downstream boundary of a model shall be set far enough below the outfall that it does not control the level there (set by this Manual).
    - **No reduction.** The river level shall not be reduced on the ground that the flood comes from rain that falls outside the town, from snow or glacier melt, or from the burst of a glacial or landslide lake, or that the site storm is small.
- (c) **Khads and nallahs.** For an outfall to a khad or a nallah, such as the Balol, Thather and Bhalwal khads and the more than a hundred dry khads of the Kandi belt around Jammu, the khads of Samba, Kathua and Hiranagar, the nallahs and khads of Udhampur, Katra, Reasi, Ramban, Doda, Kishtwar, Rajouri and Poonch, the Telbal Nallah above the Dal, and the Doodhganga, Sukhnag, Rambiara, Vishow and Romushi nallahs above the valley towns, or into a drain that ends in one:
    - **No gauge.** None of these streams has a published flood level at a town, except the Neeru and the Kalnai nallahs of item (b), and the I&FC gauges on the Vishow at Khudwani (danger 7.75 m) and the Rambiara at Wachi (warning 5.4 m) read from local zeros (as reported) [TBC]. They are seasonal, steep and boulder-laden: the Kandi's ravines are "transformed into gushing torrents" (Jammu Master Plan 2032, §2.4); they rise within an hour of a burst of rain, lose part of their flow into the gravels of the Kandi fans, carry gravel, boulders, timber and debris, and raise or scour their beds in a single flood.
    - **Design level.** The tailwater for the major-system and storage cases shall be the highest of: (i) the 1% AEP level at the outfall from a study of the stream, made with a hydrograph method of Chapter 3 for the whole catchment above the outfall, with the rainfall of its sub-area in Annex 2A, the AMC of Clause 3.8.4 and the bulking factor of Clause 6.3.6(b) on the peak flow, and routed through a hydraulic model (Clause 5.8.2(b)) of the channel as surveyed, with the crossings downstream blocked as Clause 6.3.6(c) requires, and with no credit for flow lost into the gravels; (ii) the level at the outfall of any flood study of the stream made by or for I&FC, where it gives one [TBC]; and (iii) the highest flood level surveyed at the outfall from flood marks, such as debris lines, silt and scour marks and the accounts of residents, of the floods of September 2014 and of August and September 2025 or a later flood, and from the records of I&FC, the local body or the Deputy Commissioner, with its source stated. No outfall to such a stream shall be designed without items (i) and (iii) (set by this Manual).

- **Bed level, scour and aggradation.** The designer shall survey the bed of the stream at the outfall and for at least 100 m upstream and downstream, and state the range within which the bed has moved, from past surveys, cross-sections, exposed foundations and pipes, and the records of I&FC and the local body. The outfall invert, and the seat of any flap gate on it, shall stand at least **0.5 m above the highest bed level** found in that range within 50 m downstream of the outfall, and the foundation of the outfall structure and its apron shall be taken below the scour depth computed under Chapter 9 (Clause 9.6) for the 1% AEP flow with the bulking factor (set by this Manual).
- **Siting.** An outfall shall be built into the bank and shall not project into the bed or the active channel, taken for this Manual as the land flooded once in 5 years (set by this Manual). It shall discharge in the direction of the stream's flow, with the bank protection that Chapter 9 requires, and no pipe, interceptor or chamber of the drainage system shall be laid along the bed of the stream. No outfall structure, pumping station or storage shall be built on land recorded as Gair Mumkin Khad, or released from that class, within the functional khad and corridor of Clause 6.9 (Chapter 6). No muck, spoil or excavated material from the works shall be placed in the stream or where a storm can carry it into one (Clause 6.3.6(g)).
- **Closed outfall.** Where the outfall invert is below the design level of this item, the outfall-closed check of Clause 5.10 applies with a single lock that lasts for as long as the level of the stream, computed under item (i) for the coincident cases of Clause 5.8.4, stays above the invert, and, where no hydrograph of the stream has been computed, for the whole storm (Clause 5.9.4) (set by this Manual). Where the khad or nallah itself ends at a gated or pumped outfall to the Jhelum, the lock of item (a) applies to it.
- **Interceptors.** An interception and diversion structure on a khad or nallah or its drains (Clause 8.9) shall not raise the design level of this item or reduce the capacity of the drain; it shall stand above that level or be designed to be overtopped without damage.

- (d) **Reservoirs and barrages.** For an outfall to a reservoir or barrage pond, directly or through a drain, khad or nallah that ends in it, such as the reservoirs of the Salal dam in Reasi district, the Baglihar dam in Ramban district and the Dul Hasti dam in Kishtwar district on the Chenab, the reservoir of the Ranjit Sagar dam on the Ravi along the Kathua border, and the pond of the Tawi barrage at Jammu:
  - **Consent.** Storm water shall not be discharged to a reservoir or barrage pond without the written consent of its custodian: NHPC for Salal and Dul Hasti, JKSPDC for Baglihar, the operator of the Ranjit Sagar dam in Punjab, and, for the Tawi barrage, the body that operates it, which was not confirmed during research [TBC]. The Ratle project on the Chenab and the Pakal Dul project on the Marusudar are under construction; when they are filled, this item applies to them. An outfall that carries dry-weather flow is dealt with under Clause 8.9.
  - **Design level.** The tailwater for the major-system and storage cases shall be the waterbody's **maximum water level (MWL)** as its custodian publishes it, or, where only the full reservoir level (FRL) or maximum pond level is published, **FRL plus the surcharge in its design flood**, computed from the rating of its spillway and gates with the gates operated only as the custodian's written rule provides. Where neither the MWL nor the surcharge has been published, or where the published MWL is not above the FRL, the tailwater is **FRL + 0.5 m** (set by this Manual) [TBC]. For a barrage pond, the tailwater is the higher of that level and the river level of item (b) at the barrage with its gates as operated. In every case it shall be not less than the highest level recorded at the waterbody. The minor-system tailwater is the FRL or maximum pond level, or the level at which the custodian's rule opens the gates if that is higher. The project's discharge shall be included in the level (Clauses 5.3.2 and 5.12.3).
  - **The named reservoirs.** Until the custodian confirms the MWL or the design-flood level and its datum, the tailwaters are (set by this Manual) [TBC]: **Salal**, FRL 487.68 m (as reported), with no MWL found: **488.18 m**; **Baglihar**, FRL 840 m (as reported), whose maximum design flood level is quoted as "lowered from EL 841.5 m to EL 840.0 m" in a letter of 13 July 2002 reproduced in a party's submission to an international arbitration (as quoted), so that the published MWL is not above the FRL: **840.5 m**; and **Ranjit Sagar**, whose FRL is given as 527.91 m ("1,731.5 feet", which is 527.76 m) and elsewhere as 527.13 m (as reported), a conflict that only its operator can resolve: **528.41 m**, from the highest. No level on a stated datum was found for **Dul Hasti** or the **Tawi barrage** [TBC]; no outfall to either shall be designed without the custodian's

FRL or pond level and spillway rating in writing, or, until the custodian gives them, the higher of a survey of the spillway or gate crest tied to a Survey of India benchmark and the river level of item (b) (set by this Manual).

- **Closed outfall.** Where the outfall invert is below the design level of this item, the outfall shall be treated as closed for the whole storm (Clause 5.9.4), with storage and pumping handling the full storm volume, unless the custodian's stage record shows the waterbody below the invert at the start of comparable storms and the Authority accepts it. Every reservoir and barrage pond starts every design storm at its FRL or maximum pond level (Clause 7.7.3), and no lowering of a reservoir or pond before a storm and no early or additional gate opening shall be assumed unless the custodian's written operating rule and records show it. The drawdown zone of a reservoir, such as the pondage band of 836 m to 840 m at Baglihar (as reported), is part of the reservoir: no outfall structure, pumping station or storage shall be built in it without the custodian's consent.
- **Rivers below dams and barrages.** For an outfall to a river below a dam or barrage, such as the Chenab below Salal at Akhnoor, the Chenab below Dul Hasti and Baglihar, and the Tawi below the Tawi barrage, in addition to the cases of Clause 5.8.4, the site design storm (each AEP required) shall be run with the river at the level that results from the largest recorded release of the dams and barrages above, routed to the outfall, with the flow of the catchment below them as it occurred in the same event, and with the release placed before, during and after the site storm (set by this Manual), until the operator publishes an operating rule that bounds the release [TBC]. The releases found are reported only: the gates of Salal are opened at least once a month in the monsoon to flush its silt, passing about 4,250 m³/s (an NHPC tender, as reported), and were all opened on 12 August 2025; all the spillways of Baglihar were opened on 1 August 2025; and the outflow from Ranjit Sagar rose from 9,000 to 173,000 cusecs (about 255 to 4,900 m³/s) between 24 and 27 August 2025 (all as reported). The largest recorded release of each dam and barrage and its duration shall be obtained from its operator and stated [TBC]. A release, or a release rule, alone shall not be taken to bound the river level: the level shall also be checked for the largest recorded event at the nearest gauge, with the local inflows as they occurred. No attenuation by the storage of any reservoir shall be credited to the river below unless the operator's written rule commits that storage to flood control for the event, and no dam or barrage gate shall be assumed to open earlier or wider than the operator's records show.
- **Releases without notice.** Since April 2025 the Indus Waters Treaty has been held in abeyance, and the releases and flushing of the dams in the Union Territory are reported to be no longer notified downstream (as reported). The Treaty bears on drainage design only through this: no outfall design shall depend on notice of a release or of a flushing, a flushing of Baglihar or Salal shall be assumed possible at any time in the monsoon, with the sediment it carries to outfalls below (Clause 5.11.3(b)), and the release cases of the previous item apply whether or not a release is announced (set by this Manual).

- (e) **Lakes and wetlands.** For an outfall to the Dal, Nigeen, Brari Nambal, Khushalsar, Gilsar, Anchar, Hokersar, Nambal Narkur (Narkara), Shallabugh, Hygam, the Wular, Manasbal or Mansar–Surinsar, or another sar (lake), nambal (marsh) or talab, directly or through a drain or stream that ends in it:
  - **Consent.** Storm water shall not be discharged to a lake or wetland without the written consent of its custodian: LCMA for the Dal and Nigeen, WUCMA for the Wular and its feeder channels, the Wildlife Department for a wetland conservation reserve, among them Hokersar, Shallabugh, Hygam, Freshkoori, Kranchoo, Chatlam and Manibugh, and, for a Ramsar site (the Wular, Hokersar, Hygam, Shallabugh and Surinsar–Mansar), also the J&K Wetland Authority. No wetland was found notified under rule 4 of the Wetlands (Conservation and Management) Rules 2017 [TBC]. The custodian of the other lakes and nambals was not confirmed during research [TBC]; until the Union Territory names one, the consent of I&FC and of the local body is required (Chapter 7). LCMA's NOC is already part of building permission (S.O. 304 of 1 December 2025).
  - **Outlets shut by the river.** The Dal drains through two regulated outlets: the **Dal Gate**, a lock and weir to the Tsunth Kol and so to the Jhelum, and **Nallah Amir Khan**, to Nigeen and on through Gilsar and Khushalsar to Anchar (JKPCC, NGT O.A. 504/2024). A lake or nambal whose outlet the Jhelum backs up or shuts, as it

shuts the Dal Gate, shall be routed as a closed storage for the whole river lock of item (a), with the inflow of its whole catchment (about 314 km² for the Dal) and with its outlet open only while the operator's written rule and the river level allow (set by this Manual).
    - **Design level.** No outlet, spill or gate level on a stated datum was found for any lake or nambal [TBC]; the Dal's reported level of "10.5 feet" (September 2025) is a gauge reading with an unknown zero and shall not be used as a level. Until the custodian gives one, the tailwater is the level at which the waterbody spills, from its outlet or spill crest surveyed and tied to a Survey of India benchmark, plus the head over that crest needed to pass the 1% AEP inflow, and not less than the highest level recorded at it; for the Wular it shall be not less than 1,578 m (item (a)). The waterbody starts every design storm at its spill level, and an outfall below the tailwater is closed for the whole storm (Clause 5.9.4) (set by this Manual).
    - **Flood-absorption marshes.** Hokersar, Nambal Narkur, Shallabugh, Anchar and the Rakh-e-Arth basin store the Jhelum's floods. No flood-storage volume has been published for any of them [TBC], and no storage in a marsh or low ground shall be credited to a drain unless its custodian's records show the storage free at the start of a storm. No drain shall be diverted so that it bypasses a flood-absorption marsh, no outfall structure, fill or embankment shall be built in one without its custodian's consent, and the regulatory gates proposed at Hokersar (as reported) shall be taken as closed in a storm unless a written operating rule says otherwise (set by this Manual).
    - **Sediment and sewage.** Every drain that discharges to a lake or wetland shall pass a sediment trap and a gross-pollutant screen (Chapter 8), and its dry-weather flow shall be intercepted (Clause 8.9) before it reaches the waterbody (set by this Manual): JKPCC has reported that "Untreated sewage gets entry into the Dal Lake from areas like Telbal, Lalbazar" (NGT O.A. 504/2024). No runoff shall be infiltrated on the valley floor around a lake (Clause 4.11), and no drain shall discharge into a spring (nāg) or its pool.
- (f) **Canals, city channels and khuls.** Storm water shall not be discharged to a canal of I&FC, among them the Ranbir and Sindh canals; to a city channel, among them the Tsunth Kol and the Padshahi Canal; to the flood spill channel; or to a zamindari khul (a village irrigation channel, counted among hydraulic works by the Water Resources Act 2010) without the written consent of I&FC, which controls the bed and banks of all water sources, "city channels and flood spill channels" (s.81 of the Act [TBC on the section number]); nor to a drain of another body, such as a drain of SMC, JMC, a Municipal Council or Municipal Committee, UEED, SDA, JDA, LCMA, a Smart City company, the Public Works (R&B) Department or NHAI, without the written consent of that body. The Act forbids the deposit of "any material or waste in or near any channel" (s.73 [TBC]). A drain that crosses a canal or khul shall cross by a cross-drainage work built with the consent of its manager, and not discharge into it. The flood spill channel takes its water from the Jhelum at Padshahi Bagh and stands high when the Jhelum does, so an outfall to it is a Jhelum outfall under item (a); its carrying capacity shall be taken as the 4,000 cusecs to which, by the audit of 2016, sediment had reduced a design capacity of 17,000 cusecs (CAG, Report No. 4 of 2016, §2.1.4), until I&FC confirms a later capacity in writing, because the later figures reported (8,000, 8,700 and 27,000 cusecs) conflict (as reported) [TBC]. Where consent is given:
    - the discharge shall not exceed the rate the consent allows;
    - the tailwater is the higher of the channel's design water level as its owner states it in writing and its level in the coincident case of Clause 5.8.4, computed from all the storm water it receives, including the drains of other bodies and the runoff that a khul intercepts from the slope above it, and with its downstream boundary at the river, khad, reservoir or lake level of items (a) to (e); until a design water level is published for a channel, the computed level governs [TBC];
    - the channel shall be taken in its present condition, net of silt, boulders, solid waste, weed, encroachment and obstruction by crossing services and culverts, with its narrowest section as surveyed; a widening, dredging or new channel that has been proposed but not completed, such as the supplementary flood spill channel from Dogripora to the Wular "designed for 55,000 Cusecs" that I&FC has "conceived" (Srinagar Master Plan 2035, §14.4.4.2) or the works of the second phase of the flood management plan for the Jhelum, shall not be counted; and
    - the outfall shall have a flap gate (Clause 5.11) where the design water level or the computed level is above the outfall invert.

- (g) **I&FC consent; plan, wetland and court lines.** No outfall structure, gate, pumping station or drain shall be built in the bed, bank or floodplain of a river, khad or nallah, in or on an embankment, or in the flood spill channel, a city channel, a canal or a khul, without the consent of I&FC, or of the operator of a dam, reservoir or barrage for its structures. The Water Resources Act 2010 requires permission to build "in the vicinity of any irrigation or hydraulic work" (s.66) and forbids any building, railing or platform on the slopes of an embankment without it (s.81(4)) [TBC on the section numbers]; S.O. 304 of 1 December 2025 brings the NOCs of I&FC and of Sewerage & Drainage into online building permission; the procedure for an outfall consent was not found during research [TBC]. Neither the Flood Plain Zones Act 2005 nor Part VI of the Water Resources Act 2010 has been used, and no flood zone or flood basin is notified (Chapter 7). The designer shall also check the outfall against the lines that the building rules, the master plans, the wetland rules and the courts have set, as they stand at the time of design (Chapter 7): the 50 m, 30 m and 20 m from the edge of the bank of UBBL-2021, cl. 7.12(b), and the 30 m green buffer from the highest water level of cl. 5.2.5; the buffers of the Srinagar Master Plan 2035 (Tables 8-2 and 8-3, §8.2.3) and of the Jammu Master Plan 2032 (§7.3.3); the 200 m around the Dal held by the High Court (PIL 159/2002) and around the Wular (November 2020, as reported), and the 200 m that LCMA applies at Nigeen; the Ramsar sites and the wetland conservation reserves; and the orders of the High Court in PIL 8/2017, that the original width of the Jhelum be restored and that no construction be raised near the water bodies (as quoted in its order of 29 May 2024). Whether a drain outfall is permitted within each line is to be confirmed with the authority concerned before design [TBC].

No pump, gate, lock or dam operation that helps drainage, such as pumping a drain or the Dal down before a storm, lowering a reservoir or barrage pond before a storm, closing a gate late or opening dam or barrage gates early, shall be assumed unless the operator's written records show it. Where the outfall invert is below the tailwater of this clause, the outfall shall have its own flap gate (Clause 5.11) and, where the outfall-closed check requires it, pumping (Clause 5.12), with the pumped volume included in the routing of the drain, the waterbody or the river (Clause 5.12.3). Pumping shall not be used to move water into a lake, a nambal, a reservoir, a khul or another catchment without the consent of its custodian, or onto a slope.

> **Commentary.** In large continental river basins, a site storm and a river flood are usually treated as roughly independent. That is the basis of tables of coincident frequencies such as FHWA HEC-22 Table 7.3. Jammu and Kashmir's rivers break that assumption, because the storms that fill them fall on the towns in the same spell. On 3–6 September 2014, when monsoon moisture met a western trough, Qazigund recorded 599.8 mm and Kokernag 415.2 mm in four days, Katra 698.6 mm in 72 hours and Jammu 218.3 mm on the last day (Ray et al., 2015); the Jhelum set its highest levels at Sangam on 4 September and at Ram Munshi Bagh on 8 September, and the Tawi at Sidhra on 6 September, while the towns' own drains were still full (CWC data, as copied by SANDRP). In the 24 hours to 08:30 on 27 August 2025 Jammu recorded 380 mm and Udhampur 630 mm (IMD), and the Tawi at Sidhra reached its highest recorded level, 321.1 m, at 17:00 on 26 August (CWC data, as copied by SANDRP). The two cannot be treated as independent, and a local storm can fall before, during or after the river peak. Clause 5.8.4 therefore pairs a design event on one side with a 10-yr event on the other, in the same way as Clause 2.12(b). This pairing has no direct precedent. It is more severe than an independence assumption would give.
>
> Clause 5.8.3 reflects the dams above and beside the Union Territory's towns. On the Chenab, Salal in Reasi district (NHPC) has a full reservoir level of 487.68 m and a spillway of twelve bays rated at 22,427 m³/s, and its gates are opened at least once a month in the monsoon to flush its silt, passing about 4,250 m³/s (an NHPC tender, as reported); it was flushed in May 2025 and all its gates were opened on 12 August 2025 (as reported). Baglihar in Ramban district (JKSPDC) has a full reservoir level of 840 m and a pondage band of 836 m to 840 m (as reported); its maximum design flood level is quoted as "lowered from EL 841.5 m to EL 840.0 m" in a letter of 13 July 2002 reproduced in a party's submission to an international arbitration (as quoted), and all its spillways were opened on 1 August 2025 (as reported). A press account of Baglihar's gates opening at a reservoir level of 893 m is inconsistent with that full level and is not used. No full or maximum level was found for Dul Hasti in Kishtwar district (NHPC), whose spillway is reported at 8,000 m³/s (as reported) [TBC]; Ratle, whose pondage is given as 1,015.86 m to 1,029.0 m (as quoted), and Pakal Dul on the Marusudar are under construction. On the Ravi, the

Ranjit Sagar dam on the Punjab border of Kathua district has a full level given as 527.91 m and elsewhere as 527.13 m (as reported), a conflict that only its operator can resolve [TBC]; it reached its full level on 27 August 2025, when its outflow rose from 9,000 to 173,000 cusecs over 24–27 August (as reported). No level, gate or operating rule was found for the Tawi barrage at Jammu [TBC]. Since April 2025 the Indus Waters Treaty has been held in abeyance and the releases of the dams are reported to be no longer notified downstream; in August 2025 a warning of a high flood in the Tawi was passed to Pakistan through the High Commission rather than through the Indus Commission (as reported). That changes nothing in the design of a town drain except that no outfall below a dam can rely on notice of a release or a flushing (Clause 5.8.5(d)). No operating rule or release record for any of these dams, and no hourly stage record for any gauge in the Union Territory, was obtained during research [TBC]. Until they are available, the largest recorded release applies, with the flow of the catchment below the dam as it occurred in the same event (Clause 5.8.5(d)). The river levels used in this Manual come from SANDRP's copies of CWC data, because the CWC flood-forecasting portal could not be reached during research; their datum and gauge zero are to be confirmed with CWC [TBC].

Clause 5.8.5 is set by this Manual. In Jammu and Kashmir the tailwater at a town outfall is set not by the tide but by the Jhelum held above the valley floor by its embankments, by another river held high by a storm or by the releases of a dam, by a khad or nallah whose level no one has recorded and whose bed moves, by a reservoir at its full level, by a lake or nambal whose outlet the river shuts, or by a canal or city channel, and no document found during research gives a design level for any of them. No design standard for any town drain was found: the Drainage Master Plan and DPR for Srinagar publishes no return period (as reported), the Srinagar Master Plan 2035 sets "stormwater performance standards" of 100% coverage and zero waterlogging without a design storm (§13.3), and the Jammu Master Plan 2032 leaves the storm-water DPR to be prepared after its approval (§11.1.3). The drainage sections of the Jammu and Kashmir Municipal Corporation Act 2000 and Municipal Act 2000 were not read [TBC]. The Union Territory has two statutes for flood zoning, the Flood Plain Zones Act 2005 and Part VI of the Water Resources Act 2010, and neither has been used: the first is not shown to be in force, and no flood basin has been notified under the second (Chapter 7).

The first is the Jhelum, and item (a) is the governing case for every drain on the valley floor whose outfall the river can close. Srinagar's own rain in September 2014, about 140 to 152 mm in four days, would not have flooded the city; the river did (Ray et al., 2015). Item (a) therefore takes the outfall as shut from the river stage, not from the storm. It uses the I&FC flood-declaration stage, 18 ft at Ram Munshi Bagh, the stage at which I&FC declares a flood, as the stage from which the gravity outfalls are shut and the city depends on its pumps (a NEER reading; the stage at which each gate is actually shut is to be obtained from its operator [TBC]); the river passes that stage often: it stood at 21.10 ft at Ram Munshi Bagh in August 2025 and at 19.07 ft in July 2026 (as reported). The CWC danger level is the floor of the minor-system and 10% AEP cases for the same reason, and the highest recorded level is the floor of the 1% AEP case, as in the other mountain editions. Where the lists of 2018 and 2022 give different highest levels for the same flood at the same gauge, item (a) takes the higher until CWC confirms the level, because a tailwater set too low floods the town while one set too high only costs storage; the danger levels are thresholds that CWC itself revised, so the later list applies to them. Item (a) never converts an I&FC reading in feet to metres, because the gauge zeros are not published and the two systems do not agree: the CWC highest level at Ram Munshi Bagh stands 10.5 ft above its danger level, and the I&FC peak of 2014 is reported 8.5 ft above its own.

The lock of at least 7 days is set from the way the Jhelum floods. In September 2014 the rain fell from 3 to 6 September, and the river set its highest levels at Sangam on 4 September, at Ram Munshi Bagh on 8 September and at Safapora on 9 September (CWC data, as copied by SANDRP): the crest took about five days to pass down the valley, and Srinagar's outfalls stayed shut after the rain had stopped. In 2025 the river rose twice at Khanabal, to a new highest level on 27 August and to a higher one on 3 September (as reported), so a second storm can arrive before the first has drained. The valley drains slowly: its outlet through the Wular at Ningli is reported to carry about 22,700 cusecs, and Sopore about 35,000, against a peak at Sangam in 2014 reported to have exceeded 115,000 cusecs (as reported). Seven days covers the 72-hour storm of Clause 5.10.2 with four days of drawdown, and a designer with the stage record of a CWC gauge can justify a longer or shorter lock under Clause 5.10.6. The inundation of up to 25 days in parts of Srinagar in 2014 (Alam et al., 2018, as cited by Malik, 2021)

came from the breach of the embankments, not from the closure of the outfalls; a lock of 25 days would size every drain and pump for the breach, which no drain can be sized for. Item (a) therefore treats the breach as a residual risk to be reported and planned for, not as the design case.

Item (a) counts only the permanent pumps less the largest one, for the same reason that Clause 5.12.2(b) requires a standby pump, and does not count the mobile units, which are needed where a station fails or a breach floods the land. The whole city's pumped capacity is small against its area: about 2,300 cusecs (65 m³/s) for 767 km² is about 0.085 m³/s per km², or about 0.3 mm of rain an hour (a NEER reading of figures as reported), so a Srinagar drain is limited by storage and pumping, not by its pipe size, whenever the river is up, and its design cannot be checked one site at a time. That is why item (a) asks for a joint drain–pump–river analysis for every drainage DPR on the valley floor. The station counts are kept apart because they count different things on different dates: about 56 storm-water pumping stations in 2015, 89 drainage pumping stations of three kinds in 2019 (of which the Srinagar Master Plan 2035 calls 69 "permanent/temporary dewatering stations", a figure that is not the total), and 104 permanent dewatering stations with 281 mobile units in 2026 (as reported). The city centre is also flooded by its own rain: Lal Chowk, Budshah Chowk, Residence Road and M A Road were under water after 26.4 mm on 1 August 2019 (as reported), with the river low, which is a failure of the drains themselves (Chapter 6).

The second is the other rivers. Item (b) follows the interim river rule of the series' first mountain editions, Uttarakhand and Himachal Pradesh: the design level is the 1% AEP level, and never below the highest level recorded at the nearest CWC gauge. In the Jammu division every CWC site is a level-monitoring site with no danger level, and the Tawi at Sidhra rose 2.25 m above its level of 2014 on 26 August 2025 (CWC data, as copied by SANDRP), so a level taken from before 2025 is too low. The rivers of the Jammu division cross into Pakistan a short distance below Jammu, R.S. Pura, Samba and Akhnoor, and their levels there are not available to a designer; item (b) therefore asks for a model boundary far enough downstream not to control the level at the outfall, and assumes no lowering from the reach beyond the border.

The third is the khad and the nallah. Jammu's khads, the nallahs of the hill towns and the streams that come down to the valley floor are ungauged, and no flood study of any of them was found. Item (c) therefore requires the designer to make the study, with the bulking factor of Clause 6.3.6(b), and to survey the flood marks, and takes the higher. A khad's bed is not fixed: it rises with the boulders of one flood and is scoured by the next, so item (c) sets the invert at least 0.5 m above the highest bed level surveyed downstream, a margin set by this Manual for the aggradation that a boulder bed can show in a single flood, and takes the foundation below the computed scour. It keeps outfalls off land recorded as Gair Mumkin Khad within the functional khad, because the Jammu Master Plan 2032 proposes to release much of that land (§12.2.3), and a drain outfall built on it would fix the khad's edge where the plan has not yet surveyed it.

The fourth is the reservoir. A reservoir at its full level does not fall for the rest of the season but passes its inflow over its spillway, and its level rises above FRL by whatever head the flood needs. Item (d) therefore takes the MWL, or FRL plus the design-flood surcharge, and treats an outfall below it as closed for the whole storm, which is what Clause 5.9.4 already requires when the tailwater stays above the outfall. Where only a reservoir level is published, FRL + 0.5 m is set as the interim value: it is the freeboard that this Manual uses for floor levels (Clause 6.11.1), and it is a floor, not an estimate of the surcharge, which depends on the spillway and the flood [TBC]. At Baglihar the quoted maximum design flood level is the full level itself, so FRL + 0.5 m applies there too; at Ranjit Sagar item (d) takes the higher of the two full levels reported. Item (d) also runs the town storm with the river at the largest recorded release, because the rain that fills a reservoir and the rain on the town below come from the same spell (see the Commentary to Clause 5.8.4), and because since April 2025 the releases are reported to go unannounced: the Indus Waters Treaty matters to drainage design only in that a designer can no longer assume a warning (Clause 5.8.5(d)).

The fifth is the lake and the nambal. The Dal's outlets are regulated, and the Dal Gate shuts against the river, so item (e) routes a lake whose outlet the river shuts as a closed storage for the whole river lock. The marshes of the valley were the Jhelum's flood storage, and they have shrunk: the Wular from 157.74 km² to 86.71 km² between 1911 and 2007, by one account, and Hokersar from 18.75 km² to about 13 km² (as reported). No flood-storage

volume was found for any of them, so item (e) gives no storage credit in a marsh unless its custodian's records show the storage free, and forbids drains that bypass a marsh, because a drain that bypasses one moves the marsh's storage onto the river. The sediment traps and the interception of dry-weather flow before every outfall to a lake reflect what JKPCC has reported: that only 62.01 of Srinagar's 193.34 MLD of sewage is treated (32.07%), and that untreated sewage enters the Dal from Telbal and Lal Bazar (NGT O.A. 504/2024).

The sixth is the canal, the city channel and the khul, and the seventh is the line within which an outfall may be built. The Water Resources Act 2010 puts the bed and banks of every water source, the city channels and the flood spill channels under I&FC [TBC on the section number], so item (f) asks for I&FC's consent for every outfall to them. The flood spill channel fills from the Jhelum, so item (f) treats an outfall to it as a Jhelum outfall, and takes its capacity at the 4,000 cusecs that the audit found, because the later figures conflict. Items (d) to (f) ask for the owner's consent and design level because a design that discharges to a channel, a reservoir or a lake cannot be checked without them. The lines of item (g) decide where an outfall can be built, not its level. The bye-laws measure from the edge of the bank and from the highest water level, the Srinagar plan from the edge of the water and the Jammu plan from the full tank level, and the courts add 200 m around the Dal and the Wular (Chapter 7); item (g) asks the designer to check each one as it stands.

5.9 Joint-probability cases

5.9.1 Every element draining to a tidal or backwater-affected outfall shall be checked for the cases below. The most severe governs each design quantity: storage, water level, pipe size and pump capacity.

Table 5.2 — Joint-probability cases for tidal and riverine outfalls

Case	Rainfall	Tailwater	Applies to	Basis
J1	Minor-system design AEP, Tc to 24 h	MHWS + SLA (tidal curve)	Minor system	Clause 2.12(a); Clause 5.7.1
J2	1% AEP, all durations of Clause 2.5.2	HAT + surge + SLA	Major system, detention, tanks, pumped systems	Clause 5.7.1
J3	10% AEP, **48 h**	1% AEP still-water level + SLA	Major system, detention, tanks, pumped systems	Clause 2.12(b)
J4	Design AEP, **48 h** (72 h reported)	Tidal curve per J1 with two **6 h lock windows** (Clause 5.10)	All storage and every gated or tide-affected outfall	Clause 5.10
R1	Site design AEP	River at 10% AEP level	Riverine outfalls	Clause 5.8.4(a)
R2	Site 10% AEP	River at design-AEP level	Riverine outfalls	Clause 5.8.4(b)

5.9.2 For storage elements, the 48- and 72-hour storms shall be run with the J2 and J3 tailwaters (Clause 2.5.3).

5.9.3 For tidally influenced riverine outfalls, R1 and R2 shall be run with the river model's downstream boundary at the J1 tidal curve. The Authority may also require them at J2.

5.9.4 Where tailwater is constant at a level above the outfall invert for the whole storm, the case is treated as a fully closed outfall. Storage and pumps shall then handle the full storm volume.

Commentary. Clause 2.12 sets two joint cases. Case (a) is design rainfall with MHWS plus the sea-level allowance. Case (b) is the 10-yr, 48-hour storm with the 1% still-water level. This Manual adds HAT plus surge for major-system design (Clause 5.7.1). Case J2 combines these. J4 is the outfall-closed check, which tests the

> timing of tide against the storm rather than a single level. Rainfall and surge share a cyclone cause, so they cannot be treated as independent (Clause 2.12 commentary). These cases are simple surrogates, to be replaced when a statistical joint analysis of IMD rainfall and tide-gauge records is adopted.

5.10 Outfall-closed (tide-locked) storage check

5.10.1 **Where it applies.** The check applies to:

- every storage facility;
- every minor- and major-system element; and
- every pumped system

whose outfall invert is below HAT + surge + SLA, or which drains to a reach subject to tide-lock or sand-bar closure (Clause 5.13).

5.10.2 **Storm.** Use the 48-hour design storm built per Clause 2.9.2 (peak day last), at:

- the AEP of the element: 1% AEP for detention, tanks and the major system; the minor-system AEP for minor drains; and
- AMC III.

The 72-hour storm shall also be run and reported.

5.10.3 **Lock windows.** Unless a site study under 5.10.6 gives otherwise:

- (a) the outfall is closed for **two consecutive lock windows of 6 hours each**, centred on two consecutive high tides of the local tidal curve. For a semi-diurnal tide, the window starts are therefore about 12.4 hours apart.
- (b) During each lock window, gravity discharge is **zero**.
- (c) Between lock windows, gravity discharge is computed against the J1 tidal curve, including the head loss of the flap gate and any non-return valve.
- (d) The first lock window shall be placed so that it is centred on the peak 1-hour block of the final 24 hours of the storm. A second run with the first window **starting** at that peak block shall also be made. The more severe governs.

5.10.4 **Requirement.** Storage plus pumping (where provided) shall hold the inflow so that, throughout the check:

- (a) the maximum stage in any detention facility stays below its emergency spillway crest, so the spillway does not operate. Where the outfall-closed stage is higher than the 1% AEP maximum water level of the free-outfall design, it becomes the facility's 1% AEP maximum water level for Clause 4.9.3, and the spillway crest, freeboard and wall height are set from it;
- (b) the maximum stage in the minor and major systems meets the Chapter 6 limits: building floor levels, and street depths of no more than 150 mm at the crown and no more than 350 mm at the deepest point; and
- (c) no property connection surcharges above the lowest opening it serves, or a non-return valve is fitted under Clause 5.11.

In volume terms, over each lock window and the full storm:

> $V_{inflow} \le V_{storage\ available} + V_{pumped} + V_{gravity\ (between\ locks)}$

This shall be demonstrated by routing, not by a single volume balance. The release from each facility after a lock window ends may exceed the release caps of Chapter 4, because the facility is emptying into a drain that has just reopened. That release shall be included in the downstream analysis (Clauses 5.4 and 5.9).

5.10.5 **Drawdown after the storm.** After the second lock window, the storage shall drain under the J1 tidal curve. The drawdown requirement of Clause 4.7 shall be met, with pumping where gravity cannot meet it (Clause 5.12).

5.10.6 **Site study.** A longer or shorter lock may be used where a site study gives a time series of still-water level for the design case. The study may use a calibrated hydrodynamic model, gauge records of past events, or a surge hindcast. Locks shorter than the default require the Authority's approval. A longer lock shall be used where:

- sand-bar closure (Clause 5.13) or river backwater (Clause 5.8) keeps the outfall closed for longer; or
- the gauge record shows tailwater above the outfall invert for more than 6 hours per tide in comparable past events.

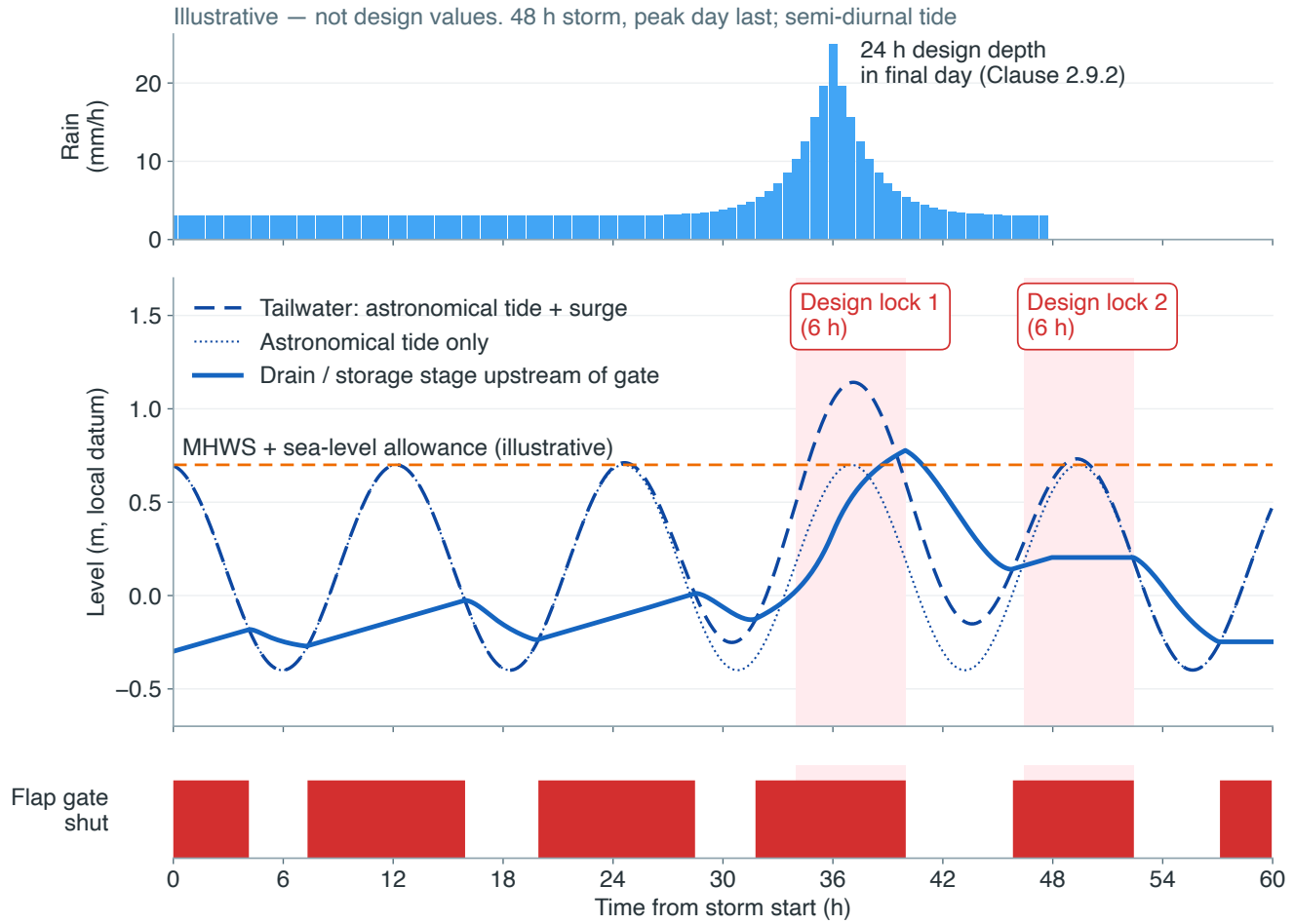

Figure 5.3 — Outfall-closed check: 48-hour storm with the peak day last (Clause 2.9.2), tailwater of astronomical tide plus surge, two 6-hour design lock windows, and the resulting stage upstream of the flap gate. Illustrative — not design values. Original drawing for this Manual, adapted from the tidal tailwater and joint-probability concepts of MoHUA/CPHEEO Manual on Storm Water Drainage Systems (2019), Part A, §6.3.6.

Commentary. The outfall-closed check is the distinctive Jammu and Kashmir requirement in this Manual. In Jammu and Kashmir it applies where an outfall is shut not by the tide but by the Jhelum, held above the floor of the Kashmir valley by its embankments, by another river in flood or below a dam, by a khad or nallah that has risen over the outlet or buried it in boulders, by a reservoir at its full level, or by a lake or nambal whose own outlet the river has shut. Once the Jhelum reaches its flood-declaration stage, the gravity outfalls of Srinagar are taken as

shut and the city drains only by storage and pumping; its dewatering stations, 104 permanent stations of about 2,300 cusecs in 2026 (as reported), can lift only about 0.3 mm of rain an hour from the 767 km² of its drainage master plan (a NEER reading of figures as reported). In September 2014 the Jhelum crested at Sangam on 4 September, at Ram Munshi Bagh on 8 September and at Safapora on 9 September (CWC data, as copied by SANDRP), and in 2025 Khanabal set a highest level on 27 August and a higher one on 3 September (as reported). A river on the valley floor stays high for days after the rain ends, a reservoir or lake at its full level stays there for the rest of the season, and a khad in flood can block an outlet with boulders, which is why Clause 5.8.5 replaces the two 6-hour windows described below with a single river lock of at least 7 days on the Jhelum and closures for the whole storm at a reservoir, lake or khad outfall below its design level. A rate rule cannot help when there is no outlet: an orificed basin behind a closed gate simply fills.

The default of two consecutive 6-hour locks has no direct precedent. It represents gravity outfalls failing to discharge for about half of each tidal cycle around the two high tides nearest the storm peak. Figure 5.3 shows why both windows matter. The first lock catches the storm peak. The second arrives before the storage has drained, so the stage rises again.

Placing the first window on the rainfall peak is deliberately unfavourable. Cyclone rainfall and surge share a cause, and Clause 2.12 already treats them as dependent. The check replaces neither the J2 and J3 level checks nor the downstream analysis; it adds a test of timing and volume.

5.11 Flap gates, tide gates and non-return valves

5.11.1 **Where required.** A flap gate, tide gate or equivalent non-return device is required on every outfall whose invert is below the **1% AEP still-water level** (Clause 5.7.3). It is also required on outfalls into irrigation channels under Clause 5.8.5.

5.11.2 **Hydraulics.** The design shall include:

- the gate's head loss and opening head, from the manufacturer's certified head–discharge curve; and
- the reduction in effective outfall capacity when the gate is partly open.

Gates shall not be assumed to seal perfectly in the outfall-closed check unless they are tested.

5.11.3 **Construction.**

- (a) Gates, hinges and seats shall be of corrosion-resistant materials suitable for seawater (Clause 4.12.5).
- (b) The gate shall be set so that sand, silt or debris on the downstream side cannot hold it shut or open. Where the bed is mobile, the gate invert shall be raised above the bed, or the approach shall be protected.
- (c) A trash screen shall be provided upstream where the gate could be jammed by debris.
- (d) A stop-log slot or penstock shall be provided upstream for maintenance isolation on outfalls larger than 600 mm.
- (e) The gate chamber shall be accessible at all tides, with its access above HAT + surge + SLA.

5.11.4 **Non-return valves on property connections.** A non-return valve, or a backwater valve with an accessible cleaning eye, is required on every property drainage connection where the lowest opening served is below:

- the major-system tailwater (J2) at the point of connection; or
- the maximum stage in the outfall-closed check (Clause 5.10).

Basement drainage shall in addition be pumped to a level above both, with its own non-return valve.

5.11.5 **Inspection.** Gates and valves shall be inspected and operated:

- before **15 June** each year;
- after every event in which they closed against a storm flow; and
- as set in the maintenance plan (Chapter 10).

> **Commentary.** The requirement for gates below the 1% still-water level is set by this Manual. The construction details follow common coastal-drainage practice. A gate that is jammed open by debris lets the tide into the drain. A gate held shut by a sand bank turns a gravity outfall into a dead end. In Jammu and Kashmir the outfalls do not cross a beach, but many of them pass through a gate in the Jhelum's embankments or end in a river whose level is set by a dam upstream. The Srinagar Master Plan 2035 counts the city's 89 drainage pumping stations as 38 lift, 21 gravity and 30 lift-cum-gravity stations (February 2019), and a gravity station drains only while its gate is open; the Dal drains to the river through the Dal Gate, a lock and weir whose flood-gates, Grierson's dictionary records, close by themselves when the Jhelum rises (Grierson, *A Dictionary of the Kashmiri Language*, p. 210); regulatory gates at Hokersar are part of the second phase of the flood management plan for the Jhelum (as reported); and no pond level or gate rule of the Tawi barrage at Jammu, dedicated in April 2026, was found (as reported) [TBC]. On the Chenab all the spillways of Baglihar were opened on 1 August 2025 and all the gates of Salal on 12 August 2025, and since April 2025, with the Indus Waters Treaty held in abeyance, releases from the dams are reported to go unannounced downstream (as reported). In September 2014 the Jhelum's embankments were breached in Srinagar; the locations and dates of the breaches were not found during research [TBC]. A gate jammed open lets the river into the drains; a gate held shut by silt turns a gravity outfall into a dead end; a dam gate opened in a hurry raises the river below. The embankments and the gates in them, the pumping stations and the drains behind them belong to different bodies: I&FC holds the river and its embankments, UEED and the Town Drainage wings of SMC and DULBK the drainage schemes and stations, LCMA the Dal, and NHPC and JKSPDC the dams; no rule linking the operation of any of these gates to the levels of the drains was found during research [TBC]. The 15 June inspection date is set ahead of the SW monsoon.

5.12 Pumped outfalls

5.12.1 **When required.** Pumping shall be provided where gravity discharge cannot meet:

- the outfall-closed check of Clause 5.10;
- the drawdown requirement of Clause 4.7; or
- the J2 and J3 cases.

Pumping shall not be used where a gravity solution meets these requirements.

5.12.2 **Capacity.**

- (a) The duty pumps together, with the storage provided, shall pass every case of Clause 5.9 (including J4), demonstrated by routing.
- (b) **Standby** capacity at least equal to the largest duty pump shall be installed (duty + 1 standby as a minimum).
- (c) Pump capacity shall be stated at the static head for the **J2** tailwater, not at mean tide.

5.12.3 **Effect on the receiving water.** Pumped discharge to a river, canal or creek shall be included in the river or creek level analysis of Clause 5.8. Pumping that raises the receiving water level above the acceptance criteria of Clause 5.5 elsewhere is not permitted.

5.12.4 **Power supply.** Pumping stations shall have either:

- two independent power supplies; or
- standby generation for 100% of the duty capacity, with on-site fuel for at least **72 hours** of duty operation.

Changeover shall be automatic.

5.12.5 **Flood immunity.** Electrical panels, control equipment, generators and fuel storage shall be set above the higher of:

- the 1% AEP flood level + 0.5 m; and
- HAT + surge + SLA + 0.5 m.

Access to the station shall remain usable in the 1% AEP event.

5.12.6 **Discharge arrangement.** Rising mains shall discharge:

- over a level above the J2 tailwater; or
- through a non-return valve and a flap gate.

The arrangement shall prevent back-siphoning.

5.12.7 **Controls and monitoring.** Each station shall have:

- automatic level control;
- remote alarms for high level, pump failure and power failure, sent to the operator; and
- a level and run-time log kept for at least 5 years.

Wet wells shall be sized to keep pump starts within the manufacturer's limits.

5.12.8 **Screens.** Inlet screens shall be provided with a cleaning method that works during a storm (a mechanical rake, or duplicate screens).

5.12.9 **Testing.** Every pumped outfall shall be test-run at full duty, including on standby power, before **15 June** each year. Private pumped systems shall be covered by a registered maintenance declaration (Chapter 10).

> Commentary. Duty + standby, 72 hours of fuel and flood-immune electrics have no single direct precedent and are set by this Manual. The 72-hour fuel figure matches the longest mandatory design storm (Clause 2.5.2). A pump station that depends only on grid power can stop exactly when it is needed, because supply to flooded areas is often switched off for safety. Singapore's April 2025 amendments added annual maintenance declarations for pumped detention tanks (PUB Addendum No. 3). Clause 5.12.9 and Chapter 10 adopt the same approach. Clause 5.12.3 prevents pumping that simply moves water from one tide-locked drain into a tide-locked river.

5.13 Sand-bar closure of river mouths

5.13.1 **Where it applies.** This clause applies to outfalls into any river or creek whose mouth is subject to seasonal sand-bar closure. That includes the mouths of the coastal States (there is none in Jammu and Kashmir: Clause 5.1.4), and any other mouth listed in Annex 5B.

5.13.2 **Assumption at the start of the SW monsoon.** The mouth shall be assumed **closed** by a bar at the start of the June–September season, at the crest level of the most recent pre-monsoon survey. This applies unless I&FC certifies that:

- a mouth-maintenance programme (dredging, bar cutting or training walls) has kept the mouth open at the start of each of the previous three SW monsoon seasons; and
- the programme is funded for the current season.

5.13.3 **Tailwater with a closed mouth.** With the mouth closed, the tailwater at the outfall shall be the higher of:

- (a) the tidal tailwater of Clause 5.7; and
- (b) the level in the river reach behind the bar, computed with the bar as a weir at its surveyed crest level. That level shall include the river flow of Clause 5.8 and the head needed to pass the flow over or through the bar.

5.13.4 **No credit for emergency cutting.** Bar cutting or breaching during the storm shall not be assumed in design, unless I&FC has a documented operating procedure, with equipment stationed for it. Where it does, the bar may be assumed lowered to the procedure's target level only after the time the procedure states.

5.13.5 **Outfall-closed check.** Where the closed-mouth level of 5.13.3(b) exceeds the outfall invert for longer than the default lock windows, the lock duration of Clause 5.10 shall be extended to that period.

> Commentary. Jammu and Kashmir has no coast and no river mouth, so Clause 5.13 does not apply in the Union Territory (Clause 5.1.4). Its nearest inland counterparts are the silt, gravel and boulders that its rivers, khads and lakes leave at an outfall or a gate. The flood spill channel of the Jhelum, built for 17,000 cusecs, had been reduced to 4,000 cusecs "due to accumulation of sediment load from various nallahs which merge with the channel" (CAG, Report No. 4 of 2016, §2.1.4); the Wular is reported to have lost about 30% of its volume to silt in three decades, and releases from the Dal are reported to be possible "only to the extent of two to three feet" because of silt (as reported); the first phase of the flood management works on the Jhelum removed about 35 lakh m³ of sediment (as reported); and the gates of Salal are opened in the monsoon to flush its silt into the Chenab (as reported). Brari Nambal lost its outlet, the Mar Canal, when the canal was filled in the 1970s (as reported). A flap gate held open or shut by silt or gravel, an outlet buried by a rising bed or left hanging by scour, or a gate that cannot be moved, turns a designed outfall into a dead end or a back-flow path. No written gate-operation rule for the gates of any dam, barrage, lake outlet or dewatering station in the Union Territory was found during research [TBC]. Clause 5.8.5 deals with both by setting outfalls above the range of bed movement and by giving no credit for a gate operation or a storage that the operator's records do not show. Clause 5.13.2 has no direct precedent. It puts the burden of proof on showing that the mouth is open rather than assuming it.

5.14 Documentation

Every project subject to this chapter shall submit a **Downstream and Tailwater Report** (Form 5-1). It shall contain:

1. a plan of the analysis extent showing:
    - the site;
    - each analysis point with its contributing catchment area and the site's percentage of it; and
    - the end point and the reason it was chosen (Clause 5.3);
2. the model description:
    - software and version;
    - the network schematic, with survey sources for the drains and crossings;
    - land use and CN for off-site areas;
    - any upstream detention included; and
    - calibration or validation evidence where available;
3. for each analysis point, AEP and duration, the existing and with-project:
    - peak flow;
    - time to peak;
    - maximum water level and velocity; and
    - duration of inundation (Clause 5.4);
4. the comparison against Clause 5.5, with each failure identified and the remedy adopted;

5. the tailwater derivation:
    - tide-table edition and port;
    - MHWS, HAT and MSL relative to chart datum;
    - the datum connection to the Survey of India benchmark and the project datum;
    - surge source and value;
    - SLA; and
    - river levels and their sources (Clauses 5.6 to 5.8);
6. the joint-case table of Clause 5.9 with results;
7. the outfall-closed check (Clause 5.10):
    - storm and lock alignment;
    - stage hydrographs; and
    - the volume balance for each lock window;
8. a schedule of flap gates, tide gates and non-return valves, with certified head–discharge data (Clause 5.11);
9. pumped outfall design, power supply, flood immunity and controls, where provided (Clause 5.12);
10. the sand-bar assumption and supporting I&FC certification, where relevant (Clause 5.13); and
11. inspection and maintenance requirements for Chapter 10.

Small sites under Clause 5.3.4 shall submit Form 5-2 (Simplified Downstream Statement) instead.

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Annexes and forms

Annex / Form	Content
5A	Tidal datums (MSL, MHWS, HAT vs CD and Survey of India datum), surge allowances and 1% still-water levels by coastal segment
5B	Major drains, riverine outfall reaches, and river mouths subject to sand-bar closure; map
5C	Worked example: outfall-closed check for a site on a khad draining to the Tawi in Jammu
Form 5-1	Downstream and Tailwater Report
Form 5-2	Simplified Downstream Statement (small sites)

CHAPTER 6

Minor and Major Drainage Systems

6.1 Purpose and scope

6.1.1 This chapter sets the level of service and the hydraulic criteria for the conveyance system that carries runoff from a development, a road or a public drainage scheme to a receiving waterway, tank or outfall. It covers:

- (a) the dual drainage concept: a minor system and a major system (Clause 6.3);
- (b) design return periods by land use and road class (Clause 6.4);
- (c) street hydraulics: spread, depth and flow hazard (Clause 6.5);
- (d) inlets, including clogging (Clause 6.6);
- (e) pipes and open and covered drains (Clause 6.7);
- (f) hydraulic grade line analysis (Clause 6.8);
- (g) overland flow paths, ponding at sags and building floor levels (Clauses 6.9 to 6.11);
- (h) culverts and road crossings (Clause 6.12); and
- (i) Jammu and Kashmir construction-practice requirements for covered drains, silt, solid waste, utilities and desilting access (Clause 6.13).

6.1.2 The detailed hydraulic design of individual structures (culverts, channels, energy dissipators, screens, pumps, gates, manholes) is in Chapter 9. Rainfall is in Chapter 2, runoff methods in Chapter 3, on-site storage in Chapter 4, tailwater in Chapter 5, waterbodies in Chapter 7 and water quality in Chapter 8.

6.1.3 This chapter applies to all public drains, all roads with kerbs or roadside drains, and all private drainage systems in developments that meet the applicability thresholds of Chapter 1. In Tier B local bodies, the simplified procedures and design aids referred to in Chapter 1 may be used for elements serving ≤ 16 ha, but the criteria of this chapter still apply.

> Commentary. Jammu and Kashmir's drains were not designed against any Union Territory or municipal standard: none was found during research, and no document found gives a design return period, runoff coefficient or drain size for any town. Srinagar has a Drainage Master Plan and DPR for 767 km², prepared by Egis India for a storm-water system "separate from the sewage system", but no return period, intensity, coefficient or pipe size from it has been published (as reported); the Srinagar Master Plan 2035 sets "stormwater performance standards" of 100% coverage and zero incidence of waterlogging, and encourages detention and retention as "source controls", without a design storm (§13.3); and the Jammu Master Plan 2032 finds that "the road side drains serve as storm water drains", that only 20% of the roads have side drains, covering about 40% of the city, and that the storm-water DPR is still to be prepared (§§5.1.3 and 11.1.3). The World Bank's flood recovery project after 2014 designed its roads and bridges "per the guidelines of the Indian Roads Congress" and set no drainage return period (JTFRP, 2015). The drains fail without the river: Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar were waterlogged after 26.4 mm of rain on the morning of 1 August 2019 (as reported), and in Jammu, Gangyal, Trikuta Nagar and Nanak Nagar were waterlogged in August 2025 (as reported), and JMC listed Rajinder Nagar, Muthi, Lakhdata Bazar and Bantalab among the localities waterlogged on 23 August 2026 (as quoted [TBC]). The drains also work in two settings that the plains editions of this Manual do not meet together. On the floor of the Kashmir valley they are flat, sit over a water table 0–2 m below ground, and end behind the Jhelum's embankments in the sumps of dewatering stations (Chapter 5); in the hill towns and across the Kandi they collect water from steep slopes that deliver gravel, stones and debris with every storm, and

end in khads whose beds move. The drains are also divided among owners: UEED, the Town Drainage wings of SMC and DULBK, JMC, the Municipal Councils and Committees, SDA, JDA, the Smart City companies, the Public Works (R&B) Department and NHAI all build or hold drains, and I&FC, LCMA and WUCMA hold the receiving waters, and no rule divides them (see the Commentary to Clause 6.9). Fixing the rainfall (Chapter 2) is only half the answer. The other half is a second, surface-level system that carries the flows the pipes cannot, without flooding buildings. That is the dual drainage concept of this chapter, taken from Kansas City Metro APWA Section 5600 (5601.8, Levels of Service), which requires every element to have a 1% AEP overflow path.

6.2 Definitions

Term	Meaning in this Manual
Minor system	Inlets, pipes, covered drains and open drains that carry runoff up to the minor design AEP of Table 6.1 without surcharge above the limits of Clause 6.8.
Major system	The surface flow paths (streets, overland flow paths, open channels, floodways and storage) that carry flow above the capacity of the minor system, up to the 1% AEP (100-yr) event.
Overland flow path	A defined surface route, in public land or a recorded easement, that carries major-system flow to a receiving waterway.
Spread (T)	Width of flow in the gutter and carriageway, measured from the face of the kerb.
Sag	A low point on a road or flow path from which water can leave only through an inlet or by ponding to an overflow level. A trapped sag has no surface overflow route.
Clogging factor	The fraction of an inlet's clean hydraulic capacity assumed lost to debris (Clause 6.6.3).
Hydraulic grade line (HGL)	The line joining the free-surface levels in a conduit system, or the piezometric levels where the system is under pressure.
Covered drain	A rectangular drain, usually beside a road, closed by cast-in-situ or precast cover slabs that form a footpath.
Sediment allowance	The depth or area of a drain or pipe assumed filled with silt when its design capacity is computed (Clause 6.7.8).
Check event	An AEP rarer than the design AEP at which the combined minor and major system must still meet the limits of Table 6.2.
High-density area	An area notified as such by the approving authority under Clause 6.4.4.
Class I area	An urban local body with a population of 1 lakh or more (the CPHEEO definition).

6.3 The dual drainage concept

6.3.1 Every drainage system shall be designed as two systems that work together:

- (a) a **minor system** that carries the minor design flow of Table 6.1 below ground or in drains, keeping streets usable and spread within Table 6.2; and
- (b) a **major system** that carries all flow above the minor-system capacity, up to the 1% AEP (100-yr) flow, on the surface without entering buildings and within the depth and hazard limits of Clause 6.5.

6.3.2 **Every element has a 1% path.** Every inlet, sag, pipe, drain, culvert and storage element shall have an identified 1% AEP overland flow path to a receiving waterway, tank or outfall. The path shall be shown on the drainage plan (Clause 6.15).

6.3.3 **Major-system design flow.** The major system at any point shall carry the 1% AEP peak flow less the minor-system capacity at that point. The minor-system capacity used in this subtraction is the capacity of the inlets after the clogging factors of Clause 6.6.3, or the pipe capacity, whichever is less. At sags and at any location used to set building floor levels, the major system shall also be checked with the minor system **fully blocked** (Clause 6.10.3).

6.3.4 **Rainfall and method.** Design flows shall use the rainfall of Chapter 2 (including the climate factor of Clause 2.8) and the methods of Chapter 3:

- (a) the Rational Method only for catchments ≤ 16 ha and a single conveyance element. It shall not be used to accumulate flows down a network whose total catchment exceeds 16 ha;
- (b) a hydrograph method with hydraulic routing (for example SWMM, HEC-HMS with a hydraulic model, or an equivalent 1D/2D model) for networks above 16 ha and for any network with storage, pumping or a tidal outfall;
- (c) a minimum time of concentration of 10 minutes.

6.3.5 **No transfer between catchments.** Neither the minor nor the major system shall divert flow from one natural catchment to another unless the approving authority accepts a catchment-wide study showing no adverse effect.

6.3.6 **Hill catchments: debris, sediment, steep drains and streets, hill roads and sloping sites.** This clause applies to every element of the minor and major systems that receives runoff from a hill catchment, which in this Manual means land in sub-area JK-B, JK-B1 or JK-D of Annex 2A, the slopes of sub-areas JK-A and JK-C (among them the Siwalik hills above the Kandi belt, the Karewa scarps and the Zabarwan hills above Srinagar), any catchment whose natural ground slopes more than 10% on average, and any khad, nallah or other seasonal stream that comes down from the hills or runs across the Kandi fans of Jammu, Samba and Kathua. Such elements shall meet Clauses 6.4 to 6.14 and, in addition (all set by this Manual):

- (a) **Debris racks and traps.** Every inlet, drain or pipe entrance and culvert that receives flow from **1 ha or more** of unbuilt hill land (forest, scrub, orchard, terraced or bare slope, or a slide scar), or from a khad or nallah whatever its catchment, shall have a debris rack or a debris trap upstream of it, designed under Chapter 9 (Clause 9.8), with machine access and a stable place to stockpile what it catches, which shall not be a slope, a khad, a nallah or a wetland. With 50% of the rack blocked, the element it protects shall still pass its design flow, and the overflow route shall not send the flow onto a building or an unprotected slope. Racks and traps shall be cleared by 31 May and, in the hill towns of sub-areas JK-B, JK-B1 and JK-D, again after the monsoon by 31 October (Chapter 10). The volume of a debris basin is to be set in Chapter 9 [TBC].
- (b) **Bulking factor.** The design flow of every channel, drain, pipe, culvert and crossing that receives flow from a hill catchment shall be the clear-water peak flow of Chapter 3 multiplied by a bulking factor of **1.25**, for the minor design flow, the check event and the 1% AEP flow; elsewhere the factor is 1.0. The factor applies to capacity, freeboard and velocity; it does not apply to the runoff volume used for storage (Chapter 4). A larger factor shall be used where a sediment study of the catchment gives one. A catchment that the screening of Clause 2.3.6(i) shows to be prone to debris flow, or that drains a mapped debris-flow fan, landslide, slide scar or subsidence zone, is not designed by a bulking factor: no building, outfall, pumping station or storage shall be placed in the debris-flow path, and the drains are designed for the bulked flow only [TBC].
- (c) **Blockage.** The blockage check of Clause 6.12.4 shall assume 50% of the inlet area blocked for every culvert and pipe entrance with a span or diameter below **3.0 m**, and 20% for larger ones, whether or not a debris rack is provided. Grate inlets keep the clogging factor of Table 6.5, and kerb openings on grade take the sag value of 20%.
- (d) **Sediment and minimum velocity.** Drains and pipes that receive flow from a hill catchment, or that run across the Kandi fans of Jammu, Nagrota, Samba and Kathua–Hiranagar, shall reach a velocity of at least **1.0 m/s** at the minor design flow, in place of the minimum of Clause 6.7.3(a). Where the gradient does not allow it, a sediment trap shall be provided upstream and the sediment allowance of Clause 6.7.8 doubled (Clause 6.7.4).
- (e) **Steep drains and energy dissipation.** Where the gradient of a drain gives a velocity above the limits of Clause 6.7.3(b), or a Froude number above 0.8, at the design flow, the drain shall be a lined chute, a stepped channel or a series of drop structures designed under Chapter 9 for the bulked flow of item (b), with the freeboard of Table 6.7 for steep channels and an energy dissipator at every change to a flatter gradient and at the outlet. No unlined drain shall be laid on a gradient on which the velocity exceeds the limit of Chapter 9 for its bed material.

- (f) **Steep streets.** On a street steeper than 5%, grate-only inlets shall not be used, and inlets shall be placed by the calculation of Clause 6.6.4 with the bypass flows of a steep gutter. On a street steeper than 10%, the flow shall be intercepted by transverse grated channels or kerb inlets at a spacing that keeps the street flow within the limits of Table 6.3 in the check and 1% AEP events. Where the 1% AEP flow cannot be kept within those limits on the carriageway, the excess shall be carried in a lined side channel or stepped drain under item (e), and the street, unless it is a notified evacuation route, is treated as closed in that event. Steps and footpaths that carry flow shall have a lined side channel.
- (g) **Hill roads as the minor system.** In sub-areas JK-B, JK-B1 and JK-D, and on any road elsewhere that crosses a hill catchment, the drainage of a road is the minor system for the land above it as well as for the road. Every road and street there shall have, as works of the road's owner, the Public Works (R&B) Department, NHAI or the local body:
  - (i) a lined catch-water drain above every cut slope where the land above drains towards the road, discharging to a natural channel or a cross-drainage work and not over the cut;
  - (ii) lined side drains on the hill side (IRC:SP:42-2014, cl. 8.5.1);
  - (iii) a cross-drainage work at every khad and nallah, and culverts or scuppers at intervals such that no side drain exceeds its capacity at the design AEP of Table 6.1 with the factors of items (b) and (c);
  - (iv) at the outlet of every scupper, culvert and side drain on the valley side, a lined chute, cascade or pipe carrying the flow to a stable natural channel, with an energy dissipator, so that road runoff is **never discharged onto an unprotected slope**, fill, retaining wall or the land of a building below;
  - (v) culverts of at least the size of Clause 6.12.5, designed under Clause 6.12 and not less than IRC:SP:42-2014 cl. 7.1.4 requires for the road; where the drainage provisions of IRC:SP:48, the Hill Road Manual, which were not read for this Manual [TBC], are stricter than this item, they apply;
  - (vi) no muck, spoil or excavated material from the construction, widening or maintenance of the road, or from a tunnel or a hydropower work, placed in or beside a khad, nallah, khul or other line of natural drainage, or on a slope from which a storm can carry it into one, and every natural drain or stream that such material has blocked cleared before the monsoon so that the runoff of its catchment reaches the nearest river, khad or nallah; and
  - (vii) no sewage pipe, and no outlet of a septic tank or soak pit, connected to a road drain or discharged onto the slope below the road (Clause 8.9).
- (h) **Sloping sites and moving ground.** On a site where the land above drains towards a building, its cut or its retaining wall, the runoff of that land shall be intercepted above them by a lined diversion drain sized for the minor design flow of Table 6.1 from the land above it, with the factors of items (b) and (c), with a 1% AEP flow path that does not pass through or against the building. The space between a building and its cut or toe wall shall be paved or lined and drained so that water does not stand against the building or soak into the foot of the cut. Both shall discharge to a public drain or a stable natural channel as item (g)(iv) requires, not onto the slope below. In a mapped subsidence or sliding zone, among them Thathri Nai Basti in Doda district, Pernote and Duksar in Ramban district and any area of Budgam district that JKPCC lists as prone to land sinking, every drain shall be lined, the surface runoff shall be diverted away from the moving part of the slope, and no runoff shall be put into the ground (Clause 4.11). Roof and paved-area runoff on a sloping site follows the hill infiltration rule of Clause 4.11. The site plan of UBBL-2021, cl. 2.6(b)(xi), which already shows contours at 0.3 m intervals where the site slopes more than 1:20, shall also show the diversion drain, the drained space and the point of discharge.

> **Commentary.** The CPHEEO (2019) manual defines major and minor systems in its glossary but gives no return period for the major system. APWA 5600 (2006, 5601.8) requires the system to convey the 1% peak and, where in-system capacity is less, an overflow system to carry the remainder. Clause 6.3.3 subtracts only the *clogged* inlet capacity, not the full pipe capacity, because in practice the pipes cannot take more water than the inlets admit. The fully-blocked check at sags has no direct precedent; this Manual sets it because of the Srinagar and Jammu experience that drains under footpaths are often silted or blocked by solid waste when the heaviest rain arrives (CPHEEO 2019 Part A, Ch 1 and 2, Figures 1.2 and 2.1 on solid waste dumping in drains). The prohibition on inter-catchment transfer follows the DID Malaysia 2008 submission checklist, which prohibits inter-catchment diversion. Clause 6.3.6 is set by this Manual for Jammu and Kashmir, as for Uttarakhand and Himachal Pradesh before it in this series, because the criteria of this chapter assume clear water on gentle ground. In the hills of

Jammu and Kashmir the water is not clear and the ground is not gentle. The Jammu Master Plan 2032 describes the ravines of the Kandi belt, "locally called Khads", as "transformed into gushing torrents" (§2.4) and counts "more than 100 small and big dry khads which have flash floods during the rainy season" (§7.3.2). In August 2025 the Chenab, the Tawi and their tributaries set new highest flood levels, and SANDRP found that "muck dumping worsens the impacts" (as reported), which is item (g)(vi). At Pernote in Ramban district the Geological Survey of India found in April 2024 that "during rains the ingress of surface runoff through these cracks may have developed the pore pressure, thus inducing the instability in the slope", and recommended "diverting the surface runoff away from the affected/active part of the slope" and that "Drains present in the affected slope should be lined/trained" (GSI note annexed to the JKPCC compliance report in NGT O.A. 642/2024); at Thathri Nai Basti in Doda district, where houses cracked from February 2023, the committee appointed by the National Green Tribunal found "no retaining wall with weep holes, or planned drainage or sewage disposal structures" and "unplanned PVC pipes for the purpose of sewerage disposal to the road side drainage downslope" (as reported). Items (g)(iv), (g)(vii) and (h) answer both: water discharged onto a slope raises its pore pressure (Chapter 4, Clause 4.11). The cloudbursts at Chasoti in Kishtwar district on 14 August 2025, which killed more than 60 people, and at Jodh Ghati in Kathua district on 16–17 August 2025, and the landslide on the Vaishno Devi route on 26 August 2025 (all as reported), were measured by no rain gauge, and no gauge in the Union Territory has recorded the cloudburst rate of 100 mm in an hour in any primary source found (Chapter 2); they were debris flows and slides, which item (b) keeps buildings and outfalls away from rather than sizing a drain for. IRC:SP:42-2014 (cl. 8.5.1) already treats hill roads differently: their side drains are "normally restricted to 60 cm" in width and lined because "rolling stones cause high friction", "culverts are required at closer intervals compared to those in plain areas", and "stepped chutes/baffles are to be provided where the longitudinal bed slope exceeds critical". No Indian guidance on bulking factors, debris racks or debris basins was found during research, and no numeric debris or bulking allowance in any Jammu and Kashmir document [TBC], so each number in Clause 6.3.6 is an interim value with a stated reason, the same as in the Uttarakhand and Himachal Pradesh editions. The 1 ha trigger for a debris rack reflects the time of concentration on hill slopes, a few minutes, so that even a small unbuilt slope delivers stones, gravel and leaves to an inlet in the first burst of a storm. The bulking factor of 1.25 is the factor for a flow that carries a fifth of its volume as sediment (bulking factor = 1 / (1 − sediment fraction by volume)): about the most that a drain can carry and still behave as a water flood. A flow with more sediment than that behaves as a debris flow, which no drain can be sized for, and the factor is to be replaced by a sediment study as soon as one is made [TBC]. The 3.0 m limit in item (c) doubles the core's 1.5 m because boulders and timber block openings that leaves and plastic do not. The 1.0 m/s minimum in item (d) replaces the 0.6 m/s of CPHEEO, which is based on carrying fine sand of 0.09 mm, because hill drains and the khads of the Kandi carry gravel and boulders. On a 10% street, the hazard limit of 2.0 m/s is reached when sheet flow on a concrete surface is only about 30 mm deep, which is why item (f) takes the flow off steep carriageways. The Kashmir valley floor is not a hill catchment and the clause does not apply there, except on the Karewa scarps and the slopes above the valley towns, where an outlet that discharges down a scarp without protection cuts a gully into it (Clause 4.11).

6.4 Design return periods

6.4.1 The minor system, roads and crossings shall be designed for the AEPs of Table 6.1. Where both a land-use row and a road-class row apply to an element, the **rarer** AEP (longer return period) governs.

Table 6.1 — Design AEPs for conveyance (matches Clause 2.4)

Element	Design AEP (return period)	Check event	Basis
Minor system: Srinagar, Jammu, Anantnag, Baramulla and Udhampur core and other high-density areas	10% (10-yr)	1% (100-yr) overland path	This Manual (see Commentary)

Element	Design AEP (return period)	Check event	Basis
Minor system: other Class I areas	20% (5-yr)	1% overland path	This Manual; CPHEEO Table 4.1
Minor system: other areas	50% (2-yr)	1% overland path	This Manual; CPHEEO Table 4.1
Arterial road drainage and crossings	2% (50-yr) for arterials that are notified evacuation or emergency routes; 4% (25-yr) for other arterials	Next higher AEP: 1% for a 2% design; 2% for a 4% design	This Manual (25–50-yr); split set by this Manual
Collector road drainage and crossings	4% (25-yr)	2% (50-yr)	This Manual
Local road drainage and crossings	10% (10-yr)	4% (25-yr)	This Manual
Road underpasses and other trapped sags on public roads	2% (50-yr)	1% (100-yr)	This Manual (Clause 6.10.5)
Airports, railway stations, power stations and other critical infrastructure	1% (100-yr) in Class I areas; 2% (50-yr) elsewhere	—	CPHEEO 2019 Table 4.1
Major (overland) system, every element	1% (100-yr)	—	This Manual
Building floor levels	1% level + 0.5 m freeboard	—	This Manual (Clause 6.11)

6.4.2 **Check events.** At the check event of Table 6.1, the combined minor and major system shall carry the check-event flow within the 1% AEP limits of Table 6.2 and without water entering any building. The 1% overland path requirement of Clause 6.3.2 applies in addition to the check event.

6.4.3 **Higher standards.** An approving authority may adopt a rarer AEP for any element, including through the high-powered committee route in Note 2 of CPHEEO Table 4.1. It shall not adopt a more frequent AEP than Table 6.1.

6.4.4 **High-density areas.** The approving authority shall notify, by map, the high-density areas to which the 10% AEP minor-system standard applies. Until it does, the 10% AEP standard applies to:

- (a) the city centre of Srinagar, among them Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds, waterlogged after 26.4 mm on 1 August 2019 (as reported), and the old city along the Jhelum; the old city of Jammu and the localities of Jammu reported waterlogged in 2025 and 2026, among them Gangyal, Trikuta Nagar, Nanak Nagar, Rajinder Nagar, Muthi, Lakhdata Bazar and Bantalab (as reported, and as listed by JMC in August 2026 [TBC]); and the old towns of Anantnag, Baramulla and Sopore: the older, densely built area within the Municipal Corporation's, Municipal Council's or Municipal Committee's area that the applicable master plan or zonal plan under the Jammu and Kashmir Development Act 1970 identifies as the core area, old city or central business district, with the boundary of each to be confirmed by the local body with SDA, JDA or the Town Planning Organisation concerned [TBC];
- (b) in every other Municipal Council and Municipal Committee, the area that the applicable plan identifies as the core area, old town or central business district, the main bazaar of a hill town, and the old village settlements that have been taken into the built-up area; and
- (c) any area in a Tier A body where the master plan permits a floor space index above the base value for the zone.

6.4.5 **Retrofit.** Where an existing drain cannot practicably be enlarged to the Table 6.1 AEP, the shortfall shall be made good by upstream storage (Chapter 4), regional storage (Chapter 7) or an improved major-system path. The approving authority shall record the residual level of service.

> **Commentary.** The values in Table 6.1 match the Clause 2.4 summary and add rows for underpasses and critical infrastructure. They exceed the CPHEEO (2019) national advisory minimums of 5-yr for Class I cities and 2-yr elsewhere (CPHEEO Part A, Table 4.1). Note 2 of that table allows a State committee to adopt higher values. The 10-yr tier for high-density areas follows Gupta (IIT Bombay), who recommends "1 in 10 year for residential-high density", and Malaysia's MSMA 2, which uses 10-yr minor and 100-yr major systems for link houses, apartments, commercial and industrial land. The road values resolve a conflict in Indian codes. IRC:SP:50-2013 recommends 1–2 years for urban road drains. IRC:SP:42-2014 suggests 25 years for urban roadside drains and a check flood at the next higher return period. APWA 5600 (2006) uses 50-yr for arterial, 25-yr for collector and 10-yr for residential street crossings. Table 6.1 adopts the APWA tiers and the IRC:SP:42 check-flood concept. Splitting arterials into 50-yr evacuation routes and 25-yr others has no direct precedent and is set by this Manual. The 50-yr standard for underpasses is likewise set by this Manual, because an underpass is a trapped sag where the failure mode is deep water on a live carriageway. The default high-density areas in Clause 6.4.4 are set by this Manual and apply until the approving authority notifies a map.

6.5 Street hydraulics: spread, depth and flow hazard

6.5.1 **Gutter flow.** Flow in a triangular kerb-and-gutter section shall be computed with the modified Manning (Izzard) equation:

> Q = (Ku / n) · Sx^(5/3) · SL^(1/2) · T^(8/3)

where Q is the gutter flow (m³/s), Ku = 0.376 (SI), n is the Manning roughness of the gutter (Table 6.6), Sx is the cross slope (m/m), SL is the longitudinal slope (m/m) and T is the spread (m). Composite and depressed gutter sections shall be analysed by the methods of FHWA HEC-22 (4th edition, 2024).

6.5.2 **Spread and depth limits.** Street flow shall not exceed the limits of Table 6.2.

Table 6.2 — Street flow limits

Road class	Minor design event (Table 6.1)	Check event and 1% AEP event
Arterial	Spread shall leave at least one through lane in each direction clear of water. No flow across the crown.	Depth ≤ 150 mm at the crown and ≤ 350 mm at the deepest point; hazard limits of Clause 6.5.3
Collector	Spread T ≤ 3 m. No flow across the crown except at a sag intersection.	As above
Local	Spread T ≤ 3 m. Flow shall not overtop the kerb.	As above
All classes, at intersections	Cross-flow over the crown ≤ 0.03 m³/s at sag intersections and superelevation transitions; none at mid-block sags.	As above

6.5.3 **Flow hazard limits.** In the check event and the 1% AEP event, the product of depth (D, m) and velocity (V, m/s) of street and overland flow shall not exceed the limits of Table 6.3.

Table 6.3 — Flow hazard limits for streets and overland flow paths

Location	Required hazard class (Table 6.4)	Limits
Carriageways of all roads	H2 or better	D·V ≤ 0.6 m²/s; D ≤ 0.35 m (Table 6.2); V ≤ 2.0 m/s
Footpaths, pedestrian crossings, school, hospital and transit-stop frontages	H1	D·V ≤ 0.3 m²/s; D ≤ 0.3 m; V ≤ 2.0 m/s
Notified evacuation and emergency routes	H1	D·V ≤ 0.3 m²/s; D ≤ 0.3 m; V ≤ 2.0 m/s
Overland flow paths in public open space or easements, away from roads	H3 or better, with warning signs	D·V ≤ 0.6 m²/s; D ≤ 1.2 m; V ≤ 2.0 m/s

Table 6.4 — Combined flood hazard vulnerability classes (reproduced for reference)

Class	Description	D·V limit (m²/s)	Depth limit D (m)	Velocity limit V (m/s)
H1	Generally safe for vehicles, people and buildings	≤ 0.3	0.3	2.0
H2	Unsafe for small vehicles	≤ 0.6	0.5	2.0
H3	Unsafe for vehicles, children and the elderly	≤ 0.6	1.2	2.0
H4	Unsafe for vehicles and people	≤ 1.0	2.0	2.0
H5	Unsafe for vehicles and people; buildings vulnerable to structural damage	≤ 4.0	4.0	4.0
H6	Unsafe for vehicles and people; all buildings vulnerable to failure	> 4.0	—	—

Source: AIDR Guideline 7-3, *Technical flood risk management guideline: Flood hazard* (2014), Tables 1 and 2, modelled after Smith and Wasko (2012).

6.5.4 Depth and velocity for Clause 6.5.3 shall be taken from the gutter-flow calculation for simple sections, or from a 1D or 2D hydraulic model where flow leaves the kerb-and-gutter section.

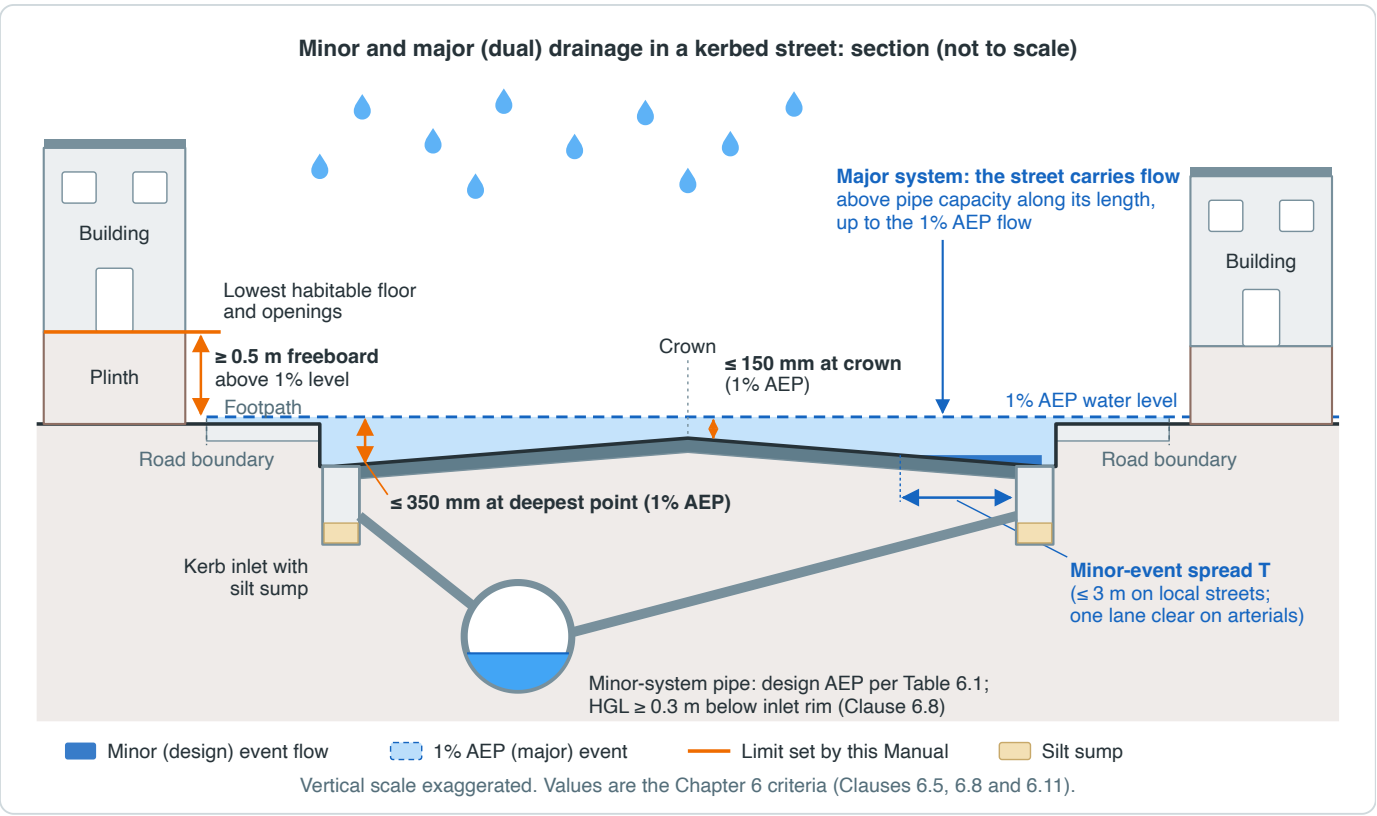

Figure 6.1 — Minor and major drainage in a kerbed street. Original drawing for this Manual, adapted from Kansas City Metro APWA, Section 5600 (2006, 5601.8) and FHWA, HEC-22 Urban Drainage Design Manual (4th ed., 2024).

> **Commentary.** The Izzard form of Manning's equation with Ku = 0.376 is used both in FHWA HEC-22 and in the CPHEEO (2019) manual (Part A, Example 5.5, where the constant is written Kc = 0.376). The arterial spread rule (one lane clear) and the 3 m spread for local and collector streets are close to the APWA 5600 (2006, 5604.2) limit of 12 ft (3.66 m) from the back of kerb in each outside lane. The cross-flow limit of 0.03 m³/s is the SI equivalent of the APWA limit of 1.0 cfs at intersection sumps and superelevation transitions, with no cross-flow at mid-block sumps. The 150 mm and 350 mm depth limits are close to the APWA 5600 limits for 1% overflow at road crossings (7 in, about 180 mm, at the crown; 14 in, about 360 mm, at the deepest point). Mumbai's criterion of no flooding above 15 cm (IRC:SP:50-2013, §6.4.1) is a local precedent for the 150 mm crown value.
>
> The hazard classes of Table 6.4 are the combined hazard curves published by the Australian Institute for Disaster Resilience (AIDR Guideline 7-3, 2014), which are modelled after Smith and Wasko (2012). Requiring H2 or better on carriageways means the 1% depth limit of 350 mm (Table 6.2) governs the depth, and the D·V product controls fast, shallow flow on steep streets. H2 is described as "unsafe for small vehicles". Two-wheelers are the dominant vehicles on Jammu and Kashmir streets, so the 1% event must be treated as a road-closure event on all roads except notified evacuation routes, which must meet H1. The assignment of hazard classes to locations in Table 6.3 has no direct precedent and is set by this Manual.

6.6 Inlets

6.6.1 **Inlet types.** Inlets may be kerb-opening inlets, grate inlets, combination inlets (a grate with a kerb opening) or slotted and trench drains. On public streets:

- (a) kerb-opening or combination inlets shall be used, unless the approving authority accepts grate-only inlets for a specific location;

- (b) inlet openings shall be set at road level, with a gutter depression where practicable, so that water is not held on the carriageway by a raised kerb or footpath;
- (c) grates in carriageways, cycle lanes and footpaths shall be of a bicycle- and pedestrian-safe pattern (Chapter 9, Clause 9.11).

6.6.2 **Inlet capacity.** The clean capacity of inlets on grade and in sags shall be computed by the methods of FHWA HEC-22 (4th edition, 2024), or from tested ratings published by the manufacturer for the exact grate and kerb-opening geometry. The empirical kerb-inlet equations of CPHEEO (2019) Part A §5.6.2 may be used as a cross-check only.

6.6.3 **Clogging factors.** The design capacity of every inlet shall be its clean capacity reduced by the clogging factors of Table 6.5:

Table 6.5 — Inlet clogging factors (share of clean capacity assumed lost)

Inlet type	On grade	In a sag
Grate	50%	50%
Kerb opening	10%	20%
Combination	Apply the grate and kerb factors to each part separately	Apply the grate and kerb factors to each part separately

Design capacity = (1 − clogging factor) × clean capacity.

6.6.4 **Inlet spacing.** Inlets shall be located by a sequential calculation that starts at the top of each gutter run. At each inlet, the intercepted flow is computed, and the bypass flow is added to the gutter flow arriving at the next inlet. Spacing shall be such that the spread limits of Table 6.2 are met everywhere in the minor design event. In addition:

- (a) inlet spacing shall not exceed 30 m on kerbed roads, whatever the calculation gives;
- (b) inlets shall be provided at every sag, immediately upstream of pedestrian crossings and intersections, upstream of bridge decks and superelevation transitions, and at the end of every gutter run;
- (c) bypass flow from the last inlet of a run shall not be passed onto a road of a higher class or into private land.

6.6.5 **Sag inlets.** At a sag on a kerbed road:

- (a) the sag inlet's design capacity (after clogging) shall be not less than the total minor design flow arriving at the sag;
- (b) flanking inlets shall be placed on each side of a sag on any road where ponding could spread beyond the Table 6.2 limits, and at every underpass;
- (c) the ponding at the sag shall comply with Clause 6.10.

6.6.6 **Inlet connections.** The pipe connecting an inlet to the main drain shall have a diameter of at least 300 mm and shall be laid at a gradient that gives at least 0.9 m/s at the inlet's design flow.

6.6.7 **Silt sumps.** Every inlet chamber on a public road shall have a silt sump at least 300 mm deep below the invert of its outlet pipe, accessible for cleaning from the surface.

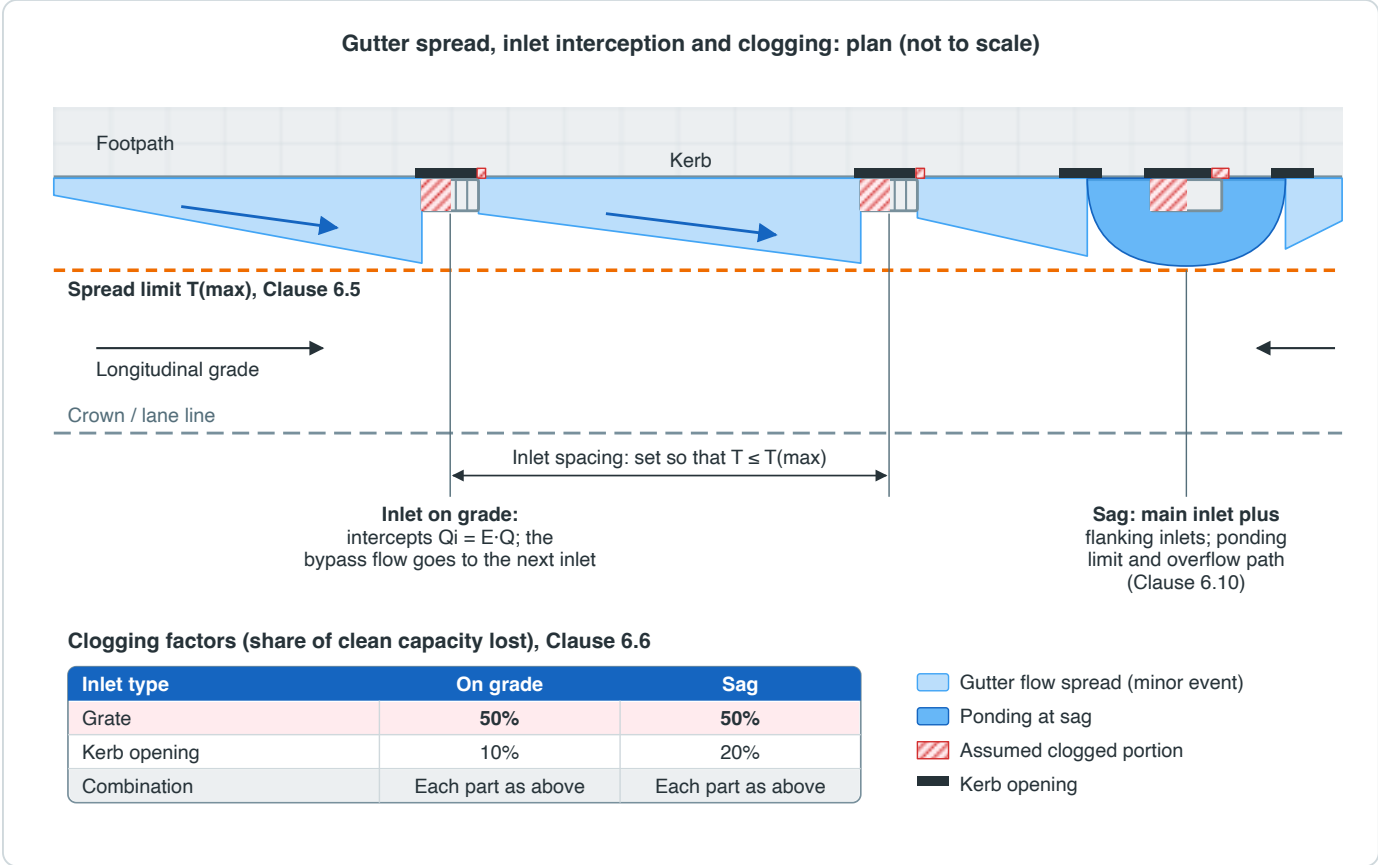

Figure 6.2 — Gutter spread, inlet interception and clogging. Original drawing for this Manual, adapted from FHWA, HEC-22 Urban Drainage Design Manual (3rd ed., 2009; 4th ed., 2024) and CPHEEO, Manual on Storm Water Drainage Systems (2019).

> **Commentary.** The clogging factors are more severe than the APWA 5600 (2006, 5604.2) rating of sump inlets at 80% of theoretical capacity (a 20% reduction), because grates in Jammu and Kashmir streets are routinely blinded by plastic and leaves. CPHEEO (2019) Part A shows solid waste dumped in drains as a primary cause of drain failure (Figures 1.2 and 2.1). APWA 5600 (2006) allows only kerb-opening inlets on public streets; Clause 6.6.1(a) is less strict because combination inlets are useful on flat roads. No standard inlet, kerb-channel or covered-drain detail of the Public Works (R&B) Department, SMC or JMC was found during research [TBC]; the bye-laws require only that "the Underground utilities" of a street, among them "storm water drainage", be "as per section proposed in the annexure" (UBBL-2021), and in Jammu the roadside drains are the storm drains (Jammu Master Plan 2032, §5.1.3). The 30 m maximum spacing and the treatment of combination inlets in Table 6.5 have no direct precedent and are set by this Manual. Roads on the Kashmir valley floor, in the Jammu plains and across the Sirowal are flat, which shortens the calculated spacing anyway; on the steep streets of the hill towns gutter flow runs fast and passes inlets by, which Clause 6.3.6(f) deals with. A fixed cap stops a single blocked inlet from leaving a long dry gutter run. The 300 mm silt sump is set by this Manual. It matches the 0.3 m sump shown on the CPHEEO catch-basin detail (CPHEEO 2019, Figure 5.9).

6.7 Pipes and open and covered drains

6.7.1 **Uniform flow.** Pipe and drain capacity shall be computed with Manning's equation:

> V = (1/n) · R^(2/3) · S^(1/2); Q = A · V

where V is the mean velocity (m/s), n is the Manning roughness (Table 6.6), R is the hydraulic radius (m), S is the friction slope (m/m), A is the flow area (m²) and Q is the discharge (m³/s). Where backwater from a tailwater, a junction or a structure affects the water level, a gradually varied flow (standard step) or hydraulic network model shall be used, and the HGL requirements of Clause 6.8 apply.

6.7.2 **Manning roughness.** Design values of n shall be taken from Table 6.6. For concrete pipes and masonry or concrete drains, the design value shall be not less than the "fair" or "rough" condition value listed, to allow for sediment, biofilm and ageing.

Table 6.6 — Manning's n for design (from CPHEEO 2019)

Material	Condition	n (CPHEEO)	Minimum design n in this Manual
Cement concrete pipe (collar joints)	Good / fair	0.013 / 0.015	0.015
Spun concrete pipe (RCC, PSC) with S/S joints	Manufacturer's design value	0.011	0.013
HDPE / uPVC pipe	—	0.010	0.011
Plastic (smooth), asbestos cement	—	0.011	0.011
Concrete drain, steel trowelled / wood trowelled	—	0.014 / 0.015	0.015
Sand and cement plaster	—	0.015	0.015
Brick masonry	Good / rough	0.015 / 0.017	0.017
Masonry	Bad condition	0.020	0.020
Rubble set in cement	—	0.017	0.017
Earth channel	Regular, good / ordinary	0.020 / 0.025	0.025
Earth channel	With stones and weeds / poor	0.030 / 0.035	0.035
Earth channel	Partly obstructed by debris or weeds	0.050	0.050
Gutter: concrete	—	0.013	0.013
Gutter: hot-mix asphalt	—	0.015	0.015
Gutter: sprayed seal	—	0.018	0.018

Source of the CPHEEO column: CPHEEO (2019) Part A, Table 5.1 (itself from the CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013) and Table 5.8 (gutters).

6.7.3 **Velocity limits.** At the minor design flow:

- (a) minimum (self-cleansing) velocity: **0.6 m/s** in open and covered drains and **0.9 m/s** in pipes;

- (b) maximum velocity: **3.0 m/s** in lined drains and in pipes, unless the drain or pipe is designed as a chute under Chapter 9. CPHEEO permits up to 6.0 m/s in plastic or plastic-lined pipes in hilly regions; this may be used in Udhampur, Katra, Reasi, Ramban, Batote, Banihal, Doda, Bhaderwah, Kishtwar, Rajouri, Poonch, Gulmarg and Pahalgam and other hill towns with the approving authority's agreement;
- (c) maximum velocity in unlined and vegetated channels: Chapter 9, Table 9.2;
- (d) the Froude number of flow in open and covered drains shall not exceed 0.8 at the design flow, unless the drain is designed for supercritical flow under Chapter 9.

6.7.4 **Gradient.** Each pipe and drain shall be laid at a gradient that achieves Clause 6.7.3(a). Where flat terrain or a fixed outfall level makes this impossible, the designer shall:

- (a) report the velocity achieved;
- (b) double the sediment allowance of Clause 6.7.8; and
- (c) provide access for mechanical desilting at the spacing of Clause 6.13.2.

6.7.5 **Pipe flow condition.** Pipes shall be sized so that the minor design flow does not exceed the pipe-full capacity. The greater discharge that a circular pipe carries at about 0.95 of its depth shall not be relied on.

6.7.6 **Minimum sizes.**

- (a) Pipes: 300 mm internal diameter; **450 mm** for public mains.
- (b) Open drains: bed width 0.3 m.
- (c) Covered public drains (drains closed by cover slabs): clear internal width **0.6 m** and clear internal depth **0.6 m**.

6.7.7 **Cover to pipes.** Pipes shall have at least 0.6 m of cover to finished level, and at least 0.9 m under carriageways unless a structural design for the traffic load is submitted. Where the seasonal high groundwater table is within 1 m of the pipe crown, the pipe shall be checked for flotation with the pipe empty (CPHEEO 2019, Table 11.2) and anchored where necessary.

6.7.8 **Sediment allowance.** The design capacity of open drains, covered drains and pipes of 600 mm diameter or more shall be computed with the following depth of sediment at the invert:

- (a) open and covered drains: the greater of **75 mm** and **10%** of the clear internal depth;
- (b) pipes of 600 mm diameter or more: **5%** of the internal diameter;
- (c) pipes below 600 mm: no allowance, but Clause 6.7.3(a) shall be met.

The Manning n for the reduced section shall be that of the drain material in Table 6.6.

6.7.9 **Freeboard in open and covered drains.** At the minor design flow, the water surface (computed with the sediment allowance) shall be below the top of the drain wall, or below the soffit of the cover slab in a covered drain, by at least the freeboard of Table 6.7.

Table 6.7 — Minimum freeboard in open and covered drains

Drain	Minimum freeboard	Source
Bed width up to 300 mm	100 mm	CPHEEO 2019 Table 5.3 (from IRC:SP:50-2013)
Bed width 300–900 mm	150 mm	CPHEEO 2019 Table 5.3
Bed width 900–1,500 mm	300 mm	CPHEEO 2019 Table 5.3
Wider drains and engineered channels, Q < 3 m³/s	450 mm	CPHEEO 2019 Table 5.12 (from IS 7784 (Part 1): 1993)
Q 3 to < 30 m³/s	600 mm	As above
Q 30 to < 300 m³/s	900 mm	As above
Q 300 to < 3,000 m³/s	1,200 mm	As above

Drain	Minimum freeboard	Source
Q ≥ 3,000 m³/s	1,500 mm	As above
Any roadside drain	Not less than 150 mm	IRC:SP:42-2014
Steep (supercritical) channels	Equal to the flow depth	CPHEEO 2019 §5.3.2

At bends, the freeboard shall be measured from the water level on the outside of the bend, including the superelevation $\Delta y = V^2 T / (2\,g\,r_c)$, where T is the top width and r_c the centreline radius (CPHEEO 2019, Eq. 5.29).

6.7.10 **Bends and junctions.**

- (a) The centreline radius of a bend in a drain shall be at least 3 times the drain width (CPHEEO 2019 §5.3.3). In engineered channels it shall be at least 2 times the top width and not less than 30 m (CPHEEO 2019 Table 5.11).
- (b) Where drains meet, a junction sump shall be provided with an internal width of at least twice the width of the outgoing drain. Incoming drains shall enter at less than a right angle to the outgoing flow, and the outgoing invert shall be below the sump floor so that water does not stand in the sump (CPHEEO 2019 §5.3.4).

6.7.11 **Manholes and access chambers on pipes.** Manholes shall be provided at every junction, change of size, alignment or gradient, and at the head of every pipe. Spacing on straight runs shall not exceed Table 6.8.

Table 6.8 — Maximum spacing of manholes on straight pipe runs

Pipe diameter	Maximum spacing
300–600 mm	40 m
700–1,000 mm	100 m
1,050–1,400 mm	150 m
1,500 mm and above	300 m

Source: CPHEEO 2019 Table 11.5. Manhole sizes, drops and covers: Chapter 9, Clause 9.12.

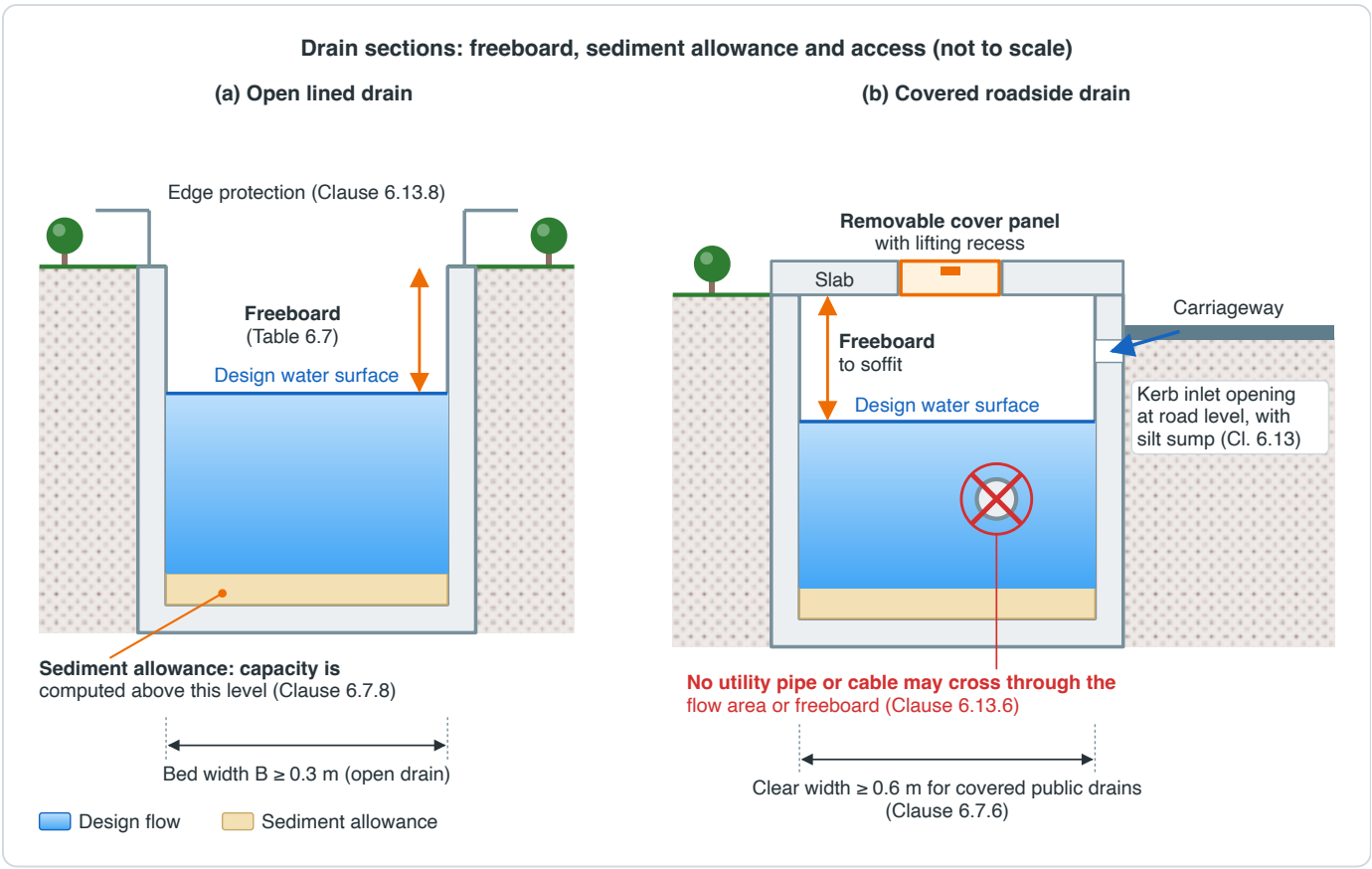

Figure 6.3 — Drain sections: freeboard, sediment allowance and access. Original drawing for this Manual, adapted from CPHEEO, Manual on Storm Water Drainage Systems (2019), Tables 5.3 and 5.12, and IRC:SP:50-2013.

Commentary. The n values are those of CPHEEO (2019) Table 5.1. The higher minimum design values have no direct precedent; this Manual sets them because CPHEEO notes that the 0.011 value for spun pipes "may be taken as given by the manufacturer". That is a clean-pipe value, and Jammu and Kashmir drains carry heavy silt and solid waste. The 0.6 m/s minimum velocity is CPHEEO's (Table 5.2), based on carrying 0.09 mm sand (§5.3.1). The 0.9 m/s value for pipes is stricter, because a silted pipe cannot be cleaned as easily as an open drain. The 3.0 m/s maximum is from CPHEEO Table 5.2 (WPCF/ASCE 1982). The Froude limit of 0.8 is from CPHEEO §5.3, which advises avoiding critical flow because the water surface becomes unstable.

The 0.6 m × 0.6 m minimum for covered drains has no direct precedent and is set by this Manual. A covered drain narrower than this cannot be desilted by hand or by small machines through a cover opening, and silted, inaccessible drains were a recurring finding after the waterlogging of Srinagar's city centre on 1 August 2019, when Lal Chowk, Budshah Chowk, Residence Road and M A Road were under water after 26.4 mm of rain (as reported), and in Jammu, whose old city floods "due to the poor condition of most of the nallahs" (Jammu Master Plan 2032, §5.1.3). The 0.6 m minimum cover is the value used in the CPHEEO (2019) worked pipe-design computation sheet (Part A, Chapter 5). The 0.9 m cover under carriageways is set by this Manual.

The sediment allowance values (75 mm or 10% for drains, 5% for large pipes) are set by this Manual. No Indian standard sets a sediment allowance for design. Srinagar and Jammu's experience is that drains run partly full of silt for much of the year, so a capacity computed for a clean section overstates the real capacity.

The CPHEEO freeboard table (Table 5.3) prints the first row as "Beyond 300 mm bed width". Read with the second row ("Beyond 300 mm & up to 900 mm"), the first row must mean "up to 300 mm"; Table 6.7 is written that way. The CPHEEO manhole spacing table (Table 11.5) gives overlapping ranges (700–1,050 mm and 1,000–1,400 mm); Table 6.8 removes the overlap by assigning 1,050 mm to the 150 m class.

6.8 Hydraulic grade line

6.8.1 **HGL analysis.** For every pipe and covered-drain network, the designer shall compute the HGL for the minor design event and for the check event, starting at the outfall and working upstream. The analysis shall include friction losses and losses at junctions, manholes, bends, inlets, outlets and gates.

6.8.2 **Starting water level.** The starting (tailwater) level at the outfall shall be the higher of:

- (a) the tailwater level of Chapter 5: mean high water springs (MHWS) plus the sea-level allowance of +0.3 m for minor-system design at tidal outfalls, and the level in the receiving drain, river or tank for the coincident event at other outfalls; and
- (b) the level computed at the outlet pipe from the critical depth and the pipe diameter, (dc + D)/2, where the receiving water is lower.

6.8.3 **Minor-event limit.** In the minor design event, the HGL shall be at least **0.3 m below** the rim of every inlet and the cover level of every manhole and access chamber.

6.8.4 **Check-event and 1% limit.** In the check event and the 1% AEP event, the HGL may rise above the inlet rims. Water that leaves the minor system shall then be carried by the major system within the limits of Table 6.2 and shall not enter any building. Manholes that can surcharge above ground in these events shall have bolted or locked covers (Chapter 9, Clause 9.12).

6.8.5 **Structure losses.** Losses at manholes and junctions shall be computed by the energy-based access-hole method of FHWA HEC-22 (2009 or 2024 edition), or by an equivalent method in an approved hydraulic model. A simplified loss-coefficient method ($h = K\,V^2/2g$) with coefficients from HEC-22 may be used for Tier B networks below 16 ha.

6.8.6 **Invert and soffit levels.** Where pipe size increases at a manhole, the soffits (crowns) of the incoming and outgoing pipes shall be matched, or the outgoing soffit set lower. The outgoing invert shall not be higher than the lowest incoming invert. Vertical drops in manholes shall follow Chapter 9, Clause 9.12.

6.8.7 **Gates and valves.** The head loss through flap gates and non-return valves in the open position shall be included in the HGL (Chapter 9, Clause 9.10).

6.8.8 **Private connections.** Building drainage that connects to a public drain whose 1% HGL is above the building's lowest drainage fitting shall have a non-return valve.

> **Commentary.** The 0.3 m clearance between the minor-event HGL and the inlet rim is set by this Manual. It keeps a margin for losses that a model underestimates, and it stops water from bubbling out of inlets in the event the system is designed for. In Jammu and Kashmir many town drains end in the sump of a dewatering station behind the Jhelum's embankments, in a khad whose bed moves, in a river held high by a storm or a dam release, or in a lake whose outlet the river shuts (Clause 5.8.5). Srinagar's drains end at the drainage pumping and gravity stations along the Jhelum, the flood spill channel and the Dal (89 in the Srinagar Master Plan 2035 of 2019; 104 permanent dewatering stations in 2026, as reported), whose gates are shut once the river reaches its flood-declaration stage; Jammu's end in the khads of the Kandi and in the Tawi, which set a new highest level at Sidhra on 26 August 2025; and the drains of the Chenab valley towns end in the Chenab and its nallahs. No flood level of any khad or nallah, and no design level of any outfall, was found during research. A drain whose HGL is started from a free outfall, or computed one length at a time without the river, the sump or the lake level, fails in exactly that way. An HGL computed from the outfall, with the tidal tailwater of Chapter 5, exposes those errors at design stage. The MHWS plus 0.3 m starting level is from CPHEEO (2019) Table 6.2. The access-hole method is described in HEC-22 from the 2009 edition onward.

6.9 Major system: overland flow paths, easements and drainage reserves

6.9.1 **Streets as the primary major system.** Streets shall be graded so that the 1% AEP major-system flow is carried along the road reserve to a receiving waterway without being trapped, except at sags designed under Clause 6.10.

6.9.2 **Overland flow paths outside streets.** Where a major-system path leaves the road reserve, it shall be:

- (a) in public land, in the open space of a layout, or in an easement recorded on the layout approval and the title;
- (b) at least as wide as the 1% AEP flow top width plus 0.5 m on each side, and not less than 3.0 m;
- (c) kept free of buildings, compound walls, fences, fill, stored materials and planting that would obstruct flow;
- (d) graded to a continuous fall with no sag that lacks an outlet; and
- (e) within the hazard limits of Table 6.3.

6.9.3 **Compound walls.** A compound wall or fence shall not be built across a mapped overland flow path. Where a wall must cross one, it shall have openings with a total area that passes the 1% AEP flow with a 50% blockage, without raising the upstream water level above the limits of this chapter.

6.9.4 **Access along open drains.** Open drains with a top width of 2 m or more shall have a maintenance access strip at least 3.5 m wide along one bank, connected to a public road at intervals of not more than 500 m.

6.9.5 **Supply channels, surplus courses and tanks.** Tank supply channels and surplus courses are part of the major system and shall be protected under Chapter 7.

6.9.6 **Drainage reserves.** A drainage reserve is a strip of land, including the drain, kept free of buildings so that the drain can be maintained, widened and used as a flood path. A drainage reserve shall be provided:

- (a) along every public drain or channel with an internal width of 1.0 m or more that runs through or along a layout or site being developed or redeveloped;
- (b) along every drain or channel shown in an adopted Basin Stormwater Master Plan (Chapter 11), at the width of the future drain in that plan; and
- (c) along every new public drain with an internal width of 1.0 m or more built by a public body.

6.9.7 **Width.** The reserve shall be not less than the width in Table 6.9, measured from the drain's internal width W. The width is based on the **required** drain size (for a planned drain, the size in the master plan), not the existing size. Where the access strip of Clause 6.9.4 is wider than the margin in Table 6.9, the wider governs.

Table 6.9 — Minimum drainage reserve width (adopted from PUB Singapore)

Internal width of drain, W	Open drain	Closed (covered) drain
1.0 m to 1.2 m	3.0 m	W + 0.6 m
more than 1.2 m to 3.0 m	W + 2.6 m	W + 1.6 m
more than 3.0 m to 4.5 m	W + 3.5 m	W + 1.6 m
more than 4.5 m to 6.0 m	W + 4.5 m	W + 3.0 m
more than 6.0 m to 9.0 m	W + 6.0 m	W + 3.0 m
more than 9.0 m to 25.0 m	W + 7.5 m	W + 3.0 m
more than 25.0 m	W + 12.0 m	W + 3.0 m

For an open drain, the larger part of the margin shall be on the side used for maintenance access.

6.9.8 **Use and protection.**

- (a) The reserve shall be shown as a separate plot on the layout or site plan and transferred to the Approving Authority free of cost, as roads and open space reservations are. Where the drain is an I&FC channel, the reserve is transferred to I&FC.
- (b) No building, compound wall, fence, ramp, step, fill or other structure shall be built in the reserve. Compound walls and boundary fences shall stand outside it.
- (c) The access strip in the reserve shall be level and continuous, and connected to a public road. Bollards or posts and chains may be used at entrances to keep out vehicles other than maintenance vehicles.
- (d) Where the reserve is not fenced off, its edge shall be marked with concrete markers at not more than 50 m spacing.
- (e) Services shall cross under the drain, with at least 1.0 m clearance below the invert, or over it on an approved structure. Services shall not run along the reserve inside the drain section.
- (f) A structure within 2 m of the edge of the reserve shall be designed to remain stable when the drain is excavated to 1.0 m below its invert. The design shall be signed by a qualified structural engineer.
- (g) The reserve counts toward the site's open space requirements only where the Approving Authority's rules allow it; it does not reduce any setback required by Chapter 7.

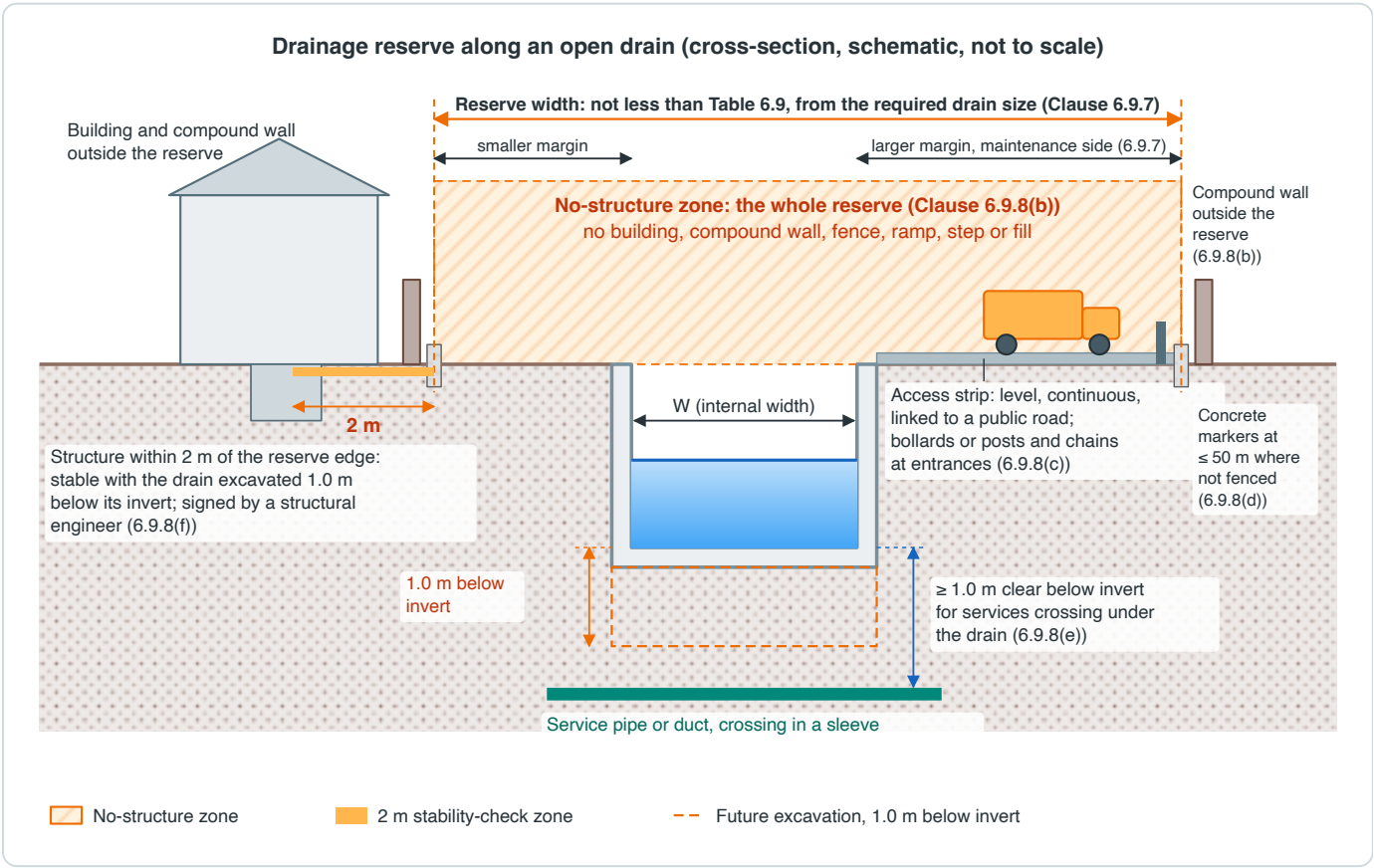

Figure 6.4 — Drainage reserve along an open drain: reserve width from Table 6.9, no-structure zone, access strip on the maintenance side, the 1.0 m service clearance below the invert and the 2 m stability-check zone (Clauses 6.9.6 to 6.9.8). Original drawing for this Manual, adapted from PUB Singapore, Code of Practice on Surface Water Drainage (7th ed., with Addendum No. 3, 2025), clauses 5.1, 5.3, 9.6 and 9.7 and Appendix 1.

Commentary. Drainage reserves follow Singapore, where "the width of a drainage reserve is based on the required drain size" and the reserve is set aside as a separate plot, "kept free of all encumbrances" (PUB Code of Practice on Surface Water Drainage, 7th ed. with Addendum No. 3, 2025, cl. 1.1). Table 6.9 reproduces PUB's Appendix 1 widths. Clauses 6.9.8(b) to (f) follow PUB clauses 5.1 (no structure within a drain or drainage reserve), 5.3 and 5.3.1 (stability for excavation 1.0 m below the invert; engineer's calculations within 2 m of the reserve), 9.6 (level,

continuous access, with bollards or posts and chains) and 9.7 (markers at a maximum of 50 m). The 1.0 m clearance for services crossing under a drain is from PUB's development-plan guidance. In Jammu and Kashmir, buildings and compound walls are often built up to the edge of a drain, so it cannot be widened or desilted by machine. Reserving the land when a plot is developed or redeveloped is the cheapest time to secure it, because widening later needs land acquisition. Basing the width on the master-plan drain size (6.9.6(b)) protects the land a future drain will need. Jammu and Kashmir has wide statutory distances from water, measured from three different lines, but no reserve width along a drain and no notified flood line. The Unified Building Bye-Laws bar development "from the edge of the bank of rivers" within 50 m of the Chenab, the Jhelum, the Tawi, the Ravi and the Ujh "or any other river/khad", within 30 m of Mansar, Surinsar, Wular, Nigeen, Manasbal "and other lakes", and within 20 m of unlisted rivulets, tributaries and minor canals such as the Ranbir and Sindh canals, "or as per building regulation whichever is more" (UBBL-2021 (as amended), cl. 7.12(b)); they leave talabs and village tanks to the distance "as may be prescribed" (cl. 7.12(c)); and they keep a green buffer along nallahs and rivers of "minimum 30 m from the highest water level or as provided in the master plan/zonal development plan or as provided under Water Regulatory Act, whichever is more" (cl. 5.2.5). The Srinagar Master Plan 2035 measures its buffers from the edge of the water: 50 m on the Telbal and Sind nallahs, 20 m on the Doodhganga, Nallah Amir Khan and the other feeder nallahs and channels, 200 m on the south, north and west sides of Anchar and 30 m on its east, 200 m on the south and west sides of Hokersar and 50 m on its east and north, 100 m at Nambal Narkur and 20 m at other small water bodies (Tables 8-2 and 8-3), and 100 m around unlisted wetland reserves (§8.2.3), with the buffers of the Dal, Nigeen and the lakes linked to them "subject to the outcome" of the public-interest litigation before the High Court. The Jammu Master Plan 2032 measures from the "Full Tank Level": 50 m on the Tawi, the Devak and the Basantar (30 m in built-up areas), 15 m on the Balol, Thather and Bhalwal khads, and 5 m on the other water bodies shown in the plan (§7.3.3); where the bye-laws apply, their 50 m from the edge of any khad and 30 m from the highest water level along nallahs override the plan's 15 m and 5 m, because each instrument applies "whichever is more". The High Court keeps 200 m free of construction around the Dal (PIL 159/2002, order of 19 July 2002, as quoted; a judgment of 30 October 2025 is reported to keep it, and was not read) and ordered the same around the Wular in November 2020 (as reported), and LAWDA, now LCMA, applied 200 m at Nigeen (order of 14 June 2021, as quoted). The Union Territory has two statutory routes to flood zoning and has used neither: the Jammu and Kashmir Flood Plain Zones (Regulation and Development) Act 2005 comes into force only on a date that the Government appoints by notification (s.1(3)), and no such notification was found; and Part VI of the Jammu and Kashmir Water Resources (Regulation and Management) Act 2010 provides for flood basins declared after survey, objections and notification, none of which was found [TBC]. The Srinagar Master Plan's proposal to notify the 25-year floodplain from Lelhar to Lasjan as a "Protected Natural Flood Absorption Basin" (§14.4.4.2) remains a proposal. Where a flood basin is notified under Part VI of the 2010 Act, or a flood plain zone under the 2005 Act, its restrictions govern; until then the mapped design flood line of Chapter 7 applies (set by this Manual). The 2010 Act puts the control of the bed and banks of all water sources, including "city channels and flood spill channels", under I&FC (s.81, by the section numbering of a title index, to be confirmed against an official copy [TBC]), and the High Court, which has called itself "Custodia Legis of river Jhelum and other water bodies", has directed that the original width of the Jhelum be restored (24 February 2015) and that "no construction of any kind is raised near the water bodies" (10 June 2016) (both as quoted in its order of 29 May 2024 in PIL 8/2017). In Jammu much of the drainage land is recorded in the revenue records as Gair Mumkin Khad (land recorded as uncultivable khad bed), which the Jammu Master Plan 2032 finds covers "more than thirty percent of the JDA land" and proposes to reduce to the "true Khad" identified with I&FC (§12.2.3). This Manual requires that no land recorded as Gair Mumkin Khad, nallah, nambal or waterbody be released for building until a hydraulic study of the functional khad or channel, for the 1% AEP flow with the bulking factor of Clause 6.3.6(b), has fixed its design flood line and the corridor of this clause, and I&FC has accepted it; the plan's own condition, "adequate buffer zones along all the drainage channels in accordance with the size, importance, and expected discharge", asks for the same (set by this Manual). For this Manual, as its own proposal and not as the meaning of the rules, the bank of a channel is its top of bank, and the edge of a lake, nambal, talab or reservoir is the higher of its full or maximum level and its monsoon water line (Chapter 7, definitions after Clause 7.2); each statutory distance is measured from its own line, and the widest result governs; every khad, nallah and khul that drains 8 ha or more is a natural channel under Clause 7.4.1(b), whoever maintains it and whether or not it is lined, piped or covered; and land recorded in the revenue records as a river, khad, nallah, nambal or waterbody is part of

the channel or waterbody whatever its present use (all set by this Manual). This Manual therefore gives the reserve a width, as its own proposal and not as a statutory width: a **hydraulic corridor** made up of the reserve of Table 6.9, based on the drain size needed to carry the design flow, with the bulking factor of Clause 6.3.6(b) where it applies (Clause 6.9.7), the access strip of Clause 6.9.4 on the access bank, and, along a river, khad, nallah or khul that drains 8 ha or more, the setbacks of Clause 7.4 measured from its top of bank, with a Zone 1 of at least 15 m. The corridor applies only where nothing wider binds: where the bye-laws, a master plan, a court or a notified flood basin sets a wider line, that line applies for as long as it binds (Chapter 7). It should be shown in the master plans and zonal plans made under the Jammu and Kashmir Development Act 1970 as non-developable land along drainage lines, and checked at building permission, where the site plan already has to show "any water body, flood affected areas" (UBBL-2021, cl. 2.6(b)(xi)) and the registered technical person already certifies that the site is clear of drains and water bodies (cl. 2.18), rather than made a new NOC.

The reserve matters because the drains of Jammu and Kashmir's towns are divided among owners, and no rule divides them. In Srinagar the Urban Environmental Engineering Department (UEED) plans, designs and builds the sewerage and drainage works of urban areas (Srinagar Master Plan 2035, §13.3), and the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir (DULBK) run drains in the city; the Srinagar Master Plan 2035 counts about 50 drainage schemes with 118,663 m of primary and secondary drains and 89 drainage pumping stations, 38 lift, 21 gravity and 30 lift-cum-gravity (February 2019), and H&UDD told the Legislative Assembly in February 2026 of a storm-water network of about 650 km with 104 permanent dewatering stations of about 2,300 cusecs and 281 mobile units (as reported): the counts are of different things on different dates and are not merged here. In Jammu the Sewerage and Drainage Division (West) of UEED works within the limits of JMC, while still holding some schemes outside them, and JMC cleans the city's nallahs and deep drains, 191 nallahs and 143 deep drains before the monsoon of 2020 (as reported); the roadside drains serve as the storm drains, and only 20% of the roads have side drains, covering about 40% of the city (Jammu Master Plan 2032, §5.1.3). I&FC holds the rivers, nallahs, khads, embankments, flood spill channels and city channels; the Public Works (R&B) Department and NHAI hold the roads and their drains, culverts and scuppers; LCMA manages the Dal and Nigeen, and WUCMA the Wular and its feeder channels; the Wildlife Department holds the wetland conservation reserves; SDA, JDA, the J&K Housing Board and the Smart City companies of Srinagar and Jammu build drains in their schemes; NHPC and JKSPDC hold the dams on the Chenab; and the Revenue Department keeps the records in which drainage land appears as Gair Mumkin Khad, nambal, rakh or kahcharai. No rule dividing the khads and natural nallahs from the municipal drains was found during research. For the purposes of this Manual, and until the Union Territory issues such a rule [TBC], the drains are assigned as follows: rivers, among them the Jhelum, the Tawi, the Chenab, the Ravi, the Ujh, the Basantar and the Devak, with their beds, banks, embankments and floodplains, the nallahs and khads, the flood spill channel and any supplementary channel, the city channels, among them the Tsunth Kol and the Padshahi Canal, and the canals and zamindari khuls, to **I&FC**, with the land as the Revenue Department records it, and with the municipal body desilting and clearing the nallahs and khads within its limits that it cleans now, under a written arrangement with I&FC [TBC]; Srinagar's drainage schemes, drains and dewatering stations to **UEED** for planning, design and construction, and to the **Town Drainage wing of SMC or of DULBK** that operates each of them for operation and maintenance, as the GIS drainage asset register of Clause 10.14.3 records [TBC]; the drains within the limits of JMC to **JMC**, and the schemes that the **UEED Sewerage and Drainage Division (West) Jammu** builds or holds to that division until they are handed over; the drains of every other town to its **Municipal Council or Municipal Committee**; drains built by SDA, JDA, the J&K Housing Board, a Smart City company or a colony developer to the body that built them until they are handed over in writing, and then to the local body; the road drains, catch-water drains, scuppers and cross-drainage of the roads of the **Public Works (R&B) Department** to that department, or to the local body that owns the road, and of national highways to **NHAI**; the Dal and Nigeen, with the drains that LCMA holds in its area, to **LCMA**, and the Wular and its feeder channels to **WUCMA**; the wetland conservation reserves, among them Hokersar, Shallabugh and Hygam, to the **Wildlife Department**, and the wetlands under the Wetlands (Conservation and Management) Rules 2017 to the **J&K Wetland Authority**; the reservoirs and their drawdown land to **NHPC** (Salal and Dul Hasti, and Pakal Dul through its joint-venture company), **JKSPDC** (Baglihar) and the operator of the Ranjit Sagar dam; sewers, interceptors and the interception of nallahs to **UEED** (Clause 8.9); and springs used for supply to the Jal Shakti Department (PHE) or to the local body that uses them (all set by this Manual). Under Clause 6.9.8(a), the reserve along a channel assigned to I&FC is transferred to I&FC. Where a channel's status is

disputed, the corridor follows the channel and not its name or its revenue entry. No approved city drainage master plan with a design return period was found for any town in the Union Territory: the Drainage Master Plan and DPR for 767 km² of Srinagar (Egis India, 2023) publishes none (as reported), and the Jammu Master Plan 2032 leaves the storm-water DPR to be prepared "immediately after the approval" of the plan (§11.1.3). A drain sized to fit the land left beside it cannot be enlarged, which is why the reserve is based on the required size. Until a Basin Stormwater Master Plan is adopted (Clause 6.9.6(b)), the required drain size of Clause 6.9.7 is the size computed by the designer under this chapter. This Manual does not prescribe a lined or an unlined section, except where Clause 6.3.6(e) and Chapter 9 require lining on steep gradients. It requires the section to meet the velocity limits of Clause 6.7.3 and Chapter 9, and a reserve wide enough for an unlined or vegetated section is a reserve that keeps both options open.

Commentary. Requirements 6.9.2(b)–(e), 6.9.3 and 6.9.4 have no direct precedent and are set by this Manual. Compound walls around individual plots are almost universal in Jammu and Kashmir and are one of the most common ways that overland flow paths get blocked. The 50% blockage assumption for wall openings is set to match the grate clogging factor of Clause 6.6.3. The 3.5 m access width is set by this Manual, sized for a small excavator or desilting vehicle. For comparison, APWA 5600 (2006, 5608.4) requires a 15 ft (about 4.6 m) maintenance access strip for detention facilities.

6.10 Ponding at sags and low points

6.10.1 **Minor event.** At every sag, the minor design flow shall be removed by inlets (after clogging) with ponded spread within Table 6.2.

6.10.2 **1% AEP event.** At every sag:

- (a) the ponded depth shall not exceed 350 mm at the deepest point of the carriageway;
- (b) a surface overflow route shall be provided (for example over a lowered kerb and footpath into a designated overland flow path), so that the ponding level cannot rise above the overflow level; and
- (c) building floor levels around the sag shall comply with Clause 6.11.

6.10.3 **Fully-blocked check.** At sags, the 1% AEP ponding level shall also be computed with the minor system fully blocked and all flow leaving by the surface overflow route. Floor levels around the sag shall be set from the higher of the two ponding levels.

6.10.4 **Trapped sags.** Where a sag has no surface overflow route, the inlets and conduits (after clogging) shall carry the 1% AEP flow, and the approving authority shall agree the arrangement.

6.10.5 **Road underpasses.** Underpasses and other trapped sags on public roads shall:

- (a) be drained by a minor system (with pumping under Chapter 9, Clause 9.9, where gravity drainage is not possible) designed for the 2% AEP (50-yr) flow, checked at the 1% AEP flow;
- (b) have flanking inlets at both approaches to intercept flow before it reaches the low point;
- (c) be protected from inflow from surrounding streets by raised approach crests where practicable; and
- (d) have depth markers and automatic warning or closure signals that operate at 150 mm depth on the carriageway.

Commentary. The fully-blocked check, the trapped-sag rule and the underpass requirements have no direct precedent and are set by this Manual. No record of a flooded road underpass in the Union Territory was found during research [TBC]. The roads already act as the major system, and in the hills as its steepest part: in August

> 2025 four bridges in Jammu, among them the bridge at Bhagwati Nagar, were damaged (as reported), and at Pernote in Ramban district the slope failure of April 2024, which the Geological Survey of India attributed in part to the "ingress of surface runoff through these cracks", affected the Ramban–Gool road (GSI note annexed to the JKPCC compliance report in NGT O.A. 642/2024). Clause 6.10.5(d) links the 150 mm crown depth limit of Table 6.2 to the point at which traffic should stop.

6.11 Building floor levels

6.11.1 The lowest habitable floor, and every opening through which water could enter a building (doors, ventilators, basement ramps, lift pits and service entries), shall be at least **0.5 m above the 1% AEP flood level**.

6.11.2 The 1% AEP flood level is the highest of:

- (a) the 1% AEP major-system water level in the street or overland flow path next to the building (Clauses 6.9 and 6.10, including the fully-blocked check at sags);
- (b) the 1% AEP flood level of any river, channel, tank or waterbody (Chapter 7); and
- (c) the 1% AEP level with the tailwater of Chapter 5; and
- (d) where the Approving Authority has adopted a 1% AEP flood depth map under Clause 7.3.4, the ground level at the plot plus the mapped 1% AEP depth.

6.11.3 **Default where no level has been computed.** For a plot below the Chapter 1 thresholds, or where no 1% AEP level has been computed for the plot, the lowest habitable floor and openings shall be at least the higher of:

- (a) **0.65 m above the highest crown level of the road on which the plot fronts**; and
- (b) where an adopted 1% AEP flood depth map covers the plot, **the ground level plus the mapped 1% AEP depth plus 0.5 m**.

The Approving Authority may adopt a regional map, such as a State-approved map or a published national map of modelled 1% AEP flood depth (for example the India Flood Atlas), until a local study replaces it. A map that does not model storm surge shall not be used in place of Clause 6.11.6.

6.11.4 **Basements.** The crest of every basement ramp and the sill of every basement opening shall meet Clause 6.11.1. Basement drainage shall be pumped to the surface drain through a non-return valve.

6.11.5 **Services.** Electrical panels, transformers, standby generators, lift machinery and pumps that serve a building shall meet Clause 6.11.1.

6.11.6 **Coastal band.** The coastal band is the land within **500 m** landward of the High Tide Line along the sea front, as defined by the CRZ Notification, 2019, with the High Tide Line as demarcated in the approved Coastal Zone Management Plan. Where the Survey of India Hazard Line lies further inland than 500 m, the band extends to the Hazard Line. Within the coastal band, in addition to Clauses 6.11.1 to 6.11.5:

- (a) the lowest habitable floor and every opening shall also be at least **0.5 m above the coastal flood level**, which is the 1% AEP still-water level (Clause 5.7.3(b), Annex 5A) plus **twice** the sea-level allowance of Clause 5.7.4 (so at least 0.6 m), because buildings have a design life of more than 50 years (Clause 5.7.4(c));
- (b) where the plot fronts the open beach, the coastal flood level shall include wave set-up from a site study;
- (c) no habitable room, electrical service room or plant listed in Clause 6.11.5 shall be placed in a basement; and
- (d) every basement opening, ramp crest and ventilation opening shall meet Clause 6.11.6(a).

Clause 6.11.6 does not authorise any construction that the CRZ Notification prohibits. Where both apply, the stricter governs.

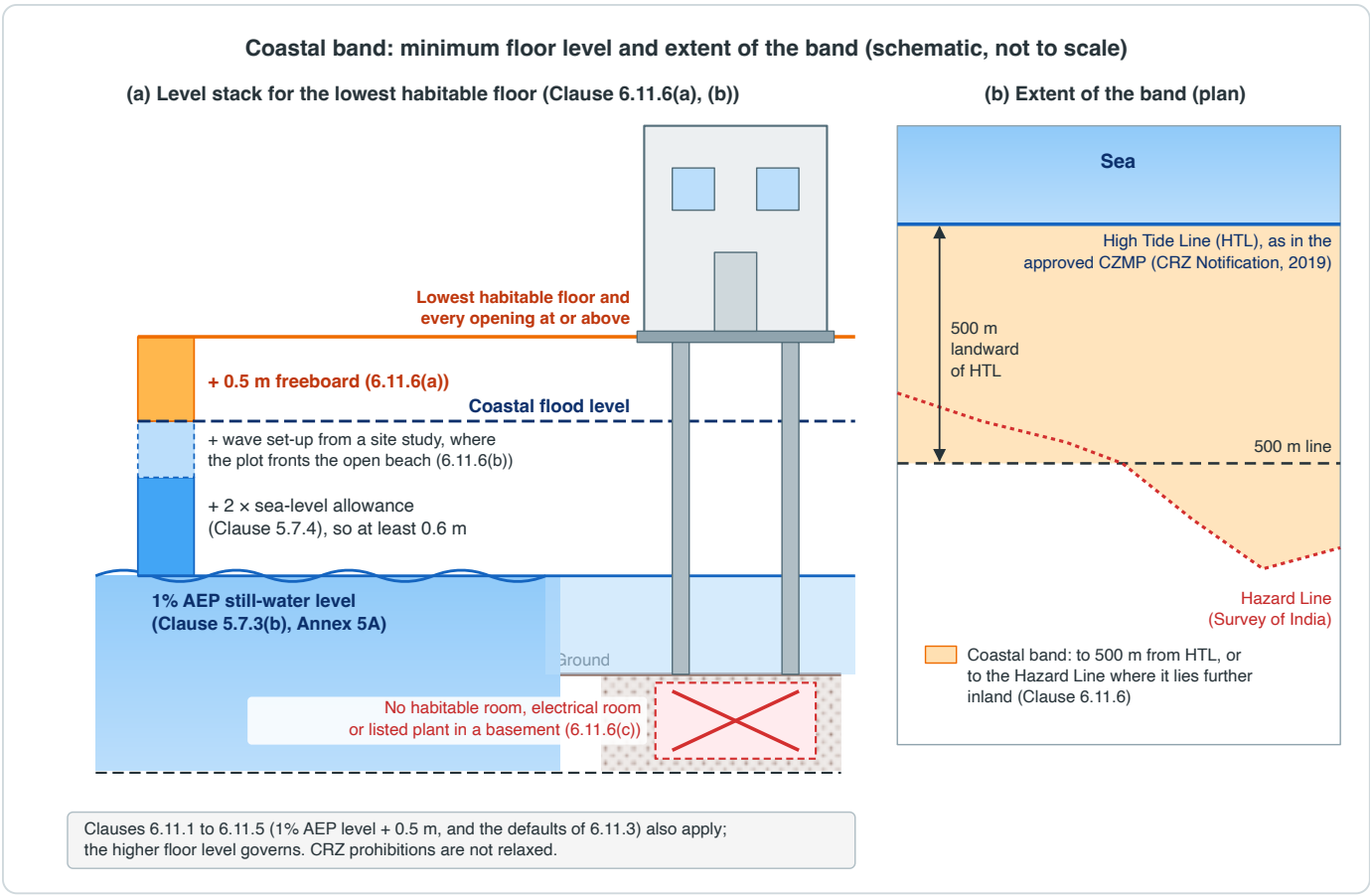

Figure 6.5 — Coastal band: the minimum floor level built up from the 1% AEP still-water level, twice the sea-level allowance, wave set-up where the plot fronts the open beach and 0.5 m freeboard; and the extent of the band, to 500 m from the High Tide Line or to the Hazard Line where it lies further inland (Clause 6.11.6). Original drawing for this Manual, adapted from the CRZ Notification, 2019 (para 1(i) and Annexure IV) and PUB Singapore, Code of Practice on Surface Water Drainage (7th ed.), cl. 2.1.1.

Commentary. The 0.5 m freeboard above the 1% AEP level follows the DID Malaysia 2008 checklist (platform and lowest floor at 100-yr ARI + 0.5 m). It is more than the APWA 5600 (2006, 5601.8 A2) requirement of 1 ft (about 0.3 m) above the 1% stage. The 0.65 m default in Clause 6.11.3 is derived from the other limits of this chapter, not separately sourced: the 1% water level at the crown may be up to 150 mm (Table 6.2), plus the 0.5 m freeboard. It has no direct precedent and applies to plots where no flood level exists. URDPFI (2015) also links minimum plinth levels to flood frequency in its flood-plain zoning, which is covered in Chapter 7.

Clause 6.11.3(b) lets a small plot use a mapped 1% AEP depth where no local study exists, instead of guessing from the road level alone. Modelled national maps are coarse (about 30 m), and most model rainfall and river flooding but not storm surge, which is why 6.11.3 keeps the road-crown check and Clause 6.11.6 sets a separate coastal rule.

The coastal band of Clause 6.11.6 uses the 500 m line of the CRZ Notification, 2019 (G.S.R. 37(E), para 1(i): "the land area from High Tide Line ... to 500 meters on the landward side"), because every coastal authority already maps it and it needs no new survey. The Hazard Line, demarcated by the Survey of India to show the extent of flooding and shoreline change, extends the band where it lies further inland (CRZ Notification, 2019, Annexure IV). The band takes the coastal level from the joint-case still-water level of Chapter 5 rather than from the rainfall map. The higher standard reflects the setting: a coastal flood rises with the sea, cannot be drained while the tide is up, and will rise further with the sea. Singapore takes the same approach with a fixed minimum platform level of 4.0 m above datum on its southern coast and 4.5 m on its northern coast, whatever the rainfall flood level (PUB Code of Practice on Surface Water Drainage, 7th ed., cl. 2.1.1). Each coastal State's tide and surge levels vary too much along its coast for one fixed level, so this Manual uses the computed still-water level instead. Using twice the sea-

level allowance applies the sensitivity case of Clause 5.7.4(c) as the design case, because a building, unlike a drain, cannot easily be raised later. The basement restriction in 6.11.6(c) is set by this Manual: a basement in the coastal band fills from the sea as well as from rain, and cannot be pumped out to a tide-locked outfall. Jammu and Kashmir has no coast, no High Tide Line and no Coastal Regulation Zone, so the coastal band is empty in the Union Territory and Clause 6.11.6 does not apply there. Clauses 6.11.3 and 6.11.4 matter instead. The building rules give two plinth figures and no flood level: a plinth of not less than 45 cm (UBBL-2021, cl. 6.1) and a ground-floor finish "Consistent 300 mm from centre of Road Line" (Table 5-9), which this Manual has not reconciled; the stricter applies [TBC]. Basements are kept within the building envelope and barred from habitable use (cl. 5.2.1.7), with no rule on their flooding or drainage, and building in areas vulnerable to floods is left to I&FC or to "the flood zonation maps notified by the department from time to time" (cl. 7.12(a)), none of which was found during research. Clause 6.11.3, which sets the lowest habitable floor and every opening 0.65 m above the road crown where no flood level has been computed, and Clause 6.11.4, which applies the same level, or 0.5 m above the 1% AEP flood level, to the crest of every basement ramp and the sill of every basement opening, are set by this Manual; both are stricter than the bye-laws, which they add to and do not replace. On the Kashmir valley floor behind the Jhelum's embankments, the 1% AEP flood level of Clause 6.11.2 includes the maximum level in the drained area from the outfall-closed routing of Clause 5.8.5(a), with the river shut out for the whole lock; a breach of the embankments, as in September 2014, is a residual risk that Chapter 5 reports and does not design for. A basement on the valley floor, where the water table stands 0–2 m below ground over the central valley and wells on both sides of the Jhelum flow under artesian pressure (CGWB), also needs the flotation check of Clause 4.12 with the groundwater at ground level or at the artesian head. On a hillside the road crown is not always the right reference: a building below a road takes the road's runoff, so Clause 6.11.2(a) sets its floor and openings from the 1% AEP level of the flow path past it, with the uphill diversion of Clause 6.3.6(h) in place, and a floor or basement cut into a slope also needs the geotechnical certificate of the hill infiltration rule (Clause 4.11). Along the rivers, khads, nallahs, canals and khuls, near the lakes, nambals, talabs and springs and on the shores of the reservoirs, the lines of Chapter 7 also apply.

6.12 Culverts and road crossings

6.12.1 **Design AEP.** A culvert or bridge that carries a road over a drain or waterway shall pass the design AEP flow of Table 6.1 for that road class without overtopping the road, and with the headwater limits of Chapter 9, Clause 9.4. Where the waterway is a State highway or national highway crossing, the design AEP shall also be not less than that of IRC:SP:42-2014 §7.1.4 for the span. The rarer AEP governs.

6.12.2 **Check event and 1% AEP.** At the check event and at the 1% AEP event, the crossing and the road together shall pass the flow:

- (a) with overtopping depth ≤ 150 mm at the road crown and ≤ 350 mm at the deepest point of the road;
- (b) within the hazard limits of Table 6.3;
- (c) with no overtopping at all of arterial roads that are notified evacuation routes; and
- (d) without raising the 1% AEP flood level at any upstream building or property boundary above the level for the existing condition, unless the affected owners and the approving authority agree.

6.12.3 **Where overtopping is not permitted.** Overtopping in the 1% AEP event is permitted only where the structure span is less than 6 m **and** the 1% AEP peak flow is not more than 7 m³/s, unless a guard rail is installed downstream of the overtopping section. Otherwise, the crossing shall pass the 1% AEP flow without overtopping.

6.12.4 **Blockage check.** The 1% AEP check shall be repeated with a blocked inlet:

- (a) 50% of the inlet area blocked for culverts with a span or diameter below 1.5 m; and
- (b) 20% blocked for larger culverts.

The results of this check shall meet Clause 6.12.2(a) and (d).

6.12.5 **Minimum size.** Culverts under public roads shall be at least 900 mm in diameter, or 900 mm × 900 mm for box culverts.

6.12.6 **Hydraulic design.** Culvert hydraulics, including inlet and outlet control, tailwater, road overtopping and outlet protection, shall follow Chapter 9, Clauses 9.4 and 9.6.

> Commentary. The design AEPs are those of Table 6.1. The overtopping limits are the street-depth limits of Table 6.2. The span and flow threshold in Clause 6.12.3 is the SI conversion of APWA 5600 (2006): overtopping allowed only where the structure span is under 20 ft and the 1% peak is 250 cfs or less, unless a downstream guard fence is installed. IRC:SP:42-2014 (§7.1.4) sets 25-yr for NH/SH culverts up to 2 m span and 50-yr for 2–6 m spans. The blockage percentages in Clause 6.12.4 and the 900 mm minimum size have no direct precedent and are set by this Manual. The 50% value matches the grate clogging factor.

6.13 Jammu and Kashmir construction-practice requirements

6.13.1 **Covered roadside drains.** Where a roadside drain is covered by slabs that form a footpath:

- (a) it shall be designed as an open channel with the freeboard of Table 6.7 measured to the soffit of the cover slab, and its HGL shall meet Clause 6.8 measured to the footpath and inlet levels;
- (b) road runoff shall enter through openings in the drain wall at road level (Clause 6.6.1(b)), each with a silt sump (Clause 6.6.7), at the spacing of Clause 6.6.4;
- (c) footpath runoff shall enter through slots or grated openings in the cover, not by ponding on the footpath; and
- (d) the clear section shall meet Clause 6.7.6(c).

6.13.2 **Removable covers and access openings.** Covered drains shall have:

- (a) removable cover panels at not more than **10 m** centres, each at least 0.6 m long and spanning the full clear width, with recessed lifting points, liftable by two workers or by a hand-operated lifting device, and flush with the footpath;
- (b) access chambers with a clear opening of at least 0.6 m × 0.6 m at every junction, bend and change of section, and at not more than **30 m** centres on straight runs; and
- (c) covers rated for the traffic or pedestrian load at their location (Chapter 9, Clause 9.11).

6.13.3 **Silt traps.** In addition to the inlet sumps of Clause 6.6.7, silt trap chambers shall be provided:

- (a) upstream of every culvert under an arterial road;
- (b) upstream of every pump station and detention facility; and
- (c) at every outfall to a tank, river or other waterbody (with the gross pollutant trap required by Chapter 8).

Each silt trap shall be sized to hold the sediment expected between scheduled cleanings, using the sediment yield in Annex 6B, and shall be reachable by a desilting vehicle.

6.13.4 **Garbage and gross pollutant screens.** Screens shall be provided where an open drain enters a covered drain, a pipe or a culvert, and at outfalls under Chapter 8. Each screen shall:

- (a) be designed under Chapter 9, Clause 9.8;
- (b) have a bypass or overflow, so that a fully blinded screen does not flood properties or the road beyond the limits of this chapter; and
- (c) be checked hydraulically with 50% of its area blocked.

6.13.5 **No building over drains.** No structure other than an approved crossing or a removable cover shall be built over a public drain. Shop frontages, ramps and steps that cross a drain shall be removable or shall leave access openings that meet Clause 6.13.2.

6.13.6 **Utilities.** No water main, sewer, power or telecom cable, gas pipe or duct shall be laid along, or pass through, the flow area or freeboard of any drain. A utility that must cross a drain shall:

- (a) cross above the cover soffit or below the drain invert, inside a sleeve; and
- (b) be shown on the drainage plan with its level.

Where an existing utility crossing obstructs a drain, its area shall be deducted from the drain section, with a 50% blockage allowance for the debris it traps, until the utility is relocated. The utility owner shall relocate it when the drain is rebuilt.

6.13.7 **Sewage.** No sewage connection is permitted to a storm drain (Chapter 8). Covered drains shall be built with sealed joints where they run next to sewers.

6.13.8 **Edge protection.** Open drains deeper than 1.0 m beside a footpath, a carriageway or a public open space shall have railings or barriers. Open drains of any depth shall not be left uncovered across a footpath.

6.13.9 **As-built levels.** The as-built invert levels of every public drain, pipe and manhole shall be surveyed and submitted (Chapter 10). Inverts shall be within ±15 mm of design. An HGL re-check shall be submitted where they are not.

6.13.10 **Desilting.** Public drains shall be desilted before the south-west monsoon each year, as set out in Chapter 10.

> Commentary. Clause 6.13 has no direct precedent; this Manual sets it on the basis of Jammu and Kashmir practice. Most urban drains in the State are covered roadside drains under footpaths. They are often built with continuous cast-in-situ slabs and few openings, so they cannot be cleaned and fill with silt and solid waste within a season. CPHEEO (2019) notes that uncovered channels "are prone to the dumping of garbage" (Part A, Ch 2), which is why the drains are covered. Covering without access openings simply moves the problem out of sight. NDMA (2010) recommends that pre-monsoon desilting be complete by 31 March. Jammu and Kashmir has two rainfall regimes, and the desilting calendar has to serve both. In the Jammu division the south-west monsoon normally sets in on 28 June and withdraws on 21 September (IMD normals for Jammu), but it set in as early as 13 June in 2021 (as reported), it withdraws from most of the Union Territory only by about 1 October, and storms come after it: Jammu recorded 160.0 mm on 5 October 1955 and Basohli 229 mm on 14 October 1955 (IMD; CWC, 1994). On the floor of the Kashmir valley only about 30% of the year's rain falls in June to September, and the wettest month is March (IMD normals for Srinagar); the western disturbances of December to April and the snowmelt of March to May raise the lakes and the water table, and the largest floods of both divisions, in September 1988, 1992 and 2014, came when monsoon moisture met a western trough (Chapter 2). The only directions found are that JMC's "first phase of de-silting shall be completed before the end of June" (2017), that 191 nallahs and 143 deep drains be cleaned before the monsoon (2020), and that SMC dewater the city after the snowfall and snowmelt of January 2026 (all as reported); no desilting order of H&UDD or of a Municipal Corporation with a completion date was found during research [TBC]. So Clause 6.13.10 refers to the south-west monsoon, and Chapter 10 requires, across the Union Territory, desilting and the clearance of debris from drains, racks, traps and culverts to be complete by 31 May; inlets, debris racks, culverts, flap gates and pumps to be certified ready and test-run by 15 June (Clauses 5.11.5 and 5.12.9), before the earliest recorded onset; and standby to continue until 31 October, because of the late withdrawals and the October storms. In sub-area JK-C it also requires the inlets to be cleared of snow and ice and every dewatering station to be run at full duty by 15 March, ahead of the western-disturbance maximum and the snowmelt, a second clearance of the drains by 15 August, ahead of the storms of late August and September, and the pumps to stand by from 1 March to 31 October and to be on call in a winter snowmelt; in the hill towns of sub-areas JK-B, JK-B1 and JK-D, a second clearance of debris racks, traps and culverts after the monsoon, by 31 October, because every storm in the hills fills them; and in towns above about 1,500 m, inlets kept clear of snow and ice from December to March. These dates are set by this Manual.

No rule of the bye-laws on building over a drain was found, and the drainage sections of the Jammu and Kashmir Municipal Corporation Act 2000 and Municipal Act 2000 were not read [TBC]. The bye-laws let the Authority require roof water to be carried "to a covered channel formed beneath the public footpath" (UBBL-2021, cl. 6.20), which is a covered drain under Clause 6.13.2. Natural drains, khads and nallahs are open channels with a drainage reserve (Clause 6.9), and should not be covered, decked or built over: the Jammu Master Plan 2032 found that "the drainage channels have fallen prey to the accelerated urban growth" and calls for an EIA "before training and covering the drainage channels" (chapter 1 and §7.3.2), and the High Court has directed that "no construction of any kind is raised near the water bodies" (PIL 8/2017, quoting its order of 10 June 2016). Where a drain is covered, Clause 6.13.2 applies to it in full; where it is open beside a footpath or a carriageway, Clause 6.13.8 applies. In the hill towns many drains run beside steps and footpaths on steep ground, where an open drain is a fall hazard and a covered one cannot be cleared of stones without its access openings.

Clause 6.13.7 is not yet the practice. In Srinagar 62.01 MLD of the 193.34 MLD of sewage generated was treated in 2024, 32.07%, and untreated sewage "gets entry into the Dal Lake from areas like Telbal, Lalbazar" (JKPCC, NGT O.A. 504/2024, 14 August 2024); in Jammu "Storm water drains carry considerable quantities of raw and untreated effluents", and the BOD of 90% of the city's drains is that of "weak to strong domestic sewage" (Jammu Master Plan 2032, §5.1.3); and in October 2025 CPCB listed seven polluted stretches in the Union Territory, among them the Chunt Kol in Srinagar, the Jhelum from its confluence with the Vishav to Baramulla, the Tawi from the Tawi Bridge to the Balol Nallah, the Basantar at Samba and the Devak at Udhampur (CPCB, as filed by JKPCC in NGT O.A. 413/2025). Clause 8.9 sets how dry-weather flow in storm drains is surveyed and intercepted until the connections are removed, including the rule that interception shall not reduce the capacity of the drain (Clause 8.9.5(b)).

The 10 m and 30 m spacings and the ±15 mm tolerance have no direct precedent and are set by this Manual. Clause 6.13.6 responds to the common sight of water mains and cables running through drains. Each one traps debris and reduces the section. Mechanical cleaning through cover openings, rather than manual entry, is assumed throughout, consistent with the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013.

6.14 Outfalls

6.14.1 Outfalls shall be designed for the tailwater conditions of Chapter 5. Outfalls below the 1% AEP still-water level shall have flap or tide gates or non-return valves (Chapter 5 and Chapter 9, Clause 9.10).

6.14.2 Outfall protection and energy dissipation shall be designed under Chapter 9, Clause 9.6. Outfalls to tanks and waterbodies shall also meet Chapters 7 and 8.

6.15 Submittal requirements

Every conveyance submittal shall include a **Conveyance Design Report** (Form 6-1) containing:

1. a catchment plan showing sub-catchments, the minor system, inlet locations and the major-system overland flow paths for the 1% AEP event (Clause 6.3.2);
2. the land-use and road-class AEP adopted for each element (Table 6.1), and the high-density area status;
3. design flows, with the rainfall sheet of Chapter 2 and the method of Chapter 3;
4. gutter spread, depth and D·V checks for the minor, check and 1% events (Tables 6.2 and 6.3);
5. an inlet schedule with clean capacity, clogging factor, design capacity and bypass flow (Clause 6.6);
6. pipe and drain design tables with n, velocity, sediment allowance and freeboard (Clause 6.7);
7. HGL profiles for the minor and check events, with the tailwater used (Clause 6.8);

8. sag ponding levels, including the fully-blocked check (Clause 6.10);
9. a floor-level schedule for every building (Clause 6.11);
10. culvert and crossing calculations (Clause 6.12 and Chapter 9); and
11. a utilities-crossing schedule and access-opening layout for covered drains (Clause 6.13).

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Annexes and forms

Annex / Form	Content
6A	Standard inlet types for Jammu and Kashmir with capacity curves (on grade and sag)
6B	Sediment yield for silt-trap sizing and calibration of the sediment allowance
6C	Standard drawings: covered roadside drain with removable covers, access chamber, inlet with silt sump
Form 6-1	Conveyance Design Report checklist

CHAPTER 7

Waterbodies, Lakes, Marshes (Nambals) and Talabs (Ponds) and Setbacks

7.1 Purpose and scope

7.1.1 This chapter treats waterbodies as part of the drainage system. It sets the rules for:

- (a) identifying and mapping every waterbody that a development or public work affects;
- (b) the setback zones around waterbodies, and the uses allowed in each zone;
- (c) fill in flood-prone land, and the compensatory storage needed where fill is allowed;
- (d) counting tank (talab) storage, including tank cascades, as design storage;
- (e) restoring and desilting tanks and ponds;
- (f) protecting supply channels, surplus courses, inlets and outlets;
- (g) wetlands, marshes and estuaries, which in Jammu and Kashmir, with no coast and no tidal water, means the five Ramsar sites, Wular, Hokersar, Surinsar–Mansar, Hygam and Shallabugh, the seven Wildlife Conservation Reserves of 1945, the lakes, nambals and flood basins of the Kashmir valley, such as Dal, Nigeen, Anchar, Brari Nambal, Khushalsar, Gilsar, Narkara, Rakh-e-Arth and Manasbal, any wetland notified under the 2017 Rules (none was found notified), and the wetlands of more than 1 ha outside forests listed before the National Green Tribunal in 2026;
- (h) the interface with encroachment and its removal;
- (i) fee-in-lieu contributions to regional tank storage (with Chapter 4); and
- (j) the safety of tank bunds and other embankments.

7.1.2 This chapter applies to every development and public work to which this Manual applies under Chapter 1 and that:

- (a) adjoins a waterbody or lies wholly or partly within its setback (Clause 7.4);
- (b) discharges to a waterbody, directly or through a drain, within the downstream analysis extent of Chapter 5; or
- (c) alters a waterbody, its bund, sluice, surplus weir, supply channel or surplus course.

7.1.3 Where a statute or statutory rule sets a wider setback or a stricter restriction, the statute governs (Clause 1.3.3). Nothing in this chapter authorises any work that the Jammu and Kashmir Unified Building Bye-Laws 2021 and the master plans made under the Jammu and Kashmir Development Act, 1970, the Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010, the Jammu and Kashmir Flood Plain Zones (Regulation and Development) Act, 2005 (once it is brought into force), the Municipal Acts of 2000, the Jammu and Kashmir Land Revenue Act, Svt. 1996, the Kahcharai Act, Svt. 2011, the Wildlife (Protection) Act, 1972 (for the Wildlife Conservation Reserves), the Wetlands (Conservation and Management) Rules, 2017, or any other law, prohibits.

> Commentary. Jammu and Kashmir has no Act for the protection of lakes, tanks, ponds or springs as such, but it has statutes on water and on flood land, much of which has never been brought into use. The **Jammu and Kashmir Unified Building Bye-Laws 2021** (UBBL-2021, as amended) apply to "all urban local bodies, urban development authorities and metropolitan regional development authorities" of the Union Territory, read with the master plans (clauses 1.1 and 2.1): they bar development "in area designated for water body, pond and Talav excluding River-front Development", keep development 50 m, 30 m or 20 m from the edge of the bank of rivers,

khads, lakes, rivulets and canals and a green buffer 30 m from the highest water level along nallahs and rivers (clauses 7.12(b) and 5.2.5), leave the distance from a "talab, village tanks, lake, water bodies etc." to be prescribed by the building permit issuing authority (clause 7.12(c)), and defer building in flood areas to I&FC "or the flood zonation maps notified by the department from time to time" (clause 7.12(a)); no such map was found notified (Clause 7.4, Disclosure). The **Srinagar Master Plan 2035** and the **Jammu Master Plan 2032**, made under the **Jammu and Kashmir Development Act, 1970**, add buffers round the lakes, wetlands, nallahs and khads, measured from the lake edge and from Full Tank Level. The **Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010** (Act XXI of 2010) defines a "water source" to include a "nallah, canal, spring, pond, lake" and "hydraulic works" to include "spring ponds, spring channels" and "zamindari khuls" (section 2), declares as State water policy a "complete ban on encroachment on water bodies, wetlands, water courses" (section 4), places "The control of the bed and banks of all water sources, navigation channels, intake channels, city channels and flood spill channels together with all works that affect the hydraulic conditions in the State" under the Irrigation and Flood Control Department (section 81), requires permission for any building "in the vicinity of any irrigation or hydraulic work" (section 66), and provides in Part VI for flood basins to be surveyed, delineated and declared by notification with "prohibitions and restrictions on the use of land" (sections 75 to 79); the section numbers were read from a title index, not from an official copy [TBC], and no flood basin was found declared. The **Jammu and Kashmir Flood Plain Zones (Regulation and Development) Act, 2005** (Act XVII of 2005) provides for the zoning of flood plains river by river, but comes into force only "on such date as the Government may, by notification in the Government Gazette, appoint" (section 1(3)), and no such notification was found: it is not treated as in force, and no flood plain zone exists under it. Both Acts were continued for the Union Territory by the Fifth Schedule to the Jammu and Kashmir Reorganisation Act, 2019. The lakes of Srinagar are managed by the Jammu and Kashmir **Lake Conservation and Management Authority** (LCMA, formerly LAWDA, renamed in 2021, as reported), which gives a no-objection certificate for building permission (S.O. 304 of 1 December 2025), and Wular by the **Wular Conservation and Management Authority** (WUCMA, constituted in 2012 under the Development Act); the Kashmir wetland reserves are **Wildlife Conservation Reserves** under the Wildlife (Protection) Act, 1972; and the wetlands are the concern of the **Jammu and Kashmir Wetland Authority**, constituted on 25 November 2020 (Clause 7.12, Commentary). The Revenue Department records drainage land in Jammu largely as **Gair Mumkin Khad**, and marsh and grassland as nambal, rakh and kahcharai, under the Land Revenue Act, Svt. 1996 and the Kahcharai Act, Svt. 2011, whose texts were not read. The **High Court of Jammu & Kashmir and Ladakh** has acted as the regulator of last resort: it declared itself "Custodia Legis of river Jhelum and other water bodies" (order of 24 February 2015, as quoted in its order of 29 May 2024 in PIL 8/2017 with PIL 2/2014 and PIL 18/2018) and holds a 200 m no-construction line round Dal (Clause 7.4, Disclosure). In the towns, drains are understood to vest in the municipal bodies under the Jammu and Kashmir Municipal Corporation Act, 2000 and the Jammu and Kashmir Municipal Act, 2000, whose drainage sections were not read for this Manual [TBC]. In this chapter **I&FC** means the Irrigation and Flood Control wing of the Jal Shakti Department, which holds the rivers, nallahs and khads, the Jhelum's embankments, the flood spill channel and the city channels, and reads the river gauges in feet; LCMA, WUCMA, the Wildlife Department and the dam operators hold the lakes, wetlands and reservoirs named against them in Clause 7.3.1.

This Manual treats every recorded waterbody as drainage infrastructure. Four features set Jammu and Kashmir apart. The first is the **lake and nambal system of the Kashmir valley**: Srinagar stands in a chain of lakes and marshes that "have been acting as flood retention basins" (Srinagar Master Plan 2035, §4.2). Dal, of 20.37 km² in a catchment of about 314 km², drains through the lock and weir at **Dal Gate** to the Tsunth Kol and the Jhelum, and through the **Nallah Amir Khan** to Nigeen, Gilsar, Khushalsar and Anchar, which the Sindh Nallah also feeds; the nambals downstream of the city's outfalls, **Hokersar, Narkara, Shallabugh, Rakh-e-Arth and Anchar**, are its flood-absorption marshes, and they have been lost in part to silt and building (Clause 7.12, Commentary); and **Wular** is the valley's flood basin, "a huge absorption basin for flood water" (WUCMA, 2024), at the foot of the flood spill channel. The second is the **embanked Jhelum**: when it rises, Dal Gate closes, the gravity outfalls shut and the city drains only by its dewatering stations (Chapter 5), so a lake or nambal behind the river is a store that cannot empty. The third is the **khad of the Jammu plains**: the "more than 100 small and big dry khads which have flash floods during the rainy season" of the Jammu planning area (Jammu Master Plan 2032, §7.3.2), crossing the boulder-gravel Kandi to the spring line and the waterlogged Sirowal, with the 365 Kandi ponds of Jammu and Kathua and the talabs of old Jammu, most of them now lost. The fourth is the **spring**, the nag and the cashma of

Kashmir, such as Kokernag, Verinag and Achabal, and the springs in Dal's own bed, with no rule that keeps building or drains away from them. Reservoirs on the Chenab, at Salal, Baglihar and Dul Hasti, and the new Tawi barrage at Jammu are run by their operators, and the glacial lakes of the high mountains are hazards. This chapter gives the design rules that protect the storage and conveyance of these waterbodies. It does not replace the bye-law, master-plan, water-resources, municipal, revenue, wildlife and wetland procedures that record and protect them in law, or the directions of the High Court of Jammu & Kashmir and Ladakh and the National Green Tribunal.

7.2 Definitions

Term	Meaning in this Manual
Waterbody	A river (such as the Jhelum, the Chenab, the Tawi, the Ravi, the Ujh, the Basantar, the Devak, the Lidder, the Vishav and the Doodhganga), khad (a seasonal torrent or ravine stream of the Kandi and the outer hills, dry for most of the year and boulder-laden in flood, such as the Balol, Thather and Bhalwal khads of Jammu), nallah (a natural or artificial drainage channel, such as the Telbal Nallah, the Nallah Amir Khan and the Sindh Nallah), kol (a stream or canal, such as the Tsunth Kol), city channel or flood spill channel, canal (such as the Ranbir and Sindh canals), kuhl or zamindari khul (an irrigation channel), lake or sar (such as Dal, Nigeen, Anchar, Manasbal, Wular, Mansar and Surinsar), nambal (a marsh or shallow lake choked by vegetation, such as Brari Nambal, Hokersar and Narkara), flood basin or flood-absorption marsh (such as Rakh-e-Arth and Shallabugh), talab (a pond or tank, such as the Kandi ponds of the Jammu plains), reservoir or barrage pond (such as Salal, Baglihar, Dul Hasti and the Tawi barrage at Jammu), spring (nag or cashma) with its recharge area, wetland (such as the Ramsar sites of Wular, Hokersar, Hygam, Shallabugh and Surinsar–Mansar, and the Wildlife Conservation Reserves), glacial or moraine-dammed lake, supply channel or surplus course, perennial or seasonal (as in Chapter 1).
Tank (talab)	A waterbody impounded by an earthen bund, fed by its own catchment and/or a supply channel, with a surplus weir and one or more sluices.
Tank cascade	A chain of tanks in which the surplus or sluice outflow of one tank feeds the next (as in Chapter 3).
Full tank level (FTL)	The crest level of the surplus weir (outlet weir, spillway, gate or lock) of a tank, or the permanent crest of its regulating structure. The tank holds water up to FTL without spilling.
Maximum water level (MWL)	The highest water level in a tank when the surplus weir passes the tank's design flood. For this Manual, it is the greater of the level recorded by I&FC and the level computed for the 1% AEP (100-yr) inflow with the climate factor of Clause 2.8 (Clause 7.7.4).
Top bund level (TBL)	The crest level of the tank bund.
Waterspread	The area of a tank submerged at FTL.
Foreshore	The land around a tank between the FTL contour and the MWL contour. Foreshore land is flooded whenever the tank surpluses, and is part of the tank's flood storage.
Supply channel (nallah, kol, kuhl or feeder channel)	A channel that brings water from a river, anicut or upstream tank into a tank.
Surplus course	The channel that carries the overflow of a surplus weir to the next tank, a river, a drain or the sea.
Sluice (sluice, gate, lock or regulator)	A controlled outlet through a tank bund, usually to an irrigation channel.
Top of bank	For a channel, the break in slope at the edge of the channel. Where it cannot be identified, the edge of the water surface at the 50% AEP (2-yr) flow.

Term	Meaning in this Manual
1% AEP flood extent	The land flooded by the 1% AEP (100-yr) flood with the climate factor of Clause 2.8, from a hydraulic model that meets Chapter 3 and Chapter 5, or from a map adopted by the Authority under Clause 7.3.4.
Floodway	The waterbody and the adjoining land that must be kept free of obstruction to pass the 1% AEP flood without raising the 1% AEP water level by more than **0.1 m** at any point (Clause 7.6.1). For a tank, all land below MWL.
Flood fringe	The part of the 1% AEP flood extent outside the floodway.
Zone 1 (waterbody protection zone)	The inner setback zone defined in Clause 7.4.3.
Zone 2 (flood fringe setback)	The outer setback zone defined in Clause 7.4.4.
Setback	Zone 1 and Zone 2 together.
Compensatory storage	Excavated storage that replaces flood storage lost to fill, under Clause 7.6.4.
Flood cushion	Storage below FTL kept empty, under a documented operating rule, to absorb a flood (Clause 7.8).

Jammu and Kashmir terms. The following terms are used in this chapter in addition to those above (see also Annex 7E):

Term	Meaning in this Manual
Talab (तालाब; تالاب; Kashmiri *talāv*)	A pond or tank: "Pond, pool, tank, reservoir of water" in Platts (*tālāb*), and "an artificial pond, a tank" in Grierson's Kashmiri dictionary (*talāv*) (Annex 7E). It is the word Jammu and Kashmir's own instruments use: UBBL-2021 bar development in a "water body, pond and Talav" and refer to the "talab, village tanks" (clause 7.12(c)), and the Jammu Master Plan 2032 calls for the "village ponds or talabs" to be revived for recharge. It is used here for any built pond or tank, including the Kandi ponds of Jammu and Kathua. A talab with a controlled outlet is a tank under Clause 7.2; a talab with an uncontrolled outlet has its FTL at the crest of that outlet, found by survey. Because Kashmiri *talab* (طلب) also means pay or wages, the word is always written with its script or gloss. Natural waterbodies keep their own words: a lake is a sar and a marsh a nambal, and an engineered detention basin is never called a talab, sar, nambal or nag: it is a detention pond.
Lake (sar) and lake outlet	A lake is a natural body of standing water, such as Dal, Nigeen, Anchar, Manasbal, Wular, Mansar and Surinsar. Where a lake drains through a gate, lock, weir or regulator, such as Dal Gate (a lock and weir to the Tsunth Kol) and the Nallah Amir Khan, that structure is its sluice under Clause 7.2, and its FTL is the level at which it spills over its outlet with every gate closed, found by survey and stated to the datum of Clause 7.3.5. Where the river into which a lake drains can shut its outlet, as the Jhelum shuts Dal Gate (Grierson records that the gates of the *Ḍal-darwāza* "automatically close" when the river rises), the lake is a store that cannot empty while the river is high, and a design that relies on it follows the commentary to Clause 7.8.
Nambal; flood basin; flood-absorption marsh	A nambal is "a grass-grown lake, a lake choked by vegetation, a shallow lake, a marsh, swamp" (Grierson), such as Brari Nambal, Nambal Narkur (Narkara), the Shalbug Nambal and the Drangbal Nambal. A flood-absorption marsh is a nambal, rakh or other low land that fills from the river or from a city's outfalls in a flood and empties as the river falls, such as Hokersar, Narkara, Shallabugh, Rakh-e-Arth and Anchar below Srinagar. Every nambal, flood basin and flood-absorption marsh is a wetland under Clause 7.12 and a marsh under Table 7.1, whatever its Revenue class and whether or not it is wet on the day of survey. A "flood basin" under section 2 of the Water Resources Act, 2010 is "the area which is required for carrying the flow of the floods", declared under Part VI of that Act; a "flood zone" under section 2(d) of the Flood Plain Zones Act, 2005 is the area "required to carry the flow of the maximum probable floods", a higher standard than the 1% AEP extent of this Manual, with which it is not equated. Where a flood basin is notified under Part VI, or a flood plain zone under the 2005 Act once it is in force, its restrictions govern; until then the mapped 1% AEP flood extent of Clause 7.3.4 applies. This reading and rule are set by this Manual.

Term	Meaning in this Manual
Recorded waterbody; Revenue class and surveyed extent	A lake, nambal, talab, nallah, khad, kol, khul, spring, reservoir or wetland shown in the Revenue records or village maps (including land recorded as Gair Mumkin Khad, nambal, rakh, kahcharai or water), on a site plan submitted under clause 2.6(b)(xi) of UBBL-2021, in the land use map or buffer tables of a master plan, in the records of a municipal body, UEED, I&FC, LCMA or WUCMA, in a Ramsar or Wildlife Conservation Reserve boundary, in the national wetland atlas, or in a list filed before the High Court of Jammu & Kashmir and Ladakh or the National Green Tribunal. A recorded waterbody is part of the drainage system for this Manual. A Revenue class records land, not its hydraulic extent: the National Green Tribunal found in its order of 13 November 2026 that wetland areas taken from Revenue records were insufficient and asked for the area on the ground, and in Baramulla a recorded rakh was reported "not existing on the spot" (as reported). For Clauses 7.3.3 and 7.13.1 the Waterbody Sheet records both the Revenue class and the surveyed extent, and the larger governs. Where a recorded waterbody is proposed to be filled, in whole or part, a drainage assessment under Chapters 3 to 5 shall show the storage and flow paths lost and their effect upstream and downstream, and the lost storage shall be replaced under Clause 7.6.4 before any design relying on the filling is approved. This definition and rule are set by this Manual.
Boundary of a lake, nambal, talab or reservoir	For Clauses 7.3.3 and 7.13.1, the boundary of a lake, nambal or talab is the largest of its Revenue record boundary, its surveyed FTL, any boundary notified or designated for it (for a Ramsar site, the Ramsar boundary, so that Wular's is taken from the Ramsar area of 18,900 ha, not from WUCMA's 13,000 ha, until the two are reconciled), and the outer edge of its water or wet ground at its seasonal high, shown by dated imagery or survey of recent years: in the Kashmir valley the high of March to May and the high of any Jhelum flood; in the Jammu division the high of July to September. The boundary of a reservoir or barrage pond is the higher of its full reservoir level and the highest level its operator states, stated to the datum of Clause 7.3.5; its drawdown land below that level is part of it. This reading is set by this Manual.
Khad; nallah; Gair Mumkin Khad; functional khad	A khad (खड्ड) is a seasonal torrent or ravine stream of the Kandi and the outer hills: in Jammu "ravines, locally called Khads are transformed into gushing torrents" (Jammu Master Plan 2032, §2.4), and UBBL-2021 name "any other river/khad" with the major rivers (clause 7.12(b)). A nallah (नाला; ﻧﺎﻟﮧ) is a natural or artificial drainage channel ("Nallas" in UBBL-2021, clause 5.2.5). Every khad or nallah that drains 8 ha or more is a natural channel under Clause 7.4.1(b), whatever its name, whether it is dry for most of the year, and whether it is lined, piped or covered. A khad carries boulders and debris in flood: its inlets and culverts take the debris racks, bulking and blockage of Clause 6.3.6, and its top of bank is the edge of its active boulder bed where that is wider than the edge of the 50% AEP flow. Gair Mumkin Khad is a Revenue class of land (glossed in this Manual as land recorded as uncultivable stream-bed; the dictionary meaning was not checked) that covers more than thirty per cent of the land of the Jammu Development Authority (Jammu Master Plan 2032, §12.2.3); the plan proposes that it be reduced to the "true Khad i.e. is functional drainage basin during peak flow", fixed with I&FC. For this Manual, the functional khad is the 1% AEP flood extent of the khad with the climate factor of Clause 2.8 and the bulking of Clause 6.3.6(b), with Zone 1 and Zone 2 under Clause 7.4 and the wider statutory lines of Clause 7.4.5, found by a hydraulic study under Chapters 3 and 5; no land recorded as Gair Mumkin Khad is released, built on or counted as developable in a design under this Manual until that study has been made. This definition and rule are set by this Manual.
Kol; city channel; flood spill channel; kuhl	A kol (Kashmiri *kŏl*, a stream, canal or irrigation channel) is a channel such as the Tsunth Kol, which takes Dal's outflow from Dal Gate to the Jhelum. A city channel or flood spill channel, such as the channel that takes the Jhelum's flood flow from Padshahi Bagh towards Wular, is under the control of I&FC (Water Resources Act, 2010, section 81 [TBC]). A kuhl or zamindari khul (कूहल) is an irrigation channel ("zamindari khuls" are hydraulic works under section 2 of that Act). Each of these is part of the drainage system: one that drains 8 ha or more is a natural channel under Clause 7.4.1(b), and no design under this Manual discharges to it, or crosses it, unless its capacity and its outlet are shown and I&FC, or the managing body of a khul, has consented.
Spring (nag, cashma); spring recharge area	A spring is a place where groundwater comes out at the surface. A nag (नाग; Kashmiri *nāg*) is a spring, "a fountain, a spring of water" in Grierson, as in Kokernag and Verinag, and cashma (چشمہ) is a spring or fountain, as in Chashma Shahi (Annex 7E). A spring is a waterbody for Clause 7.3, and its Zone 1 under Clause 7.4 is measured from its outlet or the edge of its pool or tank. Its recharge area is the area upslope from which it is fed, as a hydrogeologist maps it; within that area Clause 8.8.1 limits infiltration, no road runoff, sewage or septic effluent is led into the ground, and no drain is cut that would intercept the flow to the spring. No storm drain or sewer is laid within Zone 1 of a spring except a lined drain below its outlet that carries its overflow away. The springs in the bed of a lake, such as those that feed Dal, are part of the lake. No Jammu and Kashmir rule or buffer for springs was found; this definition and these rules are set by this Manual.
Kandi pond	One of the 365 ponds of the Kandi belt, 249 in Jammu district and 116 in Kathua, of which 165 are perennial (CGWB), which hold water on the porous Kandi because of the clay in their beds. A Kandi pond is a talab for this chapter; no work under this Manual cuts through, lines over or deepens its clay bed (Clause 7.9.3).
Sinking and sliding zones	Any mapped subsidence, land-sinking or landslide zone, including Thathri Nai Basti in Doda, Pernote and Duksar in Ramban and the areas of Budgam district listed by JKPCC as prone to land sinking. No talab, pond, retention basin or infiltration facility is placed in them (Clause 8.8.1).

Term	Meaning in this Manual
Glacial or moraine-dammed lake	A lake held by a glacier, moraine or landslide dam in the high mountains (sub-area JK-D of Annex 2A); no inventory of these lakes in the Union Territory was read for this Manual. It is a waterbody for Clause 7.3 and a hazard to be mapped under Chapter 5; it is **never** a design outfall or design storage, and no drain under this Manual discharges to it. This rule is set by this Manual.

7.3 Inventory and mapping of waterbodies

7.3.1 **Statewide inventory.** The Authority, with I&FC and the Revenue Department, shall maintain a GIS layer of every waterbody in its area (Annex 7A). For each waterbody it shall record:

- (a) its type (Clause 7.2), name and survey numbers;
- (b) its custodian (SMC, JMC, a Municipal Council or a Municipal Committee (for the drains within its area, under the Jammu and Kashmir Municipal Corporation Act, 2000 and the Jammu and Kashmir Municipal Act, 2000, whose drainage sections were not read [TBC]), UEED (for the sewerage and drainage works it plans, designs and builds in urban areas, and, through its Sewerage and Drainage Division (West) Jammu, within JMC limits), the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir (for the operation and maintenance of Srinagar's drains and dewatering stations), I&FC (for the rivers, khads and nallahs, their beds and banks, the embankments, the flood spill channel, the city channels such as the Tsunth Kol and the Padshahi Canal, and the canals and khuls, under section 81 of the Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010 [section number TBC]), LCMA (for Dal and Nigeen and the drains it holds in their catchment), WUCMA (for Wular and its feeder channels), the Wildlife Department (for the seven Wildlife Conservation Reserves), the Forest Department (for forest land), PW (R&B) or NHAI (for the drains, catch-water drains and culverts of their roads), NHPC, JKSPDC or another dam operator (for its reservoir, its drawdown land and the reach below its dam), SDA, JDA, the J&K Housing Board, a Smart City SPV or a colony developer (for the drains of a scheme until they are handed over in writing), the State Government through the Deputy Commissioner and the Tehsildar (for land recorded in the Revenue records as Gair Mumkin Khad, nambal, rakh, kahcharai or water), the Halqa Panchayat (for the talabs, ponds and khuls of a village), the Jammu and Kashmir Wetland Authority (for a notified wetland), a private owner, or another body);
- (c) its boundary as recorded in Revenue records;
- (d) for tanks: FTL, MWL, TBL, the surplus weir crest length and type, sluices, the supply channel and the surplus course, each with its datum;
- (e) its position in any tank cascade, with the upstream and downstream tanks;
- (f) the 1% AEP flood extent, where mapped; and
- (g) known encroachments, with the date recorded.

7.3.2 **Project mapping.** Every drainage report shall include a Waterbody Sheet (Form 7-1) showing all waterbodies:

- (a) within the site;
- (b) within 100 m of the site boundary; and
- (c) downstream, to the extent of the downstream analysis of Chapter 5.

The sheet shall show, on a plan at a scale of 1:1,000 or larger for (a) and (b):

- the Revenue record boundary;
- the surveyed FTL or top of bank;
- the MWL contour (tanks) and the 1% AEP flood extent;
- Zone 1 and Zone 2 (Clause 7.4); and
- every supply channel, surplus course, sluice and surplus weir.

7.3.3 **Sources.** Waterbodies shall be identified from all of the following. Where they conflict, the larger waterbody extent governs:

- (a) Revenue records and village maps of the Revenue Department, in which rivers, khads, nallahs, khuls, talabs, nambals and land covered by water are recorded, and in which drainage land in Jammu is largely recorded as Gair Mumkin Khad and marsh or grassland as nambal, rakh or kahcharai, classes that record the land, not its hydraulic extent; the "approximate location and size of any water body, flood affected areas and contours at an interval of 0.3m" that clause 2.6(b)(xi) of UBBL-2021 requires on the site plan of a sloping site, and the certificate of the registered technical person that the site is clear of drains and water bodies; the land use maps and buffer tables of the Srinagar Master Plan 2035 (Tables 8-2 to 8-4) and the Jammu Master Plan 2032 (§7.3.3), and the flood zonation of I&FC used in the Srinagar Master Plan (125 km² undevelopable and 136.50 km² vulnerable in the Srinagar planning area); the drains, nallahs and dewatering stations in the records of SMC, JMC, UEED and the other urban local bodies; I&FC's records of the rivers, khads, embankments, the flood spill channel and the city channels, and of its gauges; LCMA's records of Dal and Nigeen and WUCMA's of Wular; the boundaries of the five Ramsar sites, of the seven Wildlife Conservation Reserves and of any wetland notified under the Wetlands (Conservation and Management) Rules, 2017; NHPC's and JKSPDC's records of reservoir levels and acquired land; and the lists of wetlands, encroachments and water bodies filed before the High Court of Jammu & Kashmir and Ladakh and the National Green Tribunal, such as the 27 wetlands of more than 1 ha outside forests listed in 2026;
- (b) I&FC and Halqa Panchayat tank registers and records of FTL and MWL;
- (c) the Authority's inventory (Clause 7.3.1) and any list published under court directions;
- (d) historical topographic maps and satellite imagery, including the ISRO National Wetland Inventory and Assessment; and
- (e) a site survey by a licensed surveyor, levelled to the datum stated in Clause 7.3.5.

7.3.4 **Flood extent maps.** The Authority may adopt 1% AEP flood extent or flood depth maps for its area. A depth map adopted under this clause also sets floor levels under Clause 6.11. Where a map has been adopted, it shall be used unless a site hydraulic study under Chapters 3 and 5 shows a larger extent. Where no map has been adopted, the Applicant shall determine the 1% AEP extent by a hydraulic study for:

- (a) any site in a flood-sensitive catchment (Chapter 1);
- (b) any site of 1 ha or more adjoining a waterbody; and
- (c) any site where the Authority so requires.

For other sites, the fixed-width setback of Clause 7.4.6 may be used.

7.3.5 **Datum.** All levels in this chapter shall be stated to one datum, stated on every drawing. Where I&FC records use a local or older datum, the conversion to the project datum shall be surveyed and stated.

> **Commentary.** Jammu and Kashmir has the statutes to map flood lines but no flood line in law. No flood basin has been found declared under Part VI of the Water Resources Act, 2010, which provides for survey, delineation "including classification of land", objections and a notification with maps "showing the river channel, flood channel and the flood basin area" (sections 75 to 79 [TBC]); the Flood Plain Zones Act, 2005 has not been found brought into force; and UBBL-2021 defer building in flood areas to "the flood zonation maps notified by the department from time to time" (clause 7.12(a)), none of which was found notified. The nearest thing to a flood map is in a plan: the Srinagar Master Plan 2035 used I&FC's flood zonation to find that, of its planning area of 766 km², 125 km² is undevelopable and about 136.50 km² vulnerable to floods, and that 262 km², 34%, was under water in 2014 (§4.2); the zonation itself (the plan's Annexure C) was not read. The plan also proposes to demarcate "Flood Zone from Lelhar to Lasjan on the L/s of River Jhelum on the basis of 25 year flood plain and notify the area as Protected Natural Flood Absorption Basin"; that is a proposal of the plan, not a notification, and a 25-year line is narrower than the 1% AEP extent of this Manual. In Jammu, the master plan says the khads "other than actual drainage channels" are to be "redefined and demarcated on the basis of HFL" (§2.4), and no such demarcation was found. On the Jhelum the High Court recorded on 7 April 2015 that "the actual width … has not been identified

by completing demarcation till date" (as quoted in its order of 29 May 2024). The site plan of a building application shows "the approximate location and size of any water body, flood affected areas and contours at an interval of 0.3m" where the slope is more than 1 in 20 (UBBL-2021, clause 2.6(b)(xi)), but not a flood level. The rivers are gauged by two systems that cannot be tied together. CWC reports levels in metres at seven sites, with no datum stated in the sources read: on the Jhelum at Khanabal, Sangam, Ram Munshi Bagh and Safapora, on the Chenab at Akhnoor, on the Lidder at Ganeshpura and on the Tawi at Sidhra, where the highest flood level rose from 318.85 m (2014) to 321.1 m on 26 August 2025; at Ram Munshi Bagh the highest flood level of 8 September 2014 is 1,588.99 m in the 2022 list and 1,589.65 m in the 2018 list (all as transcribed by SANDRP). I&FC reads its staff gauges in feet, with gauge zeros that are not published and readings that can go below zero, so that a reading such as the flood-declaration stage of 18 ft at Ram Munshi Bagh is not a level above mean sea level; **no I&FC foot reading is converted to metres in this Manual**. The best evidence of flood extent is therefore on the ground and in the record: the flood marks of September 2014 (floodwater depths "of up to 16 feet" and an inundation of up to 25 days, Malik, 2021) and of August–September 2025, the extent of the 2014 flood used in the Srinagar plan, and the HFLs of the CWC sites. Clause 7.3.4 lets the Authority adopt flood maps once they exist; until then the Applicant must produce the 1% AEP extent for larger and flood-sensitive sites, with the river stage of Clause 5.8.5(a) behind every Jhelum embankment, the bulking of Clause 6.3.6 on khads and the surveyed flood marks of Clause 5.8.5(b) and (c), and a flood line delineated in a plan is a minimum that the 1% AEP extent of this Manual, with the climate factor, may exceed but never reduce. Every level shall be stated with the gauge or benchmark and the datum it refers to (Clause 7.3.5). Clause 7.3.3 makes the larger of the recorded and surveyed extents govern, because the Revenue boundary and the surveyed water edge often differ, and either may have been reduced by encroachment. The 100 m search band in Clause 7.3.2 is set by this Manual.

7.4 Setbacks

7.4.1 **Waterbodies to which setbacks apply.** Setbacks apply to:

- (a) every waterbody recorded under Clause 7.3.1 or found under Clause 7.3.3, whatever its size; and
- (b) every natural channel, whether recorded or not, that drains **8 ha** or more at the site.

7.4.2 **Two zones.** The setback has two zones, shown in Figure 7.1:

- **Zone 1 (waterbody protection zone)**, next to the waterbody; and
- **Zone 2 (flood fringe setback)**, outside Zone 1.

7.4.3 **Zone 1 width.** Zone 1 is measured outward from the FTL contour (tanks, lakes and ponds) or from the top of bank (channels). Where both apply, use whichever gives the wider zone. Zone 1 extends to the **greatest** of:

- (a) **15 m**, the minimum set by this Manual, which applies only where nothing wider binds (wider lines govern under Clause 7.4.5, and in Jammu and Kashmir they usually do: where UBBL-2021 apply, clause 7.12(b) keeps development 50 m from the edge of the bank of the major rivers "or any other river/khad", 30 m from the edge of the listed lakes "and other lakes" and 20 m from the edge of unlisted rivulets, tributaries, minor canals and watercourses, and clause 5.2.5 keeps a green buffer of at least 30 m from the highest water level along nallahs and rivers, "whichever is more"; the master plans and the High Court add wider lines round the lakes and wetlands; this Manual's 15 m governs along springs, talabs and village ponds, for which no distance has been prescribed, along drains and channels that no statutory line names, and in areas outside the reach of the bye-laws and master plans; see the Disclosure below);
- (b) the outer edge of the floodway (Clause 7.6.1); and
- (c) for a tank, the MWL contour.

7.4.4 **Zone 2 width.** Zone 2 extends from the outer edge of Zone 1 to the **1% AEP flood extent plus 10 m**. Where the 1% AEP flood extent lies inside Zone 1, Zone 2 is 10 m wide.

7.4.5 **Statutory and approval setbacks.** Where a statute, a statutory rule, a condition of planning permission or the consent of I&FC for a work on the bed or banks of a river, khad or nallah, an embankment, the flood spill channel or a city channel (Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010, section 81 [section number TBC]), its permission for a building in the vicinity of an irrigation or hydraulic work (section 66 [TBC]) and its online NOC under S.O. 304 of 1 December 2025, the NOC of LCMA for a work in the Dal–Nigeen area, the consent of WUCMA for a work at Wular or on its feeder channels, the permission of the Wildlife Department for a work in a Wildlife Conservation Reserve, the views of the Jammu and Kashmir Wetland Authority for a work in or next to a Ramsar site or a notified wetland, a buffer of the Srinagar Master Plan 2035 (Tables 8-2 and 8-3, and §8.2.3) or the Jammu Master Plan 2032 (§7.3.3), the consent of NHPC, JKSPDC or another dam operator for a work that drains to, or lies next to, its reservoir or the reach below its dam, or a direction of the High Court of Jammu & Kashmir and Ladakh or the National Green Tribunal (such as the High Court's 200 m no-construction line round Dal, listed in the Disclosure to Clause 7.4) sets a setback wider than Zone 1 or Zone 2, the wider setback governs for the uses it restricts.

7.4.6 **Fixed-width setback where no 1% AEP extent is available.** Where Clause 7.3.4 does not require a hydraulic study and no map has been adopted, the setback (Zone 1 plus Zone 2) shall be not less than the following, measured as in Clause 7.4.3:

Table 7.1 — Fixed-width setback where no 1% AEP extent is available

Waterbody	Total setback (Zone 1 + Zone 2)	Of which Zone 1
Channel draining 8 ha to 65 ha	25 m	15 m
Channel draining 65 ha to 20 km²	40 m	15 m
Channel draining more than 20 km², and rivers	50 m	20 m
Tank, lake or pond	MWL contour + 25 m	to MWL contour, and not less than 15 m from FTL
Marsh, estuary or backwater	as notified by the Authority, and not less than 50 m	15 m

This table is the alternative S-3 of the Policy Supplement (Annex 1C) and may be adopted under Clause 1.7.

7.4.7 **Minimum in all cases.** No setback under this chapter, and no variance under Clause 1.10, shall reduce Zone 1 below 15 m (Clause 1.10.3(c)).

> **Commentary.** The 15 m minimum is set by this Manual, as the floor of a hydraulic corridor where no wider line binds. Jammu and Kashmir has statutory distances from water, and they are wide. UBBL-2021, clause 7.12(b), provides that "No development, whether by filling or otherwise, shall be carried out from the edge of the bank of rivers, within following specified buffer or as per building regulation whichever is more": 50 m for the major rivers "or any other river/khad", 30 m for the listed lakes "and other lakes", and 20 m for unlisted rivulets, tributaries, minor canals and watercourses; clause 5.2.5 keeps a green buffer along nallahs and rivers of at least 30 m "from the highest water level"; the Srinagar and Jammu master plans set their own buffers, measured from the lake edge and from Full Tank Level; and the High Court holds a 200 m no-construction line round Dal and, as reported, round Wular. The 15 m floor therefore matters only where none of these reaches: along springs, talabs and village ponds, for which clause 7.12(c) leaves the distance "as may be prescribed" and none was found prescribed; along drains and channels that no line names; and in villages and other areas outside the reach of the bye-laws and master plans. It is this Manual's proposal, not a statutory width, and it never reduces a wider line (see the Disclosure below). Extending the setback to the mapped 1% AEP extent plus a margin follows the Kansas City Metro APWA Section 5600 (2025.01) two-zone structure:
>
> - APWA Zone 1 (streamside) is measured from top of bank, and only utility and road crossings are allowed in it.

- APWA Zone 2 is the 1% AEP flood extent plus 10 ft (about 3 m), for streams draining 20–40 acres.
- APWA lowered the trigger for stream setbacks from 40 acres to 20 acres (about 8 ha) in 2025.01.

(MARC, APWA 5600 Policy Supplement, Nov 2025.) Clause 7.4.1(b) adopts the 8 ha trigger. This Manual's 10 m margin is wider than APWA's 10 ft and has no direct precedent. This Manual sets it because Jammu and Kashmir flood maps are mostly coarser than US maps, the Kashmir valley floor is nearly flat, its towns stand behind the Jhelum's embankments on alluvium, Gurti clay and Nambal peat with the water table within 2 m of the ground, and the Sirowal of the Jammu plains falls at only 1 in 250 to 1 in 300 (CGWB) (so a small error in level moves the flood edge a long way), and the margin gives room for maintenance access along the waterbody.

The fixed-width table in Clause 7.4.6 is set by this Manual. Its channel widths are scaled from the 2006 APWA default stream buffers, which were 40 ft, 60 ft, 100 ft and 120 ft (12, 18, 30 and 37 m) for drainage areas of less than 40 acres, 40–160 acres, 160–5,000 acres and more than 5,000 acres (KC APWA 5600, 2006, §5605.3). They are rounded up and floored at the 15 m minimum. APWA offered a fixed-width table for the same reason: communities objected that the 1% extent is often unmapped for small drainage areas (MARC Supplement, 2025). The table should be replaced by mapped extents as soon as the Authority adopts them.

URDPFI (2015) reserves the area flooded at a 10-year frequency for parks and playgrounds, and allows residential use in the 25-year flood zone only on stilts, with minimum plinth levels and no basements. This chapter is stricter. It keeps habitable buildings out of the whole 1% AEP extent plus margin, because the 1% AEP (100-yr) event is the major-system standard of this Manual (Chapter 6).

Jammu and Kashmir's building rules are the Jammu and Kashmir Unified Building Bye-Laws 2021, published in the *J&K Official Gazette* (Extraordinary, Vol. 134, No. 39-4) of 24 December 2021 in the copy of the Jammu Municipal Corporation, adopted body by body on a common text, and amended by the Corporation's notification of 9 March 2022 and by H&UDD's S.O. 304 of 1 December 2025 and S.O. 58 of 26 February 2026 (the last seen only as a title); draft amendments of 9 September 2026 were reported and not read. Clause 7.12, "Distance from water course", provides: "(a) The building activity in the areas vulnerable to floods/flash floods shall be regulated under the provision of Irrigation and Flood Control Department or the flood zonation maps notified by the department from time to time"; "(b) No development, whether by filling or otherwise, shall be carried out from the edge of the bank of rivers, within following specified buffer or as per building regulation whichever is more": **50 m** from the edge for the listed major watercourses, the Chenab, Jhelum, Tawi, Ravi and Ujh "or any other river/khad"; **30 m** from the edge for the listed minor watercourses, "Mansar, Surinsar, Wular, Nageen, Manasbal and other lakes"; and **20 m** from the edge for "Unlisted rivulets, tributaries, minor canals and/or Watercourse", such as the "Ranbir canal, Sindh canal and other similar canals" (the 50 m line is "Recommended safe distance (Buffer) … or as specified under the relevant regulatory Act or the relevant Master Plan"); and "(c) In case of talab, village tanks, lake, water bodies etc., the distance from the water body shall be as may be prescribed under any other general or specific orders of the BPIA." The clause's list of major watercourses also names a river that does not flow through the Union Territory; this Manual reads the clause for the rivers that do. Clause 5.2.5 provides that in the Conservation Green Zone "The green buffer along the Nallas/Rivers or the open space along the River/tributary shall be minimum 30 m from the highest water level or as provided in the master plan/zonal development plan or as provided under Water Regulatory Act, whichever is more", with no building in the zone; the use-zone notes bar development "in area designated for water body, pond and Talav excluding River-front Development"; and S.O. 304 adds a "WATERBODY USE_NEGATIVE LIST" of "All Permanent structures except kiosks, cafeteria, toilet units or any other public utilities". The **Srinagar Master Plan 2035** sets, in Table 8-2, 50 m from the lake edge or building line from Dalgate to Nehru Park, 100 m from the lake edge from Nehru Park to the Nishat junction, 50 m on the Telbal Nallah and 20 m on the Nallah Amir Khan, the other feeder nallahs and the circulation, navigation and irrigation channels, with the buffers round Dal, Nigeen, Brari Nambal, Khushalsar, Gilsar and Anchar "subject to the outcome" of the public interest litigation before the High Court; in Table 8-3, 200 m on the south, north and west and 30 m on the east of Anchar, the Shalbug Nambal and the Haran forest, 200 m on the south and west and 50 m on the east and north of Hokersar, 50 m round Khushalsar and Gilsar, on the Sukhnag Nallah and on the Sind Nallah, 100 m round the Nambal Narkur, 20 m on the Doodhganga Nallah and 20 m round other small water bodies; and, in §8.2.3, 100 m round any wetland reserve not listed. The **Jammu Master Plan 2032** sets "No-

Construction Zones" in §7.3.3, measured from Full Tank Level: 50 m along the Tawi, the Devak and the Basantar (30 m in built-up areas), 15 m along the Balol, Thather and Bhalwal khads, and 5 m along other water bodies shown in the proposed land use. The **High Court** holds a 200 m no-construction line round Dal: the order of 19 July 2002 in PIL 159/2002 (as quoted); the order of 8 September 2022, which accepted the master-plan buffers for other water bodies while keeping 200 m for Dal (as reported); the order of 13 June 2023 letting the Government proceed to modify the master plan after a technical committee reported (as reported); and the judgment of 30 October 2025, reported to keep the 200 m line, which was not read and whose words are not quoted here. LAWDA refused permission in 2021 for land "within 200 meters from the fringe of the Nigeen Lake" (as quoted), and the High Court was reported in November 2020 to have barred construction within 200 m of Wular. On the Jhelum the Court directed in 2015 that "the original width of the river Jhelum is restored" and in 2016 that "no construction of any kind is raised near the water bodies" (as quoted in its order of 29 May 2024 in PIL 8/2017). The statutory routes for flood land have not been used: no flood basin has been found declared under Part VI of the Water Resources Act, 2010, the Flood Plain Zones Act, 2005 has not been found brought into force, and no flood zonation map was found notified under clause 7.12(a). The lines leave gaps. They are measured from **three different lines**: clause 7.12 from "the edge of the bank", clause 5.2.5 from "the highest water level", the Srinagar plan from the lake "edge" or "fringe", and the Jammu plan from "Full Tank Level", which for a river or a khad has no defined meaning; the Jammu plan's 15 m and 5 m khad lines are narrower than the 50 m that clause 7.12 gives "any other river/khad" and the 20 m it gives any other watercourse; no line is set for a talab, village tank or spring, which clause 7.12(c) leaves to be prescribed; and none is tied to a design flood. This Manual maps each line onto its own (Clause 7.4, Disclosure), and Clause 7.4.7 makes 15 m the floor of Zone 1 where nothing wider binds.

Disclosure. Jammu and Kashmir **has statutory distances from water, and they are wide**: where UBBL-2021 apply, clause 7.12(b) keeps development **50 m from the edge of the bank** of the major rivers "or any other river/khad", **30 m** from the edge of the listed lakes "and other lakes", and **20 m** from the edge of unlisted rivulets, tributaries, minor canals and watercourses, "or as per building regulation whichever is more", and clause 5.2.5 keeps a green buffer of at least **30 m from the highest water level** along nallahs and rivers; the master plans add their own buffers; and the High Court holds **200 m round Dal**. What the Union Territory lacks is a flood line: the **Flood Plain Zones Act, 2005 has not been found in force, no flood basin has been found declared under Part VI of the Water Resources Act, 2010, and no flood zonation map was found notified** under clause 7.12(a). The **15 m minimum** Zone 1 of Clauses 7.4.3 and 7.4.7, and every value derived from it in Table 7.1, is **set by this Manual** as a hydraulic corridor that applies **only where nothing wider binds**: along springs, talabs, village ponds and Kandi ponds, for which no distance has been prescribed; along drains and channels that no statutory line names; and outside the areas where the bye-laws and master plans apply. So are the setback zones of Clause 7.4, the 1% AEP extent that governs Zone 2, this Manual's reading of the boundary of a lake, nambal, talab or reservoir, the functional-khad study before any release of Gair Mumkin Khad land, and the rules on springs, kols and khuls, sinking zones and glacial lakes (definitions after Clause 7.2). They are **this Manual's proposal, not a statutory width or rule**, and no government body has adopted or endorsed them. The setback is applied as **the larger of the corridor and every statutory, plan, court or Tribunal line** ("whichever is more"), so the Manual is no less strict than any of them anywhere. Where a flood basin is notified under Part VI of the Water Resources Act, 2010, or a flood plain zone under the 2005 Act once it is in force, its restrictions govern; until then the mapped 1% AEP flood extent of Clause 7.3.4 applies. What exists, and governs wherever it is wider or stricter (Clause 7.4.5), is:

- **UBBL-2021, clause 7.12(b)** (as amended). 50 m (Chenab, Jhelum, Tawi, Ravi, Ujh "or any other river/khad"), 30 m (Mansar, Surinsar, Wular, Nageen, Manasbal "and other lakes") and 20 m (unlisted rivulets, tributaries, minor canals and watercourses, such as the Ranbir and Sindh canals), from the edge of the bank. For this Manual "the edge of the bank" is the top of bank of Clause 7.2, the line from which Zone 1 is measured, so a clause 7.12 line wider than Zone 1 governs as Zone 1.
- **UBBL-2021, clause 5.2.5.** A green buffer of at least 30 m from the highest water level along nallahs and rivers, in which no building is permitted. For this Manual "the highest water level" is the higher of the highest level recorded at the site and the 1% AEP flood level with the climate factor, so the 30 m is measured outward from the edge of the 1% AEP extent where that has been mapped (a reading set by this Manual); the outer 30 m then lies inside or beyond Zone 2 and governs where it is wider.

- **UBBL-2021, clause 7.12(c).** For a talab, village tank, lake or other water body, the distance "as may be prescribed" by the building permit issuing authority. None was found prescribed; until it is, Zone 1 of this Manual (15 m from FTL) and Zone 2 apply to every talab and Kandi pond, and clause 7.12(b) applies to every lake.
- **Srinagar Master Plan 2035, Tables 8-2 and 8-3 and §8.2.3.** The buffers round Dal (50 m from Dalgate to Nehru Park and 100 m from Nehru Park to Nishat, from the lake edge), the Telbal Nallah (50 m), the Nallah Amir Khan and other feeder nallahs (20 m), Anchar (200 m and 30 m), Hokersar (200 m and 50 m), Khushalsar and Gilsar (50 m), the Nambal Narkur (100 m), the Sind Nallah (50 m), the Doodhganga (20 m) and other small water bodies (20 m), and 100 m round any unlisted wetland reserve, measured from the edge of the water body; they govern as Zone 1 where wider.
- **Jammu Master Plan 2032, §7.3.3.** 50 m along the Tawi, the Devak and the Basantar (30 m in built-up areas), 15 m along the Balol, Thather and Bhalwal khads and 5 m along other water bodies, from Full Tank Level. For a river or khad this Manual reads Full Tank Level as its top of bank, and for a talab or lake as its FTL under Clause 7.2 (a reading set by this Manual). Where UBBL-2021 apply, the plan's 15 m and 5 m khad lines and its 30 m built-up line on the rivers are narrower than the 50 m that clause 7.12(b) gives "any other river/khad", and the head of that clause applies the larger, "whichever is more"; this Manual reads the narrower plan lines as overridden there (a reading of this Manual, to be confirmed by H&UDD), and the Applicant states both on Form 7-1.
- **The High Court.** No construction within 200 m of the periphery of Dal (PIL 159/2002, order of 19 July 2002, as quoted; reported to be kept by the judgment of 30 October 2025, which was not read); 200 m round Nigeen, as applied by LAWDA (2021, as quoted); 200 m round Wular (November 2020, as reported; the order was not read); the original width of the Jhelum to be restored and no construction near the water bodies (orders of 24 February 2015 and 10 June 2016, as quoted in the order of 29 May 2024 in PIL 8/2017). Where the Court's line is wider than Zone 1 and Zone 2 it governs for the uses it restricts; its status is stated on Form 7-1.
- **Wetlands, Ramsar sites and reserves.** The Ramsar sites of Wular (18,900 ha), Hokersar (1,375 ha), Surinsar–Mansar (350 ha), Hygam (802 ha) and Shallabugh (1,675 ha), to their boundaries; the seven Wildlife Conservation Reserves of 1945; and any wetland notified under the Wetlands (Conservation and Management) Rules, 2017 (none was found notified) (Clause 7.12).
- **I&FC.** Its control of the bed and banks of every water source, city channel and flood spill channel and of the embankments, its permission for building near an irrigation or hydraulic work, and its NOC under S.O. 304 (Water Resources Act, 2010, sections 66 and 81 [TBC]).

This Manual sets 15 m as the floor because the waterbodies that no statutory line reaches, the springs, talabs, Kandi ponds and the drains and channels of the towns, still need room for their flood flow and for the machinery that clears them, and because 15 m is above the smallest APWA default stream buffer (12 m) from which Table 7.1 is scaled. The reasons for the corridor are the record: in 2014, 262 km², 34% of the Srinagar planning area, was under water, and the city's growth after 1971 had gone "mostly in low lying areas, wetlands and flood absorption basins adjacent to Flood Spill Channel" (Srinagar Master Plan 2035); the Jammu Master Plan 2032 records that "The drainage channels have fallen prey to the accelerated urban growth for there has been no standardized regulations provided in the Master Plan-2021 to regulate development in their vicinity"; and Hokersar, Narkara and Wular have each lost a large part of their area (as reported; Clause 7.12, Commentary). Until a statute, rule, notification, master plan or court adopts it, the 15 m minimum is this Manual's recommended standard, and the statutory, plan, court and Tribunal lines above remain the only legal minimum. Approving authorities should state in each approval which was applied.

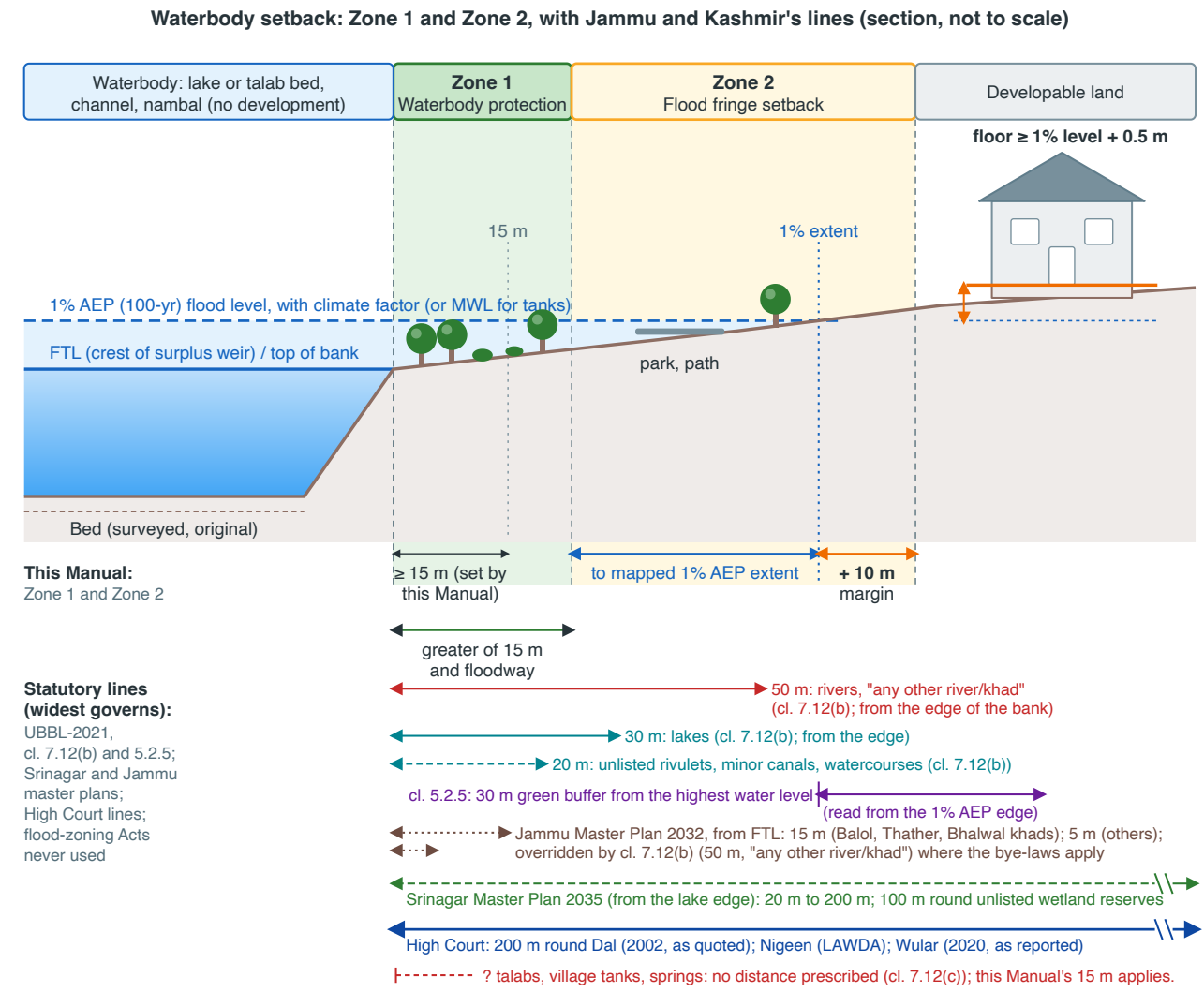

Figure 7.1 — Waterbody setback zones: section through a tank or channel showing FTL, the 1% AEP flood level, the 15 m minimum line, Zone 1 and Zone 2. Original drawing for this Manual, adapted from Kansas City Metro APWA, Section 5600 Version 2025.01 and Policy Supplement (MARC, 2025).

7.5 Uses permitted in each zone

7.5.1 **Zone 1.** No building, fill, paving, retaining wall, boundary wall, compound wall, dumping of earth, debris or solid waste, storage of materials, or construction-stage stockpile shall be placed in Zone 1. Only the following are permitted, each subject to the custodian's NOC:

- (a) road, rail and utility crossings that meet Clause 7.10.3;
- (b) flood and drainage works: outfalls, inlet structures, gross pollutant traps, sluices, surplus weirs, bund strengthening and bank protection;
- (c) native vegetation, planting and habitat works;
- (d) unpaved or permeable footpaths and maintenance tracks at existing ground level; and
- (e) waterbody restoration under Clause 7.9.

7.5.2 **Zone 2.** No habitable building, basement, school, hospital, fuel store or hazardous-material store shall be placed in Zone 2. The following are permitted:

- (a) all uses permitted in Zone 1;
- (b) parks, playgrounds, open-air sports fields and urban agriculture;
- (c) open-sided structures (shelters, pavilions) with no walls that obstruct flow;
- (d) surface parking with permeable surfacing at existing ground level, where the 1% AEP flood depth is not more than 0.3 m;
- (e) retention, detention and water quality facilities under Chapters 4 and 8, provided they are outside the floodway and their storage is not counted twice (Clause 7.6.5); and
- (f) fill, only for (a) to (e) or for essential public infrastructure, and only with compensatory storage under Clause 7.6.4.

7.5.3 **Fences.** Fences in Zone 1 and Zone 2 shall be open (chain-link or railing) with no plinth wall above existing ground level, so that they do not obstruct flow or trap debris.

7.5.4 **Open space reservation.** Zone 2 land may be counted toward the open space required by the Jammu and Kashmir Unified Building Bye-Laws 2021, where the Authority agrees. Zone 1 land shall be handed over to the custodian or kept free of private use, as the Authority decides.

> Commentary. The permitted uses follow APWA 2025.01: in Zone 1, only utility and road crossings; in Zone 2, linear utilities, trails and open-sided structures; no clearing, grading, fill or paving in either zone without approval (MARC Supplement, 2025). Clause 7.5.2 adds parks and playgrounds, the uses URDPFI (2015) allows in the 10-year flood zone. The ban on walls in Clauses 7.5.1 and 7.5.3 responds to valley and hill-town practice: compound walls along channels and tanks act as dams in floods, and are often the first step toward encroachment. The 0.3 m depth limit for parking in Clause 7.5.2(d) has no direct precedent and is set by this Manual.

7.6 Floodway, flood fringe and compensatory storage

7.6.1 **Floodway delineation.** The floodway shall be delineated by a hydraulic model of the 1% AEP flood (with the climate factor), using the encroachment method: the conveyance of the flood fringe is removed equally from both banks until the 1% AEP water level rises by 0.1 m. Where the floodway has not been delineated, the whole 1% AEP flood extent shall be treated as floodway. For a tank, all land below MWL is floodway.

7.6.2 **No fill in the floodway.** No fill, building, embankment, raised road or other obstruction shall be placed below the 1% AEP flood level within the floodway, except the works permitted in Zone 1 under Clause 7.5.1(a) and (b). Those works shall be shown by hydraulic analysis to raise the 1% AEP water level by no more than 0.01 m, upstream or downstream, outside the Applicant's land.

7.6.3 **Fill in the flood fringe.** Fill below the 1% AEP flood level in the flood fringe is permitted only:

- (a) for uses permitted under Clause 7.5.2, or outside the setback where the Authority has notified a developed-fringe area under Clause 7.6.6; and
- (b) with compensatory storage under Clause 7.6.4.

7.6.4 **Compensatory storage.** Where fill is placed in the flood fringe, compensatory storage shall be provided that (Figure 7.2):

- (a) replaces at least **1.0 m³ of storage for each 1.0 m³ of fill** placed below the 1% AEP flood level;
- (b) is provided at **equivalent levels**: the volume lost and the volume replaced shall be balanced in each elevation band of not more than **0.3 m**, from the normal water level (or the 50% AEP level, where higher) up to the 1% AEP flood level;

- (c) is in the same reach of the same waterbody, hydraulically connected to it, and not further downstream than the fill;
- (d) drains freely by gravity back to the waterbody as the flood recedes, with no pumping and no permanent pool below the normal water level;
- (e) is built before, or at the same time as, the fill is placed; and
- (f) is secured by a covenant or handover so that it is never filled later.

7.6.5 **No double counting.** Compensatory storage shall not be counted as detention or retention storage under Chapter 4. Detention and retention storage placed within the 1% AEP flood extent shall be counted only for the volume above the 1% AEP flood level, unless a model of the joint event (Clause 2.12) shows that it is available.

7.6.6 **Developed-fringe areas.** The Authority may notify, by map, areas of existing built-up land within the 1% AEP flood extent but outside the floodway, where it is impractical to apply Zone 2 to redevelopment. In a notified developed-fringe area:

- (a) redevelopment may be approved without the Zone 2 restriction;
- (b) the lowest habitable floor and all openings shall be at least 0.5 m above the 1% AEP flood level (Chapter 6);
- (c) basements are not permitted;
- (d) the redevelopment shall cause no net loss of flood storage below the 1% AEP flood level (Clause 7.6.4), and stilt construction may be used for this; and
- (e) Zone 1 continues to apply in full.

> **Commentary.** The 1:1 compensatory storage at equivalent levels is set by this Manual. A simple volume balance is not enough: storage excavated below the normal water level is full before the flood arrives and gives no flood benefit. Storage gained high up does not replace storage lost low down, because the low storage is used in every flood and the high storage only in the largest. Balancing volume within each elevation band avoids both problems. The 0.3 m band, the 0.01 m allowance for crossings, and the use of the encroachment method in Clause 7.6.1 are set by this Manual; the encroachment method is the standard way to delineate a floodway in a one-dimensional hydraulic model. The 0.1 m limit on the rise in the 1% AEP water level is tighter than the 1 ft (about 0.3 m) used by the US National Flood Insurance Program. The floor of the Kashmir valley round Srinagar, Pampore, Sopore, Baramulla and Anantnag, the margins of its lakes and nambals, and the Sirowal of the Jammu plains, which falls at 1 in 250 to 1 in 300 (CGWB), are flat, so a small rise in level spreads flooding over a wide area, and many small encroachments along the same channel add up.
>
> In Jammu and Kashmir the lines round lakes are measured from the lake's edge or fringe (UBBL-2021, clause 7.12(b); Srinagar Master Plan 2035) or from Full Tank Level (Jammu Master Plan 2032), and none of them says at what level or on what date the edge is taken, so the line from which a setback is measured must come from this Manual. The difference matters because the valley's lakes and nambals have been shrinking for a century, and the edge on the day of survey is the edge after the loss: Hokersar is reported to have shrunk from 18.75 km² in 1969 to about 13 km² in 2008, losing "nearly half of its flood storage capacity", with "60% of the Hokersar wetland … under heavy siltation"; Wular from 157.74 km² in 1911 to 86.71 km² in 2007 (or from 217 km² with its marshes, by another count), with about 30 per cent of its volume lost to silt; and 37 per cent of Narkara has been built over (all as reported). The areas also differ between authorities: Wular is 18,900 ha as a Ramsar site and 13,000 ha in WUCMA's account, and Hygam 802 ha as a Ramsar site and 7.62 km² in the Wildlife Department's. The lakes rise in another way too: when the Jhelum rises, Dal Gate closes and the lakes and nambals behind it fill from their own catchments, so their highest levels come with the river's floods and with the snowmelt of spring, not with the edge seen in the dry months. This Manual therefore gives every lake, nambal and talab a boundary measured from a high level, not from the water's edge on the day of survey: the larger of the Revenue boundary, the surveyed FTL, the Ramsar or other designated boundary, and the seasonal high edge (definitions after Clause 7.2), with the foreshore up to MWL as its flood storage. Treating all land below MWL as floodway (Clause 7.6.1) means that no new building or fill is approved in a tank foreshore.

The developed-fringe mechanism of Clause 7.6.6 is set by this Manual. Large parts of Srinagar, whose growth after 1971 went "mostly in low lying areas, wetlands and flood absorption basins adjacent to Flood Spill Channel" (Srinagar Master Plan 2035, Preface) and 262 km² of whose planning area, 34%, was under water in 2014, of the old towns of Anantnag, Pampore, Sopore and Baramulla along the embanked Jhelum, and of the colonies along the khads and the Tawi in Jammu that were flooded in August 2025 (as reported) already lie within the 1% AEP extent. A blanket Zone 2 ban on redevelopment there would stop the replacement of older, lower buildings with buildings raised above flood level. The mechanism follows the URDPFI (2015) approach for the 25-year flood zone (stilts, minimum plinth, no basements), applied here to the 1% AEP extent.

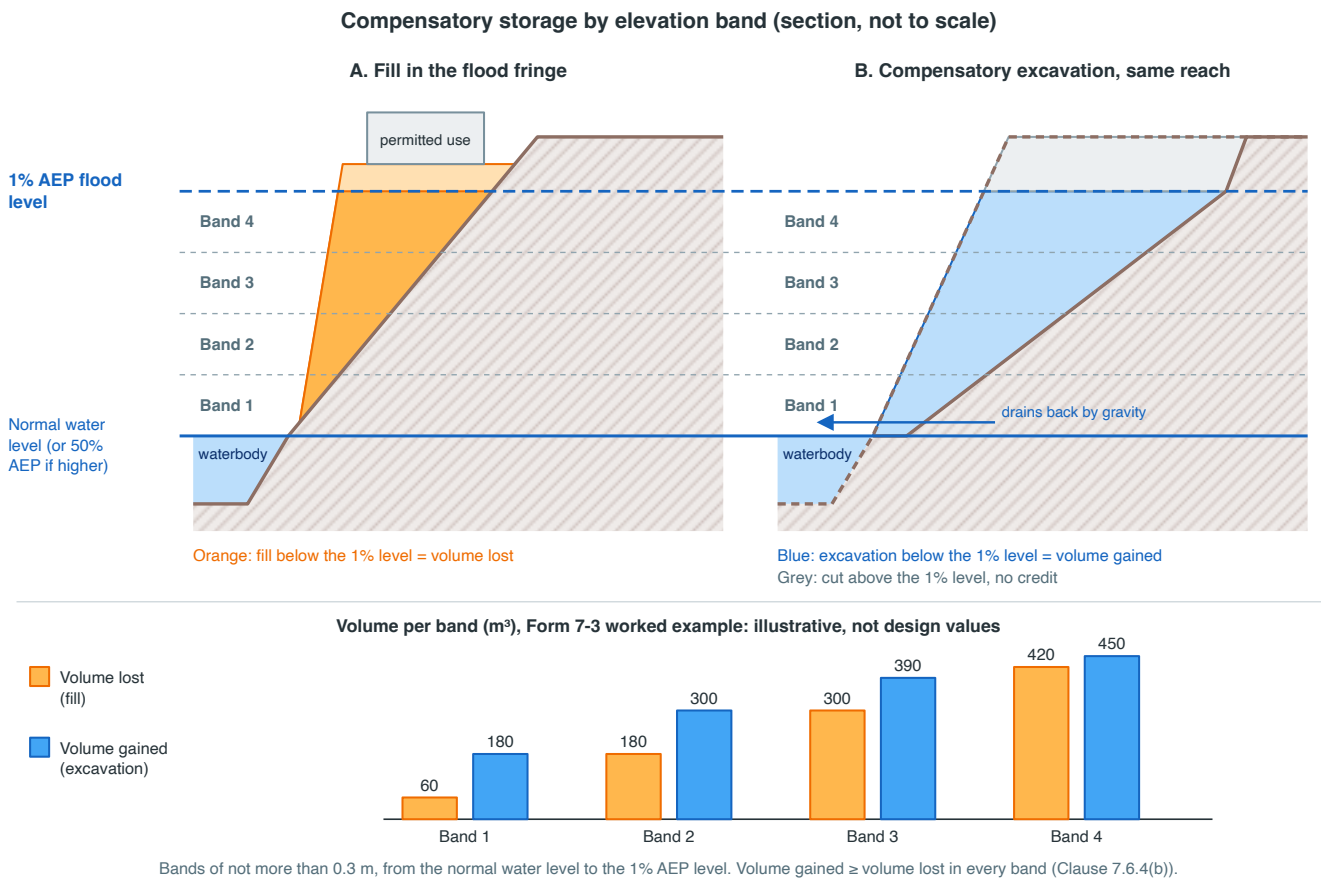

Figure 7.2 — Compensatory storage by elevation band: section through the flood fringe showing fill placed below the 1% AEP flood level and an equal or greater volume excavated within each band of not more than 0.3 m, from the normal water level (or 50% AEP level) up to the 1% AEP level, with the excavation draining back to the waterbody by gravity. Band-by-band calculation on Form 7-3. Original drawing for this Manual, illustrating the method of Clause 7.6.4, which is set by this Manual.

7.7 Tank cascades as design storage

Jammu and Kashmir has no tank Act, and its storages range from the Kandi ponds of the Jammu plains to Wular, the Kashmir valley's flood basin. The storages that matter for urban drainage are of six kinds. The first is the **gated lakes of Srinagar**: Dal, of 20.37 km² in a catchment of about 314 km², "about twenty times more than the lake area", fed by the Telbal (Dachigam) Nallah, the Mearkh Shah Nallah, the Bota Koul, the Pishpow Nallah and springs in its bed, with its outlets at Dal Gate, a lock and weir to the Tsunth Kol and the Jhelum, and the Nallah Amir Khan, through Nigeen to Gilsar, Khushalsar and Anchar (JKPCC, 2024; Forest Department, 2024); Brari Nambal, whose main outlet, the Mar Canal, was filled in the 1970s (as reported). Dal's level was reported at "10.5 feet" in September 2025, with releases

possible only "to the extent of two to three feet" because of silt (as reported); that reading has no stated datum and is not used as a level. The second is the **nambals and flood basins** downstream of the city's outfalls and along the Jhelum: Anchar (14.73 km², as reported), Hokersar (1,375 ha, Ramsar), Narkara, Shallabugh (1,675 ha, Ramsar), Rakh-e-Arth and the west-bank basins, and **Wular**, "a huge absorption basin for flood water" (WUCMA, 2024), whose outlet at Ningli is reported to pass 20,000 cusecs before and 22,700 cusecs after the works since 2014 and whose danger level is reported as 1,578 m (I&FC, as reported). No flood-storage volume was found for Wular, Hokersar, Anchar, Narkara, Rakh-e-Arth or Dal–Nigeen. Their storage is modelled at basin scale (Clause 7.12.5) and is never counted for a development. The third is the **reservoirs and barrage ponds**: Salal (full reservoir level 487.68 m, NHPC), Baglihar (840 m, JKSPDC), Dul Hasti, Ratle and Pakal Dul on the Chenab system, the Tawi barrage at Jammu, whose first phase was dedicated on 14 April 2026 and whose pool level and gates were not found [TBC], and the Ranjit Sagar reservoir on the Ravi, held in Punjab, which matters for Basohli and Kathua, whose full reservoir level is reported as 527.91 m and elsewhere as 527.13 m (the higher is used until the operator confirms it) (all as reported); their releases enter a design as inflow and tailwater (Clauses 5.8.3 and 5.8.5(d)), and they are not tanks for these clauses unless their storage is counted. The fourth is the **talabs and Kandi ponds** of the Jammu plains: 365 ponds in the Kandi belt, 249 in Jammu district and 116 in Kathua, 165 of them perennial (CGWB), and the talabs of old Jammu, Rani Talab, Talab Khatikan, Talab Tillo, Kujwani Talab, Bawa Talab and Bana Talab, which survive mostly as place names (Jammu Master Plan 2032); they are modelled as existing features where they intercept runoff but are not counted as storage unless Clause 7.7.1 is met, because none was found surveyed or with a controlled outlet. The fifth is the **springs**, nag and cashma, which are protected for their water and never counted as storage. The sixth is the smaller **lakes in small catchments**, Manasbal in Kashmir and Mansar and Surinsar in the Jammu hills (a Ramsar site of 350 ha), whose outlets are unrecorded [TBC], and the glacial and moraine-dammed lakes of the high mountains, which are hazards (definitions after Clause 7.2). These are the waterbodies for which Figure 7.3 and Clause 7.8 matter: on the valley floor every drain ends in a lake, a nambal, a city channel or the river, and the river shuts them all when it rises; in the Jammu plains every khad crosses the Kandi to the Sirowal, with its ponds and talabs on the way. Any lake, talab or reservoir whose storage is to be counted is subject to Clause 7.7.1 in full, with I&FC, LCMA, WUCMA, the dam operator or other custodian, and the custodian of each waterbody shall be confirmed for the inventory (Annex 7A) [TBC].

7.7.1 **When tank storage may be counted.** The storage of a tank or tank cascade may be counted as design storage (in a basin plan, a regional facility or a fee-in-lieu scheme under Clause 7.11) **only** where all of the following are met:

- (a) **Surveyed levels.** FTL, MWL, TBL, the surplus weir crest and length, and the sluice sill levels have been surveyed to the datum of Clause 7.3.5 within the previous 5 years.
- (b) **Stage–storage curve.** A stage–storage curve has been derived from a bathymetric and topographic survey of the waterspread and foreshore within the previous 5 years, or after the last desilting, whichever is later.
- (c) **Operating rule.** A documented operating rule has been agreed with the custodian (Clause 7.8).
- (d) **Maintained structures.** The surplus weir, sluices and bund are maintained under an O&M plan (Chapter 10), and the latest pre-monsoon inspection found them serviceable.
- (e) **Custodian concurrence.** I&FC, or the other custodian, concurs in writing.

Storage in a tank that fails any of (a) to (e) shall not be counted, though the tank shall still be modelled as an existing feature (Chapter 3).

7.7.2 **Modelling.** Tank cascades shall be modelled under Clause 3.12.5 (level-pool routing of each tank, with surplus weir and sluice ratings) and Clause 3.13 (continuous simulation). The whole cascade, from the uppermost tank whose surplus can reach the site or facility to the next river, major drain or sea outfall, shall be modelled together, including, on the Kashmir valley floor, every drain and dewatering station that discharges to a lake or nambal, the lake's gated outlet, the nambals and flood basins downstream, the flood spill channel, and the embanked river whose stage shuts the outfalls (Clause 5.8.5(a) and (e)), and, in the Jammu plains, every khad from the foot of the Siwalik hills across the Kandi and the spring line to the Sirowal, with any talab or Kandi pond on it, down to its confluence with the river (Clause 5.8.5(b) and (c)), as shown in Figure 7.3.

7.7.3 **Starting level.** The starting level in every tank shall be **FTL** for the design-storm analysis. A lower starting level may be used only under a flood-cushion operating rule that meets Clause 7.8.

7.7.4 **Design maximum level.** For the 1% AEP inflow with the climate factor, routed through the cascade:

- (a) the computed maximum level shall be not higher than MWL (as defined in Clause 7.2); and
- (b) the freeboard from the computed maximum level to the lowest point of the bund (TBL) shall be not less than I&FC's freeboard standard for the tank.

Where (a) or (b) fails, the tank storage above FTL shall not be counted until the surplus weir capacity is increased or the bund raised under Clause 7.7.6.

7.7.5 **Creditable volume.** The creditable design storage of a tank is the volume between the starting level (Clause 7.7.3) and the computed maximum level of Clause 7.7.4, less any volume already committed to another facility or scheme.

7.7.6 **Changes to FTL, weirs and bunds.** No surplus weir crest shall be raised or lowered, no shutters or falling boards shall be added, and no bund shall be raised, cut or breached except under a design approved by the custodian that:

- (a) routes the cascade under Clause 7.7.2;
- (b) shows the effect on flood levels in the foreshore and upstream, and on flows in the surplus course and downstream; and
- (c) checks the bund under Clause 7.14.

> Commentary. This Manual allows tank cascades to be used as design storage subject to three basic conditions (surveyed FTL, a documented operating rule and maintained surplus weirs). Clause 7.7.1 adds the stage–storage survey and the custodian's concurrence, because the storage a tank actually offers depends on its silt level and on who controls the sluices. The 5-year survey interval is set by this Manual.
>
> The FTL starting level follows Clause 3.12.5. In Jammu and Kashmir the waterbodies are fullest when the storms come. On the Kashmir valley floor the water table is at its shallowest in May, after the winter rain and the snowmelt (CGWB), and the lakes and nambals behind the Jhelum fill whenever the river rises and Dal Gate and the other outlets close; in August 2025 Wular stood at 1,575.66 m against its danger level of 1,578 m (I&FC, as reported). In the Jammu division the Kandi ponds, 165 of which hold water all year (CGWB), and the reservoirs fill in the monsoon: the Ranjit Sagar reservoir on the Ravi reached its full level on 27 August 2025 and its outflow rose from about 9,000 to 173,000 cusecs between 24 and 27 August (as reported), and Salal's and Baglihar's gates were all open in August 2025 (Clause 7.8, Commentary). The largest floods of both divisions came in September (1988, 1992 and 2014), when monsoon moisture met a western disturbance, after weeks of rain or snowmelt, so a late storm finds the lakes, ponds and reservoirs high. While a lake or talab is full, or its outlet is shut by the river, it stores nothing more below FTL, the drains and khads that flow into it discharge against its level, and any release adds to the flow in the river below it. A tank cascade passes floods from one tank to the next, so a design that counts storage in one tank and ignores the surplus arriving from the tank above it will overstate the benefit. That is why Clause 7.7.2 requires the whole cascade to be modelled.

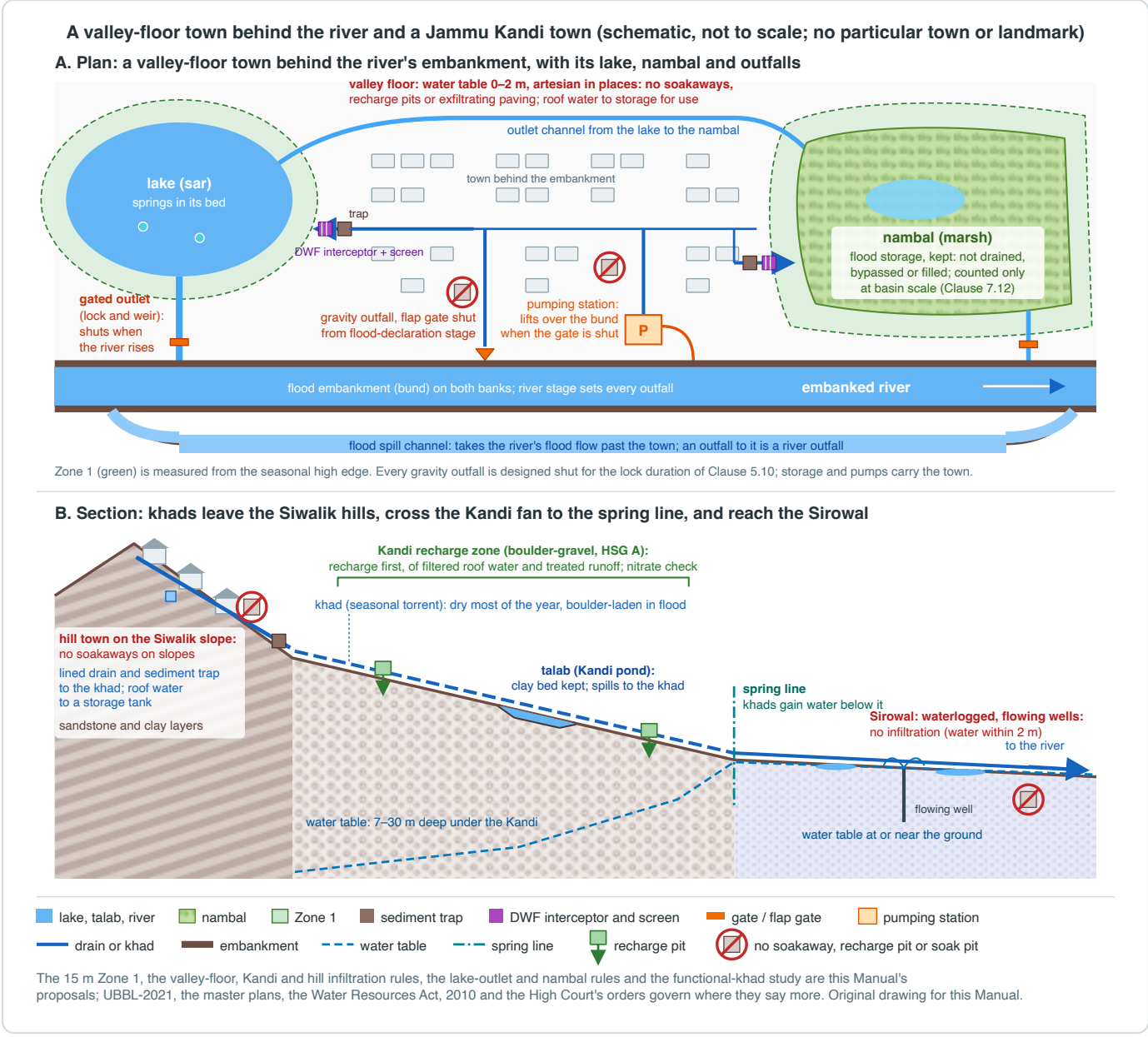

Figure 7.3 — A valley-floor town behind the river and a Jammu Kandi town: lakes, nambals, khads and talabs (schematic, not to scale; no particular town, lake or landmark is shown). A: on the Kashmir valley floor the town stands behind the river's flood embankment, on alluvium, Gurti clay and Nambal peat with the water table within 2 m of the ground, where no soakaway, recharge pit or exfiltrating paving is built (Clause 8.8.1, item (i)). Its drains run to a gravity outfall through the embankment, with a flap gate that shuts when the river rises, and to a pumping station that lifts the water over the bund when the gate is shut; the outfall is designed for the river stage and the lock duration of Clauses 5.8.5(a) and 5.10, not for the storm alone. Part of the town drains to a lake through sediment traps and dry-weather-flow interceptors with screens (Clauses 7.10.6 and 8.9); the lake leaves through a gated outlet to the river, which the river's rise also shuts, and through a channel to a nambal downstream, which is kept as the town's flood storage and is not drained, bypassed or filled (Clause 7.12). A flood spill channel takes the river's flood flow past the town, and outfalls to it count as river outfalls. Zone 1 and Zone 2 are measured from the lake's and the nambal's boundary at their seasonal high (definitions after Clause 7.2), and the wider statutory, master-plan and court lines govern (Clause 7.4.5). B: in the Jammu plains the khads leave the Siwalik hills and cross the boulder-gravel Kandi fan, where the water lies deep and recharge of filtered roof water and treated runoff comes first (Clause 8.8.1, item (ii)), to the spring line, below which the khads gain water from the ground and the Sirowal is waterlogged, with flowing wells and no infiltration (item (i)). A talab on the Kandi is kept with its clay bed (Clause 7.9) and spills to the khad. On the hill slope above, roof water goes to the storage of UBBL-2021 and its overflow and the road runoff go by lined drains through sediment traps to the khad, and no soakaway or soak pit is placed on the slope (item (iii)). Zone 1 along the khad is measured from the top of its

boulder bed, and the 50 m of UBBL-2021, clause 7.12(b), for "any other river/khad" governs where the bye-laws apply; the khad's 1% AEP level, found with bulking, sets the flood edge from which Zone 2 is measured, and no land recorded as Gair Mumkin Khad is released before that study (definitions after Clause 7.2). The 15 m minimum, the valley-floor, Kandi and hill infiltration rules, the lake-outlet and nambal rules and the functional-khad study are this Manual's proposals; UBBL-2021, the master plans, the Water Resources Act, 2010 and the orders of the High Court govern where they say more. Original drawing for this Manual.

7.8 Operating rules and pre-monsoon flood cushion

7.8.1 **Operating rule content.** Every tank whose storage is counted under Clause 7.7 shall have a written operating rule, agreed by the custodian and kept with the O&M plan (Chapter 10). It shall state:

- (a) the levels and dates for filling, holding and drawdown through the year;
- (b) the sluice and regulator settings at each level;
- (c) who operates the sluices and regulators, and who may order a release;
- (d) the maximum release rate, set so that the release, added to the flow from the downstream catchment, does not cause flooding of buildings downstream;
- (e) the forecast and warning triggers (IMD district warnings, J&K SDMA alerts, and city forecast systems where available) and the actions taken at each trigger;
- (f) communication with downstream ULBs and residents before any release; and
- (g) the records to be kept: daily levels in the SW monsoon, releases, and gate settings.

7.8.2 **Flood cushion.** A tank may be operated with a flood cushion (a level below FTL during part of the SW monsoon), and the cushion counted under Clause 7.7.3, only where:

- (a) the tank has a gated sluice, regulator or other controllable outlet able to draw the tank down to the cushion level in the time stated in the rule;
- (b) the operating rule fixes the cushion level and the dates it applies;
- (c) continuous simulation (Clause 3.13) shows that the cushion is available at the start of a design storm in at least **90%** of SW monsoon seasons in the record, allowing for the rain that usually comes before the peak storm;
- (d) the custodian accepts any loss of irrigation or water-supply yield, and any agreed compensation is recorded; and
- (e) the release needed to create or restore the cushion meets Clause 7.8.1(d).

7.8.3 **No storage credit without control.** Where a tank has no controllable outlet, no flood cushion shall be assumed, whatever the past practice.

7.8.4 **Coordination.** For tanks under I&FC control, the operating rule shall be I&FC's rule. This Manual does not authorise any other body to operate a I&FC tank.

> **Commentary.** No lake, nambal or talab in Jammu and Kashmir was found with a written operating rule. Dal has the Union Territory's best-known control: the lock and weir at Dal Gate, whose gates, Grierson records, "remain open" when the Jhelum is low and "automatically close" when it rises to a certain height, "thus preventing inundation of the land round the lake"; its other outlet, the Nallah Amir Khan, carries water on to Nigeen, Gilsar, Khushalsar and Anchar. In September 2025 Dal's level was reported at "10.5 feet", with releases possible only "to the extent of two to three feet" because of silt (as reported, with no datum). Regulatory gates at Hokersar are part of the second phase of the Jhelum flood-management plan (as reported), and the Srinagar Master Plan 2035 proposes a "Supplementary Discharge Channel to drain out the overflow of Natural Flood Absorption Basin into Hokersar/Doodhganga". The reservoirs are run by their operators to rules that were not read for this Manual: Salal's gates are opened monthly in the monsoon to flush silt; all the spillways of Baglihar were opened on 1 August 2025 and all the gates of Salal on 12 August 2025; and since India placed the Indus Waters Treaty "in abeyance" in April 2025 such releases may no longer be announced in advance (all as reported). Without an

agreed rule with dates, levels, release rates and a named operator, storage in a lake or reservoir cannot be relied on, and a release made without warning to the towns downstream is itself a flood. Clause 7.8.2 turns that principle into a rule that can be checked, with a reliability test, because a cushion that is refilled by the rain and snowmelt before the peak storm gives no protection when the peak storm comes. The 90% reliability in Clause 7.8.2(c) has no direct precedent and is set by this Manual.

For a lake whose outlet the river can shut, Clause 7.8.3 is the governing condition, and a gate does not make a cushion: Dal Gate closes when the Jhelum rises, which is when the cushion would be needed. A design that relies on such a lake routes the storm with the outlet shut for the lock duration of Clause 5.10 (Clause 5.8.5(e)), starting from the lake's outlet level, or from a higher level where the custodian records one, and shows that the rise in the lake does not flood buildings on its shore; no drawdown before the storm is assumed unless the custodian has agreed it in writing under Clause 7.8.2. This rule is set by this Manual. For a talab or Kandi pond with no controllable outlet, no cushion is assumed, a design that relies on it routes the storm through it from its outlet level, and the outflow over the outlet is limited by the khad or nallah below it, which shall be shown to carry it with the debris of Clause 6.3.6. For a reservoir, a design takes the operator's level and release for the storm being checked (Clause 5.8.3), not a drawdown the operator has not agreed to in writing. Most lakes and nambals have other users: Dal and Nigeen carry about 910 houseboats (JKPCC, 2024), and about ten villages depend on Shallabugh (Forest Department, 2024), which is why Clause 7.8.2(d) requires the custodian to accept any drawdown.

7.9 Restoration, desilting and deepening

7.9.1 **Pre-works survey.** Before any desilting or restoration, the proponent shall:

- (a) survey the waterspread, foreshore, bund, weirs and sluices (Clause 7.7.1(a) and (b));
- (b) find the original bed level by test pits or augering on a grid, and from historical records where available; and
- (c) where the tank receives urban runoff or sewage, test the silt for heavy metals and other contaminants before disposal is planned.

7.9.2 **Desilting limit.** Desilting shall remove accumulated sediment down to the original bed level. It shall not deepen the tank below the original bed, except under Clause 7.9.3.

7.9.3 **Deepening.** Deepening below the original bed is permitted only where a hydrogeological report shows that:

- (a) it will not cut through a clay or silt layer that holds water in the tank or protects an aquifer from polluted water;
- (b) in coastal areas, it will not draw saline water into the tank or the aquifer; and
- (c) the extra storage will be refilled and used, and will not stand stagnant below the sluice sill.

Storage created below the lowest sluice sill shall not be counted as flood storage.

7.9.4 **Safe edges.** Where the public has access to the waterbody edge:

- (a) side slopes shall be no steeper than **1V:4H** from 0.5 m above FTL down to 1.2 m below FTL, or a level safety bench at least 3 m wide shall be provided between 0.3 m and 0.5 m below FTL; and
- (b) no isolated deep pit or vertical cut shall be left in the bed.

7.9.5 **Storage not to be reduced.** Restoration shall not reduce the storage below MWL. Islands, walkways, bund widening into the waterspread, ring roads, parking, buildings and "lake-front" platforms within the waterspread or foreshore shall be counted as lost storage and shall be offset under Clause 7.6.4.

7.9.6 **Silt disposal.** Desilted material shall not be placed within the setback, on the bund (except for approved bund strengthening), or on any flood path. Silt found to be contaminated shall be disposed of as the Jammu and Kashmir Pollution Control Committee (JKPCC) directs.

7.9.7 **Inlet treatment.** Every restoration of a tank that receives urban runoff shall include sediment and gross pollutant control at each inlet: a sediment forebay, a constructed wetland inlet zone, or a gross pollutant trap (Chapter 8), so that the restored storage does not silt up again.

7.9.8 **Timing.** Desilting shall be completed, and the waterbody made safe, by **31 May** each year (Chapter 10).

> Commentary. No Union Territory order fixing a date for the cleaning of drains, nallahs, lakes or talabs was found; the Jammu Municipal Corporation was reported to finish "the first phase" of its drain cleaning before the end of June, and the Srinagar Municipal Corporation ran a dewatering drive in January 2026 "triggered by recent snowfall and subsequent snowmelt" (both as reported). The waterbodies are losing their storage to silt: the flood spill channel of the Jhelum, built for 17,000 cusecs, carried 4,000 cusecs by 2014 "due to accumulation of sediment load from various nallahs which merge with the channel" (CAG Report No. 4 of 2016); the CAG found that the central cunnette and "Flood Threat to River Jhelum" schemes had excavated only 84% and 43% of their quantities, and later "a significant shortfall of targets in terms of dredging" in the first phase of the Jhelum flood-management plan (CAG, PMDP audit, 2021); 60% of Hokersar is reported under heavy siltation, Wular to have lost about 30 per cent of its volume to silt, and Dal's releases to be limited by silt (all as reported). The date of 31 May in this Manual is set by this Manual, before the monsoon's normal onset at Jammu of 28 June (IMD) and ahead of the early onset of 13 June 2021 (as reported); on the Kashmir valley floor the drains and inlets are also cleared of snow, ice and silt by 15 March, ahead of the western-disturbance maximum and the snowmelt of March and April, and cleared a second time by 15 August, ahead of the late-August and September storms; and hill towns clear debris again by 31 October (Chapter 10). Excavation to "increase capacity" is governed by Clause 7.9.3. Two cases need care in Jammu and Kashmir. On the valley floor the lakes and nambals lie in Gurti clay and Nambal peat (CGWB) over aquifers that are artesian in places (in Anantnag district almost every CGWB well drilled below 25 m flows), so deepening can cut through the layer that holds the lake's water or open a path from a polluted lake to a confined aquifer; and in the Kandi the ponds hold water only because of the clay in their beds, which checks "heavy seepage in the highly porous Kandi Belt" (CGWB, citing NIH), so deepening or desilting below that clay drains the pond. This Manual allows no lake or nambal bed in the valley to be deepened below its original bed except under Clause 7.9.3, and no Kandi pond's clay bed to be cut through or removed. Silt from a lake or nambal that receives sewage is tested before disposal (Clause 7.9.1(c)), because the lakes receive the drains of the city (Clause 8.9, Commentary). The 31 May deadline matches the pre-monsoon inspection date of Chapter 10. The limits on deepening are set by this Manual. Deepening tanks to "increase capacity" is common, but it can breach the silt and clay layer that holds water in the tank, it can let polluted urban water reach the aquifer, it can draw salt water toward the coast, and it creates storage below the sluice sill that never empties and gives no flood benefit. Deep pits with steep sides are also a drowning hazard. The slope and bench values in Clause 7.9.4 are adapted from common pond-safety practice; they have no Jammu and Kashmir precedent.

7.10 Supply channels, surplus courses, inlets and outlets

7.10.1 **Part of the major system.** Supply channels and surplus courses are part of the major drainage system (Chapter 6). They shall be protected as waterbodies, with Zone 1 and Zone 2 setbacks under Clause 7.4.

7.10.2 **No closure or covering.** No supply channel or surplus course shall be closed, filled, diverted, covered, culverted along its length, or converted into a road or a closed drain, except under a design approved by the custodian that keeps or increases its 1% AEP capacity and its access for maintenance.

7.10.3 **Crossings.** Every road, rail, utility or access crossing of a waterbody, supply channel or surplus course shall:

- (a) pass the 1% AEP flow (with the climate factor), or the surplus of the upstream tank at its MWL, whichever is greater, with the freeboard required by Chapter 9;

- (b) not reduce the waterway width at the crossing below the full channel width as recorded in Revenue records or as surveyed, whichever is greater;
- (c) keep the channel bed level and grade; and
- (d) not raise the 1% AEP water level by more than the limit in Clause 7.6.2.

7.10.4 **Capacity.** The design capacity of a surplus course shall be the greater of the surplus weir discharge at MWL and the 1% AEP flow from its own catchment, combined as the cascade model (Clause 7.7.2) shows.

7.10.5 **Protection at structures.** Outlets of surplus weirs and sluices, and drain outfalls into waterbodies, shall have energy dissipation and scour protection designed under Chapter 9, so that the flow leaving them does not erode the bund, the bank or the channel bed.

7.10.6 **Drain outfalls into waterbodies.** A storm drain outfall into a tank, channel or wetland shall:

- (a) have its invert at or above the normal water level of the receiving waterbody, unless the drain is designed for submerged outfall under Chapter 5;
- (b) be located and aligned so that it does not cut through or weaken a tank bund;
- (c) have a gross pollutant trap and first-flush treatment (Chapter 8); and
- (d) not carry sewage or dry-weather flow (Chapter 8).

> Commentary. This Manual protects supply channels and surplus courses as part of the major system. In urban areas they are often the first to be lost. Surplus courses are narrowed by culverts and compound walls, and supply channels are covered and turned into roads, which cuts the tank off from its source or leaves its surplus with nowhere to go. In Jammu and Kashmir the drains of a town are understood to vest in its municipal body, under Municipal Acts whose drainage sections were not read for this Manual [TBC]; in Srinagar they are planned and built by UEED and run by the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir, and in Jammu by JMC and UEED's Sewerage and Drainage Division (West); while the rivers, nallahs, khads, embankments, city channels and flood spill channels lie with I&FC (Water Resources Act, 2010, section 81 [TBC]), the road drains with PW (R&B) and NHAI, Dal and Nigeen with LCMA and Wular with WUCMA. No rule or order dividing the natural channels from the municipal drains, or the local bodies' drains from the road drains, was found; Chapter 6 gives this Manual's working assignment. The channels have been lost in the ways this clause is written to prevent. Brari Nambal's main outlet, the Mar Canal, was filled in the 1970s (as reported); the Padshahi Canal, which ran from the Sindh at Ganderbal through Rangpora and Malbagh to Lal Bazar, was encroached (PIL 2/2014), and the High Court directed in April 2015 that the Padshahi Bagh Canal be restored (as recalled in its order of 29 May 2024); the Nallah Amir Khan, Dal's outlet towards Khushalsar and Anchar, is to be revived (Srinagar Master Plan 2035, §14.4.4.2); and the flood spill channel silted to a quarter of its design capacity by 2014 (CAG). In Jammu, "The drainage channels have fallen prey to the accelerated urban growth" (Jammu Master Plan 2032, chapter 1); the roadside drains serve as the storm drains, and only 20% of the roads have side drains, covering about 40% of the city (§5.1.3); the plan calls for "Carrying out EIA before training and covering the drainage channels" (§7.3.2); and it proposes to release for development the land along the khads recorded as Gair Mumkin Khad once the "true Khad" has been fixed with I&FC (§12.2.3), which is land that Clause 7.4 and the functional-khad rule (definitions after Clause 7.2) protect. UBBL-2021 give the watercourses wide lines (clause 7.12(b)) and require that "These restricted development zones and other water courses, which pass through a land shall be developed and maintained according to the discharge of water" (clause 7.12(d)), and the Water Resources Act, 2010 lets I&FC prohibit and remove obstructions (sections 52, 53 and 67 [TBC]); neither keeps a channel at its recorded width once it has been lined, piped, covered or filled, which is the failure Clauses 7.10.2 and 7.10.3 are written to prevent. Clause 7.10.3(b) prevents a crossing from narrowing a channel to its current, encroached width.

7.11 Fee-in-lieu and regional tank storage

7.11.1 Where a basin plan has been notified, and the Authority has adopted alternative S-5 of the Policy Supplement (Clause 1.7), a development may pay a fee in lieu of on-site detention under Chapter 4. The fee shall be applied to restoring or creating storage in a tank, pond or regional facility in the same basin.

7.11.2 Tank storage funded by fee-in-lieu shall:

- (a) meet Clause 7.7.1 in full before it is counted;
- (b) be downstream of the contributing development and upstream of the flood-prone area it is meant to protect;
- (c) be created, or under construction, before the development it serves is occupied, or within a period the basin plan fixes; and
- (d) be recorded in the register of Clause 10.17 with the developments that funded it, so that the same volume is not sold twice.

7.11.3 Fee-in-lieu does not replace:

- (a) the retention requirement of Chapter 4, which is always met on site; or
- (b) the water quality requirement of Chapter 8, which is met on site or in a regional facility treating the same runoff before it reaches the tank.

> Commentary. Chapter 4 provides for fee-in-lieu toward restored talab or tank storage in master-planned basins. Malaysia's 2008 DID checklist allowed on-site detention only for small sites and required community ponds for larger areas (DID, 2008). In Jammu and Kashmir no shared form of storage is required by the building rules: chapter 10 of UBBL-2021 requires rainwater harvesting with no storage volume (only the descriptive "55,000 litres per 100 sq. m. area per Year from rooftops"), and the bye-laws have no detention, peak-flow or "zero runoff" rule. The Srinagar Master Plan 2035 describes "source controls" that "store and slowly release stormwater … (detention) or dispose of stormwater onsite (retention)" and a "stormwater performance standard" of 100% coverage and no waterlogging, with no volume, return period or release rate (§13.3); it proposes the Lelhar–Lasjan floodplain as a "Protected Natural Flood Absorption Basin" and a supplementary discharge channel into Hokersar and the Doodhganga, which are regional flood works, not storage for developments. The Jammu Master Plan 2032 proposes check dams to "harvest rain water in small ponds" and the revival of village talabs for recharge (§§7.3.2 and 8). On the Kashmir valley floor a regional facility cannot infiltrate (Clause 8.8.1): it is storage behind a gated or pumped outfall, and its volume is needed for the outfall-closed case of Clause 5.10. A nambal or flood basin is never sold as storage to a development (Clause 7.12.5). In the Jammu Kandi a restored talab or Kandi pond can recharge the aquifer, as the plan intends. None of these sets a technical standard for counting storage. Clause 7.11.2(b) matters because a tank downstream of the flood-prone area protects nothing. Clause 7.11.3 keeps retention on site: it is the volume-control layer of this Manual, and a regional tank cannot recharge the aquifer under the developed site.

7.12 Wetlands, marshes and estuaries

7.12.1 **Scope.** This clause applies to marshes, swamps, backwaters, estuaries, and tidal creeks and lagoons, including:

- (a) wetlands notified under the Wetlands (Conservation and Management) Rules, 2017 or listed by the Jammu and Kashmir Wetland Authority;
- (b) the Union Territory's five Ramsar sites, Wular Lake (18,900 ha; designated on 23 March 1990), Surinsar–Mansar Lakes (350 ha; 8 November 2005), Hokera (Hokersar) Wetland (1,375 ha; 8 November 2005), Hygam Wetland Conservation Reserve (802 ha; 8 June 2022) and Shallabugh Wetland Conservation Reserve (1,675 ha; 8 June 2022), to their Ramsar boundaries, and any wetland notified under the 2017 Rules;

- (c) the seven Wildlife Conservation Reserves of Order No. 710-C of 17 July 1945, Hokersar, Shallabugh, Hygam, Freshkoori, Kranchoo, Chatlam and Manibugh, and the wetland reserves of the Srinagar Master Plan 2035 (Table 8-4);
- (d) the lakes, nambals and flood basins of the Kashmir valley, such as Dal, Nigeen, Brari Nambal, Gilsar, Khushalsar, Anchar, the Shalbug Nambal and the Haran forest, Narkara (Nambal Narkur), Mirgund, Rakh-e-Arth, the Pampore lagoons, Manasbal and the Wular marshes, the wetlands of the national atlas, and the wet margins, springs and seeps of the valley and the hills, within the 1% AEP extent of Clause 7.3.4 (a river, lake or reservoir itself is also a waterbody under the rest of this chapter); and
- (e) any other nambal, marsh or wetland that the Authority notifies, that the wetland authority lists, that is listed before the National Green Tribunal (such as the 27 wetlands of more than 1 ha outside forests listed in 2026), or that the High Court of Jammu & Kashmir and Ladakh or the National Green Tribunal directs to be protected.

7.12.2 **No drainage of wetlands.** No drain, channel, cut or pump shall be designed to drain a wetland, to lower its normal water level, or to reduce the period for which it is wet, except under a plan approved by the wetland authority.

7.12.3 **Inflows.** Every drain discharging into a wetland in Clause 7.12.1 shall:

- (a) meet Clause 7.10.6;
- (b) pass through water quality treatment for the WQv of its catchment (Chapter 8) before entering the wetland; and
- (c) where practicable, spread its flow across a vegetated margin rather than discharge at one point.

7.12.4 **Hydraulic connectivity.** Roads, embankments and utility corridors across or along a wetland shall have openings that:

- (a) pass the 1% AEP flow without raising the 1% AEP water level by more than the limit in Clause 7.6.2; and
- (b) keep the wetland's normal water exchange, including tidal exchange in estuaries, with openings spread along the crossing so that no part of the wetland is cut off.

7.12.5 **Storage counted at basin scale only.** Wetland storage shall be included in basin and regional models. It shall not be counted as detention for any individual development.

7.12.6 **Tidal wetlands and estuaries.** For estuaries and tidal wetlands:

- (a) tailwater shall be taken from Chapter 5 (Clause 2.12 joint cases);
- (b) works shall also comply with the Coastal Regulation Zone Notification in force; and
- (c) mouth-opening works, training walls and dredging are outside the scope of this Manual and need their own studies.

7.12.7 **No dumping.** No solid waste, construction debris or dredged material shall be placed in a wetland or its setback.

> Commentary. Jammu and Kashmir's wetlands are the concern of the **Jammu and Kashmir Wetland Authority**, constituted under the Wetlands (Conservation and Management) Rules, 2017 by a notification of 25 November 2020 of the Forest, Ecology and Environment Department (its number is uncertain in the copy read), which met on 31 March 2021 and 3 August 2022, considered Dal–Nigeen and Wular, and "approved … for Notification" the Brief Document of Wular, with its integrated management plan; a wetland management cell was proposed in the Department of Ecology, Environment and Remote Sensing. **No wetland had been notified under rule 4 of the 2017 Rules** as of September 2024 (Forest Department report of 9 September 2024 in NGT O.A. 239/2024), and a plan of 2021 to declare Wular, Dal, Nigeen, Sanasar, Manasbal and Purmandal "Protected Wetlands" was reported, not confirmed. The Union Territory has five Ramsar sites: **Wular Lake** (designated on 23 March 1990; 18,900 ha), **Surinsar–Mansar Lakes** (8 November 2005; 350 ha), **Hokera (Hokersar) Wetland** (8 November 2005; 1,375 ha), **Hygam Wetland Conservation Reserve** (8 June 2022; 802 ha) and **Shallabugh Wetland Conservation Reserve** (8 June 2022; 1,675 ha) (Ministry of Environment, Forest and Climate Change, list of 31 January 2024); WUCMA gives Wular as 13,000 ha and the Wildlife Department Hygam as 7.62 km², and this Manual uses the Ramsar

figures. Seven wetlands, **Hokersar, Shallabugh, Hygam, Freshkoori, Kranchoo, Chatlam and Manibugh**, are **Wildlife Conservation Reserves**, first notified as game reserves and State rakhs by Order No. 710-C of 17 July 1945 under the Game Preservation Act of 1942, and now under the Wildlife (Protection) Act, 1972, which applies to the Union Territory from 31 October 2019 (Wildlife Department, 27 July 2024). "In the Kashmir Valley alone, wetlands occupy an area of nearly 42,661 hectares comprising of 755 small and large water bodies" (as quoted in the National Green Tribunal's order). The wetlands that matter to drainage are the nambals and flood basins that receive the city's outfalls and the river's floods: Hokersar, fed by the Doodhganga and the Sukhnag "on the flood plain of River Jhelum" about 10 km west of Srinagar, with depths of 0.75 to 2.50 m (Forest Department), is reported to have shrunk from 18.75 km² to about 13 km² and to have "lost nearly half of its flood storage capacity"; Wular from 157.74 km² in 1911 to 86.71 km² in 2007; Narkara to be 37 per cent built over; and the valley's wetlands as a whole to have declined by about 25% between 1990 and 2020 while built-up land increased by about 1,500% (all as reported). No flood-storage volume was found for any of them. In Jammu the National Green Tribunal was told in 2026 of 27 wetlands of more than 1 ha outside forests, 10 in Jammu district, 9 in Samba, 6 in Kupwara and one each in Kathua and Baramulla, and that all three samples from the Jammu wetlands failed water-quality Class B (order of 13 November 2026 in O.A. 239/2024, as reported). A drain outfall, desilting, diversion or gate operation in or near a Ramsar site, a Wildlife Conservation Reserve or a notified wetland therefore needs the views or permission of the Wetland Authority or the Wildlife Department where the Rules or the Wildlife (Protection) Act, 1972 reach it, the consent of LCMA or WUCMA at Dal–Nigeen and Wular, and compliance with this chapter; for the nambals, talabs, springs and wet margins they do not reach, this chapter, the bye-laws and the master-plan buffers are the only controls. Clause 7.12.2 targets a specific risk: drains built to relieve flooding next to a marsh can drain the marsh itself, and once it is dry it is encroached. Sewage reaches Jammu and Kashmir's lakes, nambals and rivers through the drains (Clause 8.9, Commentary): "Untreated sewage gets entry into the Dal Lake from areas like Telbal, Lalbazar etc." (JKPCC, 2024), the samples of December 2025 were reported to flag the outfalls of the Habak and Hazratbal treatment plants on Dal (as reported), and all three samples from the Jammu wetlands before the National Green Tribunal in 2026 failed water-quality Class B (as reported). Clauses 7.10.6(d) and 7.12.3 therefore cannot yet be met by many existing outfalls. In Jammu and Kashmir they apply in full to every new outfall, and every existing outfall to a lake, nambal, wetland, talab, reservoir or river that carries dry-weather flow comes under the annual survey and the interception of Clauses 8.9.4 and 8.9.5 until its sources are removed; every outfall to Dal, Nigeen, Anchar or Wular, and to any other lake, nambal or Wildlife Conservation Reserve, carries a DWF interceptor and a screen whether or not DWF has yet been measured in it (Clause 8.9, Commentary). Every drain that enters a lake, nambal or talab also passes a sediment trap first (Figure 7.3), because the lake is the end of its catchment's drainage and has no other way to lose the silt. The flood-absorption marshes downstream of Srinagar's outfalls, Hokersar, Narkara, Shallabugh, Rakh-e-Arth and Anchar, are part of the city's drainage: no drain, channel or pumped outfall whose catchment now drains to one of them shall be designed to bypass it, none shall discharge to it without the sediment trap and interception above, and no drain shall be designed to lower its level (Clause 7.12.2); this rule is set by this Manual.

7.13 Encroachment interfaces

7.13.1 **Boundary.** For design under this Manual, the boundary of a waterbody is the larger of its Revenue record boundary and its surveyed FTL (or top of bank), as in Clause 7.3.3. Setbacks are measured from that boundary.

7.13.2 **No reliance on encroached land.** No design shall:

- (a) count, as storage or conveyance, land within a waterbody boundary that is occupied by encroachment, unless its removal is ordered and funded; or
- (b) treat the encroached width of a channel as its design width.

7.13.3 **Public works in encroached reaches.** Where a public drainage work passes through an encroached reach:

- (a) it shall be designed for the full waterbody width (Clause 7.13.1);

- (b) where the full width cannot be cleared before the work is built, the design report shall state the interim capacity and the flood risk until it is cleared; and
- (c) the work shall be built so that the full width can be restored later without rebuilding it.

7.13.4 **Boundary marking.** Every development adjoining a waterbody shall, before the completion certificate:

- (a) mark the outer edge of Zone 1 on the ground with permanent survey markers at intervals of not more than 30 m and at every change of direction; and
- (b) show the setback zones on the approved layout plan and in the sale documents of every plot that includes setback land.

7.13.5 **Retaining walls.** No retaining wall, bund or embankment shall be built along the edge of a waterbody, within Zone 1, to protect or reclaim land, except to protect existing public infrastructure under the custodian's approval.

> Commentary. Jammu and Kashmir's main controls on building in its rivers, lakes and marshes are the bye-laws, the master plans and the courts, and the High Court has done most of the work. In the public interest litigation that followed the floods of 2014 (PIL 8/2017 with PIL 2/2014 and PIL 18/2018, *Environmental Policy Group v. Union of India*) it held on 24 November 2014 that "A duty is cast upon the Chief Engineer and other statutory authorities to ensure removal of all encroachments from the banks of River Jhelum along its entire course"; directed on 24 February 2015 that a committee under the Divisional Commissioner ensure "that the original width of the river Jhelum is restored", and that "Since, the Court is Custodia Legis of river Jhelum and other water bodies, no Court or Tribunal shall consider any suit/ application / appeal" on them; recorded on 7 April 2015 that the actual width had not been demarcated; directed the Deputy Commissioners in 2016 "to ensure that no construction of any kind is raised near the water bodies within their territorial jurisdiction"; and ordered in 2017 the demarcation of the wetland reserves "as concomitant steps towards the main aim of preventing floods" (all as quoted in its order of 29 May 2024, which asked for affidavits of compliance on the encroachments removed from the Jhelum). In September 2025 the Court was reported to have named "Rakh Arth, Transworld University, and IIM Srinagar" as encroachments that could aggravate flood vulnerability (as reported; not read). For Dal the Court has held a 200 m no-construction line since 2002, and for Wular it was reported in November 2020 to have barred construction within 200 m and ordered encroachments removed (Clause 7.4, Disclosure). WUCMA reports encroachment on Wular and land retrieved from it, but its figures are internally inconsistent and are not cited here. The National Green Tribunal, in O.A. 239/2024 on the Kashmir wetlands, found on 13 November 2026 that the wetland areas reported from the Revenue records for 27 wetlands of more than 1 ha outside forests were "insufficient", asked for the existing area on the ground, and was told that a recorded rakh in Baramulla was "not existing on the spot" and used for paddy (as reported); 37 per cent of Narkara is reported built over. The Water Resources Act, 2010 states a policy of "complete ban on encroachment on water bodies, wetlands, water courses" (section 4) and lets I&FC prohibit and remove obstructions and encroachments (sections 52, 53 and 67), with offences for building that changes the flow of a water source (section 168) (section numbers [TBC]); and the CAG found a 1,641 m drainage channel in a wetland stopped for want of the wetland authority's no-objection certificate (CAG Report No. 4 of 2016). In Jammu the master plan records that developed colonies on land recorded as Gair Mumkin Khad, such as Trikuta Nagar, Sainik Colony, Sunjwan, Bhatandi and Roopnagar, "would fall under the category of illegal development" under that classification, and proposes to resolve it by fixing the "true Khad" with I&FC (Jammu Master Plan 2032, §12.2.3); this Manual requires that study to be hydraulic (definitions after Clause 7.2). This Manual cannot evict anyone. It can stop designs from treating encroachment as permanent (Clause 7.13.2), make public works restorable to full width (Clause 7.13.3), and make the setback visible on the ground and in property documents so that new buyers know it is there (Clause 7.13.4). The 30 m marker interval is set by this Manual.

7.14 Safety of tank bunds and embankments

7.14.1 **Dam Safety Act screening.** For every tank, and every embankment built or altered under this Manual, the designer shall determine whether it is a "specified dam" under the Dam Safety Act, 2021. Under the Act, a specified dam is a dam:

- (a) more than 15 m high, measured from the lowest point of the general foundation area to the top of the dam; or
- (b) between 10 m and 15 m high, where the crest length is not less than 500 m, or the reservoir capacity is not less than one million m³, or the maximum flood discharge dealt with by the dam is not less than 2,000 m³/s, or the dam has specially difficult foundation problems, or the dam is of unusual design.

Where it is a specified dam, the Act and the requirements of the State Dam Safety Organisation govern, in addition to this Manual.

7.14.2 **Hazard class.** Every tank bund and detention embankment that is not a specified dam shall be given a hazard class:

- **High hazard:** a breach could flood a habitable building, a school, a hospital, an arterial road or critical infrastructure.
- **Low hazard:** any other case.

7.14.3 **High-hazard embankments.** For high-hazard tank bunds and embankments:

- (a) the surplus weir or spillway shall pass the 1% AEP inflow at MWL with the freeboard of Clause 7.7.4(b), and shall be checked for the 0.2% AEP (500-yr) inflow without overtopping the bund (as for detention basins in Chapter 4);
- (b) a breach analysis shall map the area flooded by a breach at MWL;
- (c) an emergency action plan shall be prepared, with the warning and evacuation arrangements for the breach area; and
- (d) the design shall be certified and independently checked under Clause 10.6.

7.14.4 **Inspection.** Every tank whose storage is counted under Clause 7.7, and every high-hazard embankment, shall be inspected before the SW monsoon (by 31 May) and after every heavy-rainfall event (Chapter 10) for seepage, slips, cracks, animal burrows, trees on the bund, and blockage of the weir and sluices.

7.14.5 **No unauthorised cutting.** No person shall cut, lower or breach a tank bund or surplus weir during a flood except under the custodian's emergency procedure.

> **Commentary.** The definition of a specified dam is quoted from the Dam Safety Act, 2021 (Act 41 of 2021). The Act defines a "dam" as an artificial barrier constructed across rivers or tributaries to impound or divert water. It excludes flood embankments, dikes and guide bunds. The lakes and nambals of the Kashmir valley are natural waterbodies, not held by tank bunds, though their outlets are regulated by gates, locks and weirs such as Dal Gate; the Jhelum's flood embankments, which hold the river away from Srinagar and the other valley towns, are flood embankments and so outside the Act's definition of a dam; and the Kandi ponds and village talabs are too low to be specified dams. Each outlet work, gate or bund shall still be screened under Clause 7.14.1. The dams of the Chenab and its tributaries, such as Salal, Baglihar, Dul Hasti, Ratle and Pakal Dul (a 167 m concrete-faced rockfill dam, NHPC), are specified dams under the Act, and the Tawi barrage at Jammu shall be screened when its levels and gates are known [TBC]. Where the storage of a lake, talab or reservoir is counted under Clause 7.7, its bund, outlet works or dam is a tank bund for Clause 7.14.2 unless the Act applies. A glacial or moraine-dammed lake is never counted as storage, but where it lies upstream of a town, its breach path is mapped as a hazard (definitions after Clause 7.2; Chapter 5). Whether a tank bund that is not across a river or tributary is a "dam" under the Act is not clear from its text. In Jammu and Kashmir the embankments that matter most to the towns are the Jhelum's flood embankments through the Kashmir valley, and they have failed: in September 2014 the river breached them, and the floodwater stood up to 16 feet deep, for up to 25 days (Malik, 2021), over 262 km² of

> the Srinagar planning area (Srinagar Master Plan 2035); the CAG found that the flood spill channel had silted from its design capacity of 17,000 cusecs to 4,000, and that, had two earlier flood schemes been carried out as approved, "the impact of the floods of September 2014 may have been mitigated" (CAG Report No. 4 of 2016). The locations of the 2014 breaches were not found for this Manual. The Water Resources Act, 2010 bars any building, railing or platform on the slopes of an embankment and makes it an offence (sections 81(4) and 168 [TBC]). On the Chenab, the reservoirs of Salal and Baglihar opened all their gates and spillways in August 2025, and their gate operations may now be unannounced (as reported; Clause 7.8, Commentary). In the high mountains, glacial lakes and landslide dams are hazards for which no inventory or breach study in the Union Territory was read. No breach map or emergency action plan for an embankment, a lake gate, a barrage or a reservoir was read for this Manual. A failed or overtopped bund floods the town below it, a breach of the Jhelum's embankments floods the city behind them for weeks, and an unannounced release floods the towns below a dam, which is why Clause 7.14.3 asks for breach mapping and an emergency action plan for high-hazard embankments; for the Jhelum's own embankments, a breach is the residual risk of Chapter 5, mapped and warned for, not a design case. The hazard classes, the breach analysis and the emergency action plan for high-hazard tanks are set by this Manual. They extend the Chapter 4 requirement for detention basins (1% AEP spillway with outlet blocked, 0.2% AEP for high-hazard basins) to tanks that are counted as design storage.

7.15 Submittal requirements

Every drainage report for a development or work under Clause 7.1.2 shall include:

1. the **Waterbody Sheet (Form 7-1)** under Clause 7.3.2, with the setback zones and their basis (mapped extent, hydraulic study or fixed width);
2. the hydraulic study of the 1% AEP extent and floodway, where Clause 7.3.4 requires it;
3. the **Compensatory Storage Calculation (Form 7-3)**, by elevation band, where fill is proposed in the flood fringe;
4. for any tank storage counted: the **Tank Storage Credit Sheet (Form 7-2)**, with the survey, stage–storage curve, operating rule, cascade model results and custodian concurrence of Clause 7.7.1;
5. for any crossing, outfall or work in Zone 1: the custodian's NOC and the hydraulic analysis of Clause 7.6.2 or 7.10.3;
6. for restoration or desilting: the pre-works survey, silt tests and hydrogeological report of Clause 7.9; and
7. for any embankment: the Dam Safety Act screening and hazard class of Clause 7.14.

7.16 Review and update

7.16.1 This chapter shall be reviewed with the rest of the Manual (Chapter 1). The fixed-width table of Clause 7.4.6 shall also be reviewed within 2 years of the Authority adopting 1% AEP flood maps for its area.

7.16.2 Where the Authority adopts new 1% AEP flood maps, they apply to new submittals **6 months** after adoption, unless the Authority notifies otherwise.

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Annexes and forms

Annex / Form	Content
7A	Statewide waterbody GIS layer and inventory fields
7B	Fixed-width setback table (alternative S-3, with Annex 1C)
7C	Template tank operating rule, with flood cushion
7D	Desilting and restoration specification
7E	Glossary of Kashmiri and Urdu waterbody terms and regional variants
Form 7-1	Waterbody Sheet
Form 7-2	Tank Storage Credit Sheet
Form 7-3	Compensatory Storage Calculation (by elevation band)

CHAPTER 8

Water Quality and Recharge

8.1 Purpose and scope

8.1.1 This chapter sets the requirements for the quality of stormwater leaving a site or a public drainage system, and for groundwater recharge. It covers:

- (a) the water quality volume (WQv) and the water quality design flow;
- (b) the treatment train, and the selection and design of best management practices (BMPs);
- (c) the criteria for infiltration and recharge;
- (d) the exclusion of sewage and dry-weather flow from storm drains;
- (e) gross pollutant traps, first-flush treatment and screens at outfalls to waterbodies;
- (f) how rainwater harvesting (RWH) fits with retention and detention;
- (g) erosion and sediment control during construction; and
- (h) monitoring.

8.1.2 This chapter applies to every development and public work to which Chapter 4 applies (Chapter 1). Clauses 8.9 (sewage) and 8.12 (construction erosion and sediment control) apply to every development that needs a building permit or layout approval, and to every public drainage work, whatever its size.

8.1.3 Retention under Chapter 4 is the first and preferred form of water quality control. Runoff retained on site is treated in full. The rest of this chapter applies to the part of the WQv that is not retained.

> **Commentary.** CPHEEO (2019) is the only Indian manual that covers stormwater quality in any detail. Its Chapter 9 reproduces US event mean concentrations, but cautions that "in an Indian context the values would be much higher" because drains receive night soil, urine and food waste, and it sets no Indian numeric criteria (CPHEEO 2019, Part A §9.5). Its Chapter 10 describes water-sensitive urban design, LID and SuDS treatment trains (CPHEEO 2019, Part A Ch. 10). This chapter turns that guidance into requirements. It follows the treatment approach of the MARC/APWA BMP Manual (2012), now merged into APWA 5600 (2025.01), with the Malaysian 3-month ARI water quality storm (MSMA 2, 2012) and the Georgia water quality volume (GSMM, 2016) as tropical and US benchmarks.

8.2 Definitions

Term	Meaning in this Manual
Water quality volume (WQv)	The runoff volume that must be retained or treated, from the water quality rainfall depth (Clause 8.4).
Water quality rainfall depth (P_wq)	The greater of the retention depth (Annex 2E, Clause 2.10) and the 24-hour 3-month ARI depth (Annex 8A).

Term	Meaning in this Manual
3-month ARI depth	The 24-hour rainfall depth equalled or exceeded on average four times a year, from a partial-duration series of the long-term daily record.
Water quality design flow (Q_wq)	The peak flow from the 3-month ARI storm, used to size flow-through devices and diversion structures (Clause 8.4.5).
Runoff coefficient for WQv (Rv)	The volumetric runoff coefficient for small storms, Rv = 0.05 + 0.009·I.
BMP	A best management practice: a structural or non-structural measure that reduces pollutant loads or runoff volume.
Treatment train	Two or more BMPs in series, from source to site to regional scale (Clause 8.5).
Pretreatment	A BMP that removes coarse sediment, litter and oil before runoff reaches a filter or infiltration BMP.
First flush	The early part of a runoff event, which usually carries the highest concentrations of sediment, litter and oil.
Gross pollutant trap (GPT)	A device that captures litter, plastics, vegetation and coarse sediment, typically above about 5 mm.
Dry-weather flow (DWF)	Flow in a storm drain when it has not rained for at least 72 hours. In a separate storm system, DWF is evidence of sewage, sullage, groundwater infiltration or illicit discharge.
Cross-connection	Any pipe, channel or opening that lets sewage or sullage (grey water from kitchens, bathrooms and laundries) enter a storm drain.
Infiltration facility	A facility designed to store runoff below the ground surface, or in a depression, and let it soak into the soil: infiltration trenches and basins, unlined bioretention, permeable pavement with an open base, soakaways, recharge pits and recharge wells.
Seasonal high groundwater table	As defined in Clause 3.10.2: the highest level in the SW monsoon season.
Hotspot	A land use with a high risk of spills or contaminated runoff (Clause 8.8.8).
Level of Service (LoS) / Value Rating (VR)	The scoring system of Clause 8.6, from the MARC/APWA BMP Manual (2012).

8.3 Objectives and pollutants of concern

8.3.1 Stormwater treatment under this Manual shall aim to:

- (a) remove litter, plastics and other gross pollutants before they reach a waterbody;
- (b) remove suspended sediment, and the metals, nutrients and oil carried on it;
- (c) keep sewage and sullage out of storm drains and waterbodies;
- (d) recharge groundwater where soils and groundwater depth allow, without polluting it; and
- (e) prevent erosion and sediment discharge during construction.

8.3.2 The design shall address the following pollutants for every site, and the hotspot pollutants of Clause 8.8.8 where they apply:

Table 8.1 — Pollutants of concern, sources and primary controls

Pollutant	Main sources in Jammu and Kashmir towns	Primary control
Gross pollutants (plastics, litter, vegetation)	Streets, markets, open dumping in drains	Source collection; GPTs and screens (Clause 8.10)

Pollutant	Main sources in Jammu and Kashmir towns	Primary control
Suspended sediment	Construction sites, unpaved roads and verges, road wear, drain silt	Erosion and sediment control (Clause 8.12); pretreatment; filtration
Oil, grease and fuel	Roads, parking, fuel stations, workshops, bus depots	Oil-grit separators at hotspots; bioretention
Pathogens and organic load (BOD)	Sewage and sullage cross-connections, animal waste	Exclusion and DWF interception (Clause 8.9)
Nutrients (N, P)	Sewage, fertiliser, food waste, detergents	Exclusion; bioretention; wetlands
Heavy metals	Roads, roofs, industrial yards	Filtration; sedimentation

> **Commentary.** Gross pollutants and sewage come first in Clause 8.3 because they dominate the pollution of urban waterbodies in Jammu and Kashmir, and because no treatment BMP works for long if they are not removed. CPHEEO (2019) notes that Indian drains carry night soil, urine and food waste (Part A §9.5). In its WSUD procedure it lists TSS, total nitrogen, total phosphorus and gross pollutants as the key pollutants (Part A Ch. 10). AMRUT 2.0 funds the harvesting of rainwater "through storm water drains into water body (which is not receiving sewage/effluent)" (Lok Sabha unstarred question AU1419), which only works if sewage is first kept out of the drains.

8.4 Water quality volume and design flow

8.4.1 **Water quality rainfall depth.** The water quality rainfall depth is:

> $P_{wq} = \max(P_{ret}, P_{3m})$

where:

- P_{ret} = the retention depth for the site's zone (Annex 2E, Clause 2.10), mm; and
- P_{3m} = the 24-hour 3-month ARI depth for the site's zone (Annex 8A), mm.

8.4.2 **Water quality volume.** The WQv shall be computed as:

> $WQv = (P_{wq} / 1000) \times Rv \times A$

where:

- WQv is in m³;
- A = the contributing area, m²;
- $Rv = 0.05 + 0.009 \cdot I$; and
- I = the impervious percentage of the contributing area (0–100), after the connectivity rules of Clause 3.9.

The Rv form above may be used only for sites under 0.5 ha and under the Tier B simplified method (Clause 4.14). This is the same limit as for the retention volume (Clause 4.4.2). For all other sites the WQv shall be computed with the SCS-CN method, as the retention volume is: WQv (m³) = 10 × Q_{wq} × A, where Q_{wq} (mm) is the SCS-CN runoff from P_{wq} for each sub-area and A is in ha.

8.4.3 **Climate factor.** The climate factor of Clause 2.8 shall not be applied to P_wq. P_ret and P_3m are frequency statistics of ordinary rainfall, not AEP design depths.

8.4.4 **WQv met by retention.** The volume retained on site under Chapter 4 counts toward the WQv in full. Where the retained volume is equal to or greater than the WQv, no further treatment is required for that area, except:

- (a) pretreatment of inflows to each retention facility (Clause 8.5.3);
- (b) hotspot controls (Clause 8.8.8); and
- (c) the outfall requirements of Clause 8.10, where the site discharges to a waterbody.

8.4.5 **Water quality design flow.** Flow-through devices (swales, filter strips, oil-grit separators, GPTs) and diversion weirs for off-line BMPs shall be sized for Q_wq. Q_wq shall be computed from the 3-month ARI intensity at the time of concentration of the contributing area:

- (a) by the Rational Method, where Chapter 3 allows it (a single element draining no more than 16 ha); or
- (b) as the peak of a hydrograph method using the 3-month ARI 24-hour depth with the alternating-block pattern of Clause 2.9.1.

8.4.6 **Bypass.** Flows above Q_wq shall bypass flow-through and off-line treatment devices without washing out the material already captured. The bypass shall be part of the minor or major system (Chapter 6).

8.4.7 **Drawdown.** Where the WQv is held in an extended-detention BMP (wet pond, constructed wetland or dry extended-detention basin), it shall be released over **24–48 hours** (Chapter 4).

> Commentary. The WQv depth is the runoff from the 3-month ARI storm or the retention depth, whichever is greater. The 3-month ARI is the Malaysian water quality design storm (MSMA 2, 2012). The Malaysian 2008 checklist gave its depth as about 40 mm and said it captures 90% or more of 24-hour storm runoff volume (DID, 2008). The Jammu and Kashmir value must be computed (Annex 8A). Georgia sets its WQv as the runoff from 1.2 inches (about 30 mm), the depth that covers 85% of storms in an average year, and requires 80% removal of the average annual post-development TSS load (GSMM 2016, Vol 1, Standard #4). Kansas City's water quality storm is the 1.37-inch (about 35 mm) event that produces up to 90% of the runoff from all 24-hour storms in a year (MARC BMP Manual, 2012).
>
> The Rv formula is from the MARC/APWA BMP Manual (2012), which computes WQv = P × Rv with Rv = 0.05 + 0.009·I. Rv is used instead of the SCS curve number because the CN method greatly understates runoff from small storms on pervious ground. Not applying the climate factor (Clause 8.4.3) has no direct precedent; this Manual does so because it treats P_wq like the retention depth, as a statistic of ordinary rainfall. Bypass of larger flows and the 24–48 hour drawdown follow Chapter 4; MARC (2012) required at least 40 hours of extended detention of the WQv.
>
> **Illustrative — not design values.** For a 1.0 ha site with 80% impervious cover and an assumed P_wq of 50 mm:
>
> - Rv = 0.05 + 0.009 × 80 = 0.77
> - WQv = (50 / 1000) × 0.77 × 10,000 = 385 m³

8.5 Treatment train and pretreatment

8.5.1 **Treatment train.** Water quality control shall be designed as a treatment train, in the order shown in Figure 8.1:

- (a) **source controls** on the plot: roof runoff to RWH, rain gardens, permeable paving, disconnection of impervious areas, and silt traps at inlets;

- (b) **site controls**: bioretention, swales, filter strips, infiltration, oil-grit separators at hotspots, wet ponds and extended detention; and
- (c) **regional controls**, for public drainage: GPTs and DWF interceptors at outfalls, constructed wetlands at tank inlets, and regional ponds.

8.5.2 A development shall meet the WQv on site, through (a) and (b). Regional controls under (c) may count toward a development's WQv only where a regional facility treating the same runoff has been built under a notified basin plan (Clause 7.11).

8.5.3 **Pretreatment.** Every bioretention cell, infiltration facility, permeable pavement receiving run-on, wet pond and constructed wetland shall have pretreatment at each concentrated inflow. Pretreatment shall be a sediment forebay, grass filter strip, silt trap or proprietary device that holds at least **10% of the WQv** of its contributing area, or that is sized for Q_wq for flow-through devices.

8.5.4 Pretreatment shall be accessible for cleaning without entering or disturbing the main BMP.

> **Commentary.** The treatment train follows CPHEEO (2019, Part A §10.2.3, SuDS treatment train) and CIRIA C753 *The SuDS Manual* (2015). It is also the order of priorities of this Manual: preserve, retain, detain, convey (Chapter 1). The 10% forebay volume has no Indian precedent; it is a common sizing rule for forebays in US manuals. In Jammu and Kashmir, unpaved verges, construction sites and drain silt deliver a heavy sediment load. Bioretention and infiltration facilities without pretreatment clog, often within a year or two.

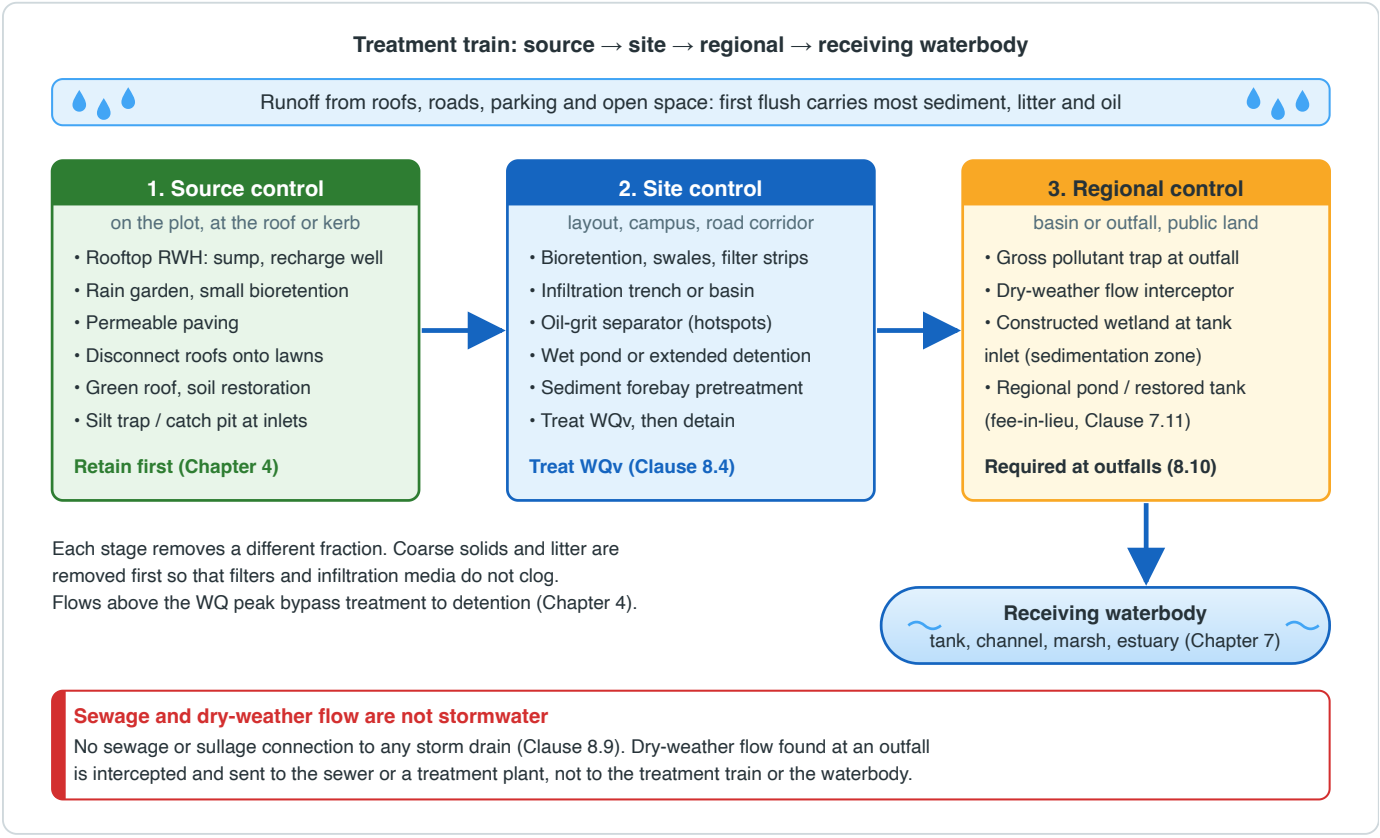


Figure 8.1 — Treatment train: source, site and regional controls before the receiving waterbody, with sewage and dry-weather flow kept out of the system. Original drawing for this Manual, adapted from CIRIA, The SuDS Manual (C753), 2015, and MARC/APWA, Manual of Best Management Practices for Stormwater Quality, 2012.

8.6 BMP selection: Level of Service and Value Rating

8.6.1 **Method.** In Tier A areas, the BMPs for each site shall be selected by the Level of Service (LoS) method of this Clause. In Tier B areas, the simplified route of Clause 8.6.5 may be used.

8.6.2 **Required Level of Service.** For a site that is not redevelopment, the required LoS depends on the change in curve number (ΔCN) from pre- to post-development (Chapter 3):

Table 8.2 — Required Level of Service for sites that are not redevelopment

ΔCN	Impact	Required LoS
17 or more	High	8
7 to 16	Moderate	7
4 to 6	Low	6
1 to 3	Minimal	5

For redevelopment (existing impervious cover of 20% or more of the site), the required LoS shall be taken from Annex 8B.

8.6.3 **Value Rating.** Each BMP treating the WQv has a Value Rating (VR) from Table 8.3. The site's composite VR is the area-weighted average of the VRs of the BMPs serving each part of the site. Treatment trains get a composite VR under Annex 8B. The composite VR shall be equal to or greater than the required LoS.

8.6.4 **Conditions for a Value Rating.** A BMP earns its VR only if:

- (a) it is sized for the WQv (or Q_wq for flow-through devices) of the area credited to it;
- (b) it meets the design requirements of Clause 8.7 and, for infiltration, Clause 8.8; and
- (c) it has pretreatment under Clause 8.5.3.

8.6.5 **Tier B simplified route.** In Tier B areas, the requirement of Clause 8.6.3 is deemed met where the whole WQv of the site is either:

- (a) retained on site under Chapter 4; or
- (b) treated by a bioretention cell, rain garden or infiltration facility designed under Clauses 8.7 and 8.8, with pretreatment.

Table 8.3 — BMP Value Ratings and suitability in Jammu and Kashmir

BMP	VR (MARC 2012)	Main pollutants removed	Volume reduction / recharge	Kandi boulder-gravel fans and khad beds	Laterite / hard rock	Valley floor (Gurti clay, Nambal peat), Sirowal or Upper Karewa / high water table	Jammu and Kashmir notes
Native vegetation (preserved)	9.25	All	High	Suited	Suited	Suited	Counts only for preserved, undisturbed area
Rain garden / infiltration	9.0	Sediment, metals, oil, nutrients	High	Suited if 1.0 m separation met	Conditional (test)	Not suited	Mosquito control: drain within 48 h
Bioretention	8.5	Sediment, metals, oil, nutrients	Medium–high (unlined); low (lined)	Suited	Suited, with underdrain	Lined, with underdrain	Media source and phosphorus content to be specified

BMP	VR (MARC 2012)	Main pollutants removed	Volume reduction / recharge	Kandi boulder-gravel fans and khad beds	Laterite / hard rock	Valley floor (Gurti clay, Nambal peat), Sirowal or Upper Karewa / high water table	Jammu and Kashmir notes
Permeable pavement	7.5	Sediment, metals, oil	Medium–high	Suited	Conditional	Lined only	Not where run-on carries heavy silt
Extended detention wetland	7.0	Sediment, nutrients, metals	Low	Conditional (water balance)	Suited	Suited	Good at tank inlets (Clause 7.9.7)
Media / sand filter	6.0	Sediment, metals	Low	Suited	Suited	Suited (lined)	Needs frequent cleaning
Extended wet detention (wet pond)	5.0	Sediment, metals, some nutrients	Low	Conditional (water balance)	Suited	Suited	Dry-season water balance (Clause 8.7.8)
Vegetated filter strip	5.0	Sediment	Low–medium	Suited	Suited	Suited	Mostly as pretreatment
Native vegetation swale	4.0	Sediment, oil	Low–medium	Suited	Suited	Suited	Not where Q_wq velocity is high
Extended dry detention	4.0	Coarse sediment	Low	Suited	Suited	Suited	Combine with detention (Chapter 4)
Proprietary / hydrodynamic devices	3.0–5.0	Coarse sediment, oil, litter	None	Suited	Suited	Suited	VR from verified test data only
Signage (public education)	+0.25	—	—	—	—	—	Added to composite VR

The VR column is from the MARC/APWA BMP Manual (2012), Table 4.4. The suitability columns and notes have no direct precedent and are set by this Manual.

> **Commentary.** The LoS and VR method is from the MARC/APWA Manual of Best Management Practices for Stormwater Quality (2012), Tables 4.2 and 4.4. The VRs combine a water quality score, based on effluent TSS concentrations in the International Stormwater BMP Database, with scores for volume reduction, temperature, and oils and floatables. The method suits Jammu and Kashmir for two reasons. It rewards volume reduction and preservation, which also serve recharge. It can also be checked by a reviewer without water quality modelling. Its weakness is that the scores come from US data. Jammu and Kashmir stormwater carries more litter and more sewage than the US runoff behind the scores (CPHEEO 2019, §9.5), so this Manual requires GPTs and DWF exclusion separately (Clauses 8.9 and 8.10) and does not let a VR stand in for them.

8.7 BMP design summaries

8.7.1 **General.** Each BMP shall be designed to the requirements below and to Annex 8D (BMP design sheets). The dimensions given are **recommended starting values** where marked; the designer shall justify any departure. Every BMP shall be designed for safe passage of flows above Q_wq (Clause 8.4.6) and shall have access for maintenance (Chapter 10).

8.7.2 **Bioretention and rain gardens** (Figure 8.2).

- (a) Surface ponding depth not more than **300 mm** above the mulch, with an overflow at the maximum ponding level.
- (b) Surface ponding drained within **48 hours**.
- (c) Filter media 600–900 mm deep: an engineered sandy loam with low fines and low phosphorus content (Annex 8D), with a 50–75 mm mulch layer.
- (d) A transition (choker) layer and a gravel drainage layer below the media.
- (e) A perforated underdrain where the design infiltration rate of the native soil (Clause 8.8.4) is below the rate needed to meet (b), or where the cell is lined.
- (f) Unlined cells shall meet the infiltration criteria of Clause 8.8. Cells that cannot meet them, and cells at hotspots, shall be lined.
- (g) Plants: native or naturalised species tolerant of both waterlogging and long dry spells.

8.7.3 **Vegetated swales.**

- (a) Trapezoidal or parabolic section, with side slopes no steeper than 1V:3H.
- (b) Longitudinal slope 0.5% to 4%, with check dams where steeper.
- (c) Flow depth at Q_wq not more than the height of the grass, and velocity at Q_wq not more than 0.3 m/s.
- (d) The 1% AEP flow (or the bypass) shall not erode the swale (Chapter 9 permissible velocities).
- (e) Where longitudinal slopes are below 1% or the subsoil is poorly drained, an underdrained ("dry") swale with filter media.

8.7.4 **Vegetated filter strips.**

- (a) Receive sheet flow only, with a level spreader where flow arrives concentrated.
- (b) Length in the direction of flow at least 5 m, and slope 1% to 8%.
- (c) Used mainly as pretreatment for bioretention, infiltration and swales.

8.7.5 **Permeable pavement.**

- (a) Run-on from impervious areas not more than twice the permeable area, and no run-on from unpaved or eroding areas.
- (b) Base reservoir of clean, open-graded aggregate, sized to hold its share of the WQv in its voids.
- (c) An open base (infiltrating) only where Clause 8.8 is met; otherwise lined with an underdrain, and then counted as filtration only.
- (d) Structural design for the traffic loading by the road authority's standards.
- (e) Not at hotspots, and not where the surface will be resurfaced with impermeable material.

8.7.6 **Infiltration trenches and basins** (Figure 8.3).

- (a) Pretreatment under Clause 8.5.3 in every case.
- (b) Trenches filled with clean washed aggregate, with a void ratio confirmed by test, wrapped in geotextile on the sides and top, on a sand base.
- (c) An observation well to the base of each trench.
- (d) Storage volume = WQv (or the retention volume of Chapter 4, where greater) held in the voids; emptied within 72 hours at the design infiltration rate.
- (e) An overflow to the minor or major system at grade.
- (f) Not brought into service until the contributing area is stabilised (Chapter 10).

8.7.7 **Wet ponds (extended wet detention).**

- (a) A permanent pool of at least the WQv, plus extended detention of the WQv above the pool, released over 24–48 hours.
- (b) A sediment forebay at each inlet (Clause 8.5.3).
- (c) Length-to-width ratio of the flow path at least 3:1, with no short-circuiting.

- (d) Permanent pool depth 1.0–2.5 m, with a safety bench (Clause 7.9.4).
- (e) A dry-season water balance (Clause 8.7.8).
- (f) The detention storage of Chapter 4 may sit above the extended detention level.

8.7.8 **Water balance for permanent pools.** Wet ponds and wetlands shall be shown, by a monthly water balance using IMD rainfall and pan evaporation, to keep at least 50% of the permanent pool volume (or the minimum wetland depth) through the driest year in 10. They shall not be topped up with groundwater, potable water or sewage. Where the balance fails, a dry extended-detention basin or a constructed wetland with a smaller permanent pool shall be used instead.

8.7.9 **Constructed wetlands.**

- (a) An inlet sedimentation pond (forebay) followed by a shallow vegetated macrophyte zone.
- (b) Extended detention of the WQv above the normal water level, released over 24–48 hours, with an extended detention depth not more than 0.5 m.
- (c) A flow path length-to-width ratio of at least 3:1, with deep zones across the flow path to spread the flow.
- (d) A high-flow bypass so that floods do not scour the macrophyte zone.
- (e) Where built at a tank inlet, the wetland shall sit within the tank's setback but outside its waterspread, and its storage shall not be counted as tank storage.

8.7.10 **Gross pollutant traps.**

- (a) Sized to treat Q_wq, with all flows up to the 1% AEP passing without washing out captured material.
- (b) Capture of gross pollutants down to about 5 mm.
- (c) Head loss included in the hydraulic grade line of the drain (Chapter 9), with the screen assumed **50% blocked**.
- (d) Storage for captured material sized for the cleaning interval of the O&M plan, and not less than the 3-monthly cleaning of Chapter 10.
- (e) Vehicle access for cleaning by suction or grab.

8.7.11 **Oil-grit separators.**

- (a) Required at the hotspots of Clause 8.8.8 that involve fuel or oil: fuel stations, vehicle workshops and washing bays, bus and truck depots, and parking areas of more than 50 spaces.
- (b) Sized for Q_wq, with a high-flow bypass.
- (c) Not to be used as the only treatment: they shall be followed by a filtering BMP where the site needs a VR above 5.

8.7.12 **Silt traps and catch pits.**

- (a) At every inlet that receives runoff from unpaved ground, and at the inlet of every drain discharging to a BMP or waterbody.
- (b) A sump at least 300 mm below the outlet invert.
- (c) Silt traps are pretreatment only and earn no VR.

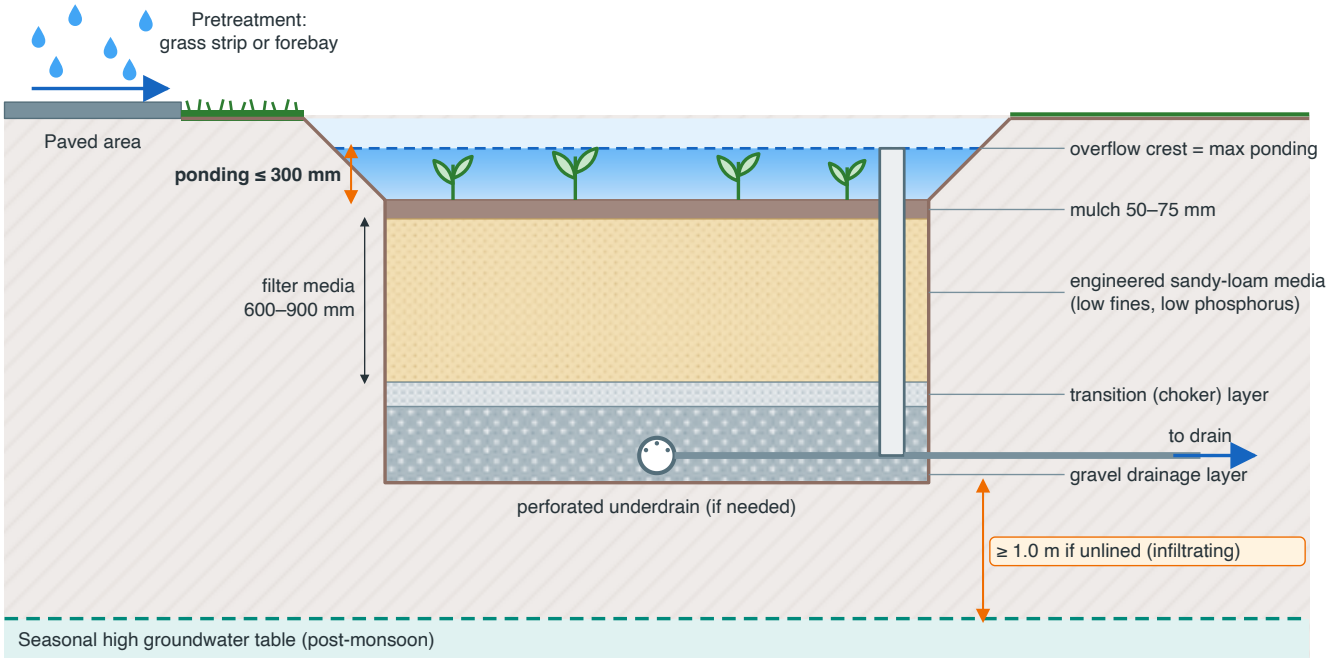
> **Commentary.** The design summaries draw on the MARC/APWA BMP Manual (2012), the Georgia Stormwater Management Manual (2016, Vol 2), CIRIA C753 *The SuDS Manual* (2015) and PUB Singapore's ABC Waters Design Guidelines. The dimensions are typical of those manuals but have not been calibrated in Jammu and Kashmir. Three local issues drive changes from the source manuals:
>
> - **Mosquitoes.** Dengue is endemic in Jammu and Kashmir. Surface ponding in bioretention and rain gardens must drain within 48 hours (Clause 8.7.2(b)), well inside the time mosquito larvae need to develop. This is consistent with the 24–48 hour WQv drawdown of Clause 8.4.7.
> - **Dry seasons.** Jammu and Kashmir has two rainfall regimes. Jammu receives 1,401.9 mm a year, 77% of it from June to September in the south-west monsoon, with its wettest month in July (416.5 mm); Srinagar receives 697.5 mm, only 30% of it from June to September, with its wettest month in March (104.6 mm),

and more than 55% of its rain falls from December to April with western disturbances (IMD; CWC Flood Estimation Report, 1994). In the Jammu division the drier months run from October to May, broken by the rain of western disturbances; in the Kashmir valley the precipitation is spread through the year, and in winter much of it falls as snow (the snowmelt of January 2026 set off a dewatering drive in Srinagar, as reported). The Jhelum stands at about 1,585 m at Srinagar (CWC), so the whole valley floor, and every hill town above about 1,500 m, is in the zone where every BMP is checked for frost, snow and ice from December to March. In the towns the feed of a drain or pond in the dry months is often sewage, because the drains carry it (Clause 8.9, Commentary). A wet pond or constructed wetland whose water balance (Clause 8.7.8) cannot keep its permanent pool through the dry months on its own catchment's runoff is not to be used. On the valley floor, where Clause 8.8.1 bars infiltration and the water table is within 2 m, the practical forms are lined bioretention with an underdrain, swales, storage for use and lined extended detention behind the outfall; in the hill towns, where Clause 8.8.1 bars infiltration on the slopes, lined bioretention, swales on gentle ground, storage for use and lined dry detention; and on the Kandi, infiltration and recharge where the tests allow. Clause 8.7.8 applies to BMPs, which shall not be topped up with sewage; lakes, nambals, talabs, Kandi ponds, springs and wetlands are waterbodies under Chapter 7 and are not to be used as treatment for a development. Wet ponds that dry out turn into stagnant pools or are used for dumping. Clause 8.7.8 requires a water balance and bans topping up with sewage, which is a common practice for keeping urban ponds "full".

- **Litter and silt.** GPTs and silt traps are treated as essential, not optional, because Jammu and Kashmir drains carry heavy litter and silt loads. The 50% blockage factor for screens matches the grate clogging factor of Chapter 6.

The 50-space threshold for oil-grit separators, the 5 mm GPT capture size, the 0.3 m/s swale velocity and the other dimensions in this Clause have no direct precedent and are set by this Manual.

Bioretention cell (rain garden): section, not to scale



Lined version (no infiltration): impermeable liner below the gravel layer. Required at pollution hotspots and wherever the 1.0 m separation to seasonal high groundwater cannot be met.

Dimensions as set in Clause 8.7.2.

Figure 8.2 — Bioretention cell (rain garden) in section: pretreatment, surface ponding, filter media, transition and gravel layers, underdrain, overflow, and the 1.0 m separation to seasonal high groundwater for an unlined cell. Original drawing for this Manual, adapted from MARC/APWA, Manual of Best Management Practices for Stormwater Quality, 2012, and CIRIA, The SuDS Manual (C753), 2015.

8.8 Infiltration and recharge criteria

8.8.1 **Groundwater separation.** An infiltration facility is permitted only where the **seasonal high groundwater table is at least 1.0 m below the base** of the facility. There is no exception in Jammu and Kashmir, which has no coastal sand areas (Clause 8.8.9). For this Clause the seasonal high groundwater table is, in the Jammu division, the highest post-monsoon level (September to November); on the Kashmir valley floor, the Karewas and the hill towns of the Pir Panjal, the higher of that level and the level from March to May, when the snowmelt and the winter rain leave the valley's water table at its shallowest, in May (CGWB); and, where wells flow, the ground surface. Jammu and Kashmir needs opposite rules on its valley floor, its Kandi and its slopes, and Clause 8.8.1 applies with the following, which are the three infiltration rules of Clause 4.11. **(i) No infiltration on the Kashmir valley floor, or where the water is within 2 m (Clause 4.11, valley-floor rule).** No infiltration facility, soakaway, soak pit, recharge pit, shaft or well, infiltration trench, unlined bioretention or permeable paving with an exfiltrating base shall be built or credited, and no infiltration credit shall be given, on the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor (sub-area JK-C of Annex 2A), whatever depth to water a single reading shows, or on the Sirowal, the river terraces and floodplains and the margins of lakes, nambals, talabs and reservoirs anywhere in the Union Territory wherever the seasonal high water table is within 2 m of the surface or wells flow. Over the central and south-western valley the water table stood 0 to 2 m below ground in November 2014, wells on both sides of the Jhelum are artesian, with heads from 2 m above ground to 12 m below it, almost every CGWB well drilled below 25 m in Anantnag district flows (2.50 m above ground at Charsoo), 81.8% of the observation wells in Baramulla stood within 2 m of the ground in May 2021, and the CGWB states for Srinagar that "As depth to water level in the district is shallow there is no scope for artificial recharge to ground water" (CGWB). There, the exception for roof water in Clause 8.11.3(c) does not apply, the rainwater harvesting of UBBL-2021 is storage and reuse, not recharge, and retention is met by storage for use and by detention under Chapter 4, sized for the outfall-closed case and the pump capacity of Chapter 5. On the Upper Karewa tablelands (Budgam, Pulwama, Pampore and the airport plateau), whose marls and varved clays have "Low permeability" and perched water (CGWB), infiltration is used only at a small scale, after a test at the site, and only where item (iii) does not apply; outlets down a Karewa scarp are lined and erosion-resistant. On the Lower Karewa infiltration is judged case by case on a test. **(ii) Recharge first in the Kandi (Clause 4.11, Kandi recharge rule).** On the Kandi fans and khad beds north of the spring line (Jammu north, Nagrota, Samba and Kathua–Hiranagar north), whose boulder-gravel "acts as a very good medium for the recharge", with the water 7 to 30 m below ground over most of the belt and a transmissivity of 21 to 1,197 m²/d in Jammu and 692 to 2,613 m²/d in Kathua (CGWB aquifer mapping), recharge is the first means of meeting retention wherever the site tests allow, with a silt trap, a filter and a first-flush diverter; the base of a facility is at least 0.6 m above the post-monsoon water level and at least 1.0 m above the seasonal high water table (this Clause); a bore or shaft is used only after a hydrogeologist's check that includes a nitrate test of the target aquifer, because nitrate exceeded 45 mg/L in 9.2% of the CGWB's 2024 samples in the Union Territory, with the exceedances in Baramulla, Jammu, Kathua, Kupwara, Rajouri and Samba; no recharge bore or shaft is placed within the protection zone of a public supply well, for which no Jammu and Kashmir distance was found [TBC], because Jammu's water supply is understood to be drawn largely from groundwater (a reading of this Manual); and no road, parking, industrial or sewage-laden runoff is led into a bore or shaft. The Kandi ponds are kept and revived as recharge talabs (Jammu Master Plan 2032). The rule stops at the spring line: below it lies the Sirowal, where item (i) applies. All three Kandi districts, Jammu, Samba and Kathua, have been assessed Safe in every assessment from 2017 to 2024 (CGWB), so recharge here is for the water supply and the baseflow of the khads, not to relieve a stressed aquifer. **(iii) No infiltration on hill slopes (Clause 4.11, hill infiltration rule).** No deliberate infiltration practice (soakaway, soak pit, recharge pit, shaft or well, infiltration trench, unlined bioretention, or permeable paving with an exfiltrating base) shall be built or credited on natural ground sloping more than 10°; on the Murree and Siwalik clay–sandstone sequences of the hills; in a mapped subsidence or sliding zone, including Thathri Nai Basti (Doda), Pernote and Duksar (Ramban) and any area of Budgam district listed by JKPCC as prone to land sinking; on colluvium, slide debris or moraine, whatever its slope; or upslope of a cut slope or retaining

wall within a distance of twice its height — unless a geotechnical certificate by a qualified geotechnical engineer or engineering geologist shows that the added water will not destabilise the slope. The rule applies in sub-areas JK-B, JK-B1 and JK-D and to the slopes of JK-A and JK-C, such as the Karewa scarps and the foothills round the valley. On such sites roof runoff goes to the rainwater storage of UBBL-2021, and its overflow, with all other runoff, is led by a lined drain through a sediment trap to a stable channel, never onto an unprotected slope; the exception for roof water in Clause 8.11.3(c) does not apply, no infiltration is credited, and sewage is never led into a roadside drain on a slope. At Pernote the Geological Survey of India found in April 2024 that "During rains the ingress of surface runoff through these cracks may have developed the pore pressure, thus inducing the instability in the slope", and recommended "diverting the surface runoff away from the affected/active part of the slope" and that "Drains present in the affected slope should be lined/trained"; at Thathri the committee before the National Green Tribunal found no planned drainage and sewage pipes discharging to the roadside drains downslope (as reported). (iv) Springs. No Jammu and Kashmir rule keeps building or drains away from a spring (nag or cashma), though the Water Resources Act, 2010 counts springs among its water sources and spring ponds and spring channels among its hydraulic works. Within the recharge area of a spring used for drinking water, as a hydrogeologist maps it, only roof water and runoff that has passed a filtering BMP may be infiltrated, where items (i) and (iii) allow any infiltration at all; road runoff, sewage and septic effluent never are; and no infiltration facility, soak pit or septic tank is placed within Zone 1 of the spring (Clause 7.4). These rules for springs are set by this Manual. (v) Quality. UBBL-2021 require that provision be made "not to inject contaminate water into recharge structures in industrial areas" (Table 10-1), and the Water Resources Act, 2010 forbids the discharge of sewage or industrial effluent into the water of an irrigation work. No industrial or sewage-laden runoff is led to any recharge structure; arsenic exceeded 10 ppb in 0.8% of the 2024 samples, in Baramulla and Kupwara (CGWB), so recharge in those districts is of roof water only. Where recharge is through a well or shaft into fractured rock or deep gravel, a hydrogeologist's report shall confirm the depth to water, the receiving zone, and that no drinking-water well or spring within 30 m will be harmed. The 2 m limit, the 10° trigger, the distance of twice the wall height and these conditions are set by this Manual: no Jammu and Kashmir rule on infiltration or soak pits was found, and the CGWB records the soil infiltration rate as "Not Available on any Scale" in both the Kashmir valley and the Jammu plains The seasonal high groundwater table shall be determined under Clause 3.10.2.

8.8.2 Other separation. The base of an infiltration facility shall also be at least 1.0 m above bedrock or any impermeable layer, unless the facility is designed to recharge a fractured or weathered rock aquifer under Clause 8.8.10.

8.8.3 Infiltration tests. The infiltration rate shall be measured at the proposed base level of the facility:

- (a) by a double-ring infiltrometer test (ASTM D3385) for basins, bioretention and permeable pavement;
- (b) by a falling-head borehole or trial-pit soakage test (for example BRE Digest 365) for trenches, soakaways, recharge pits and recharge wells;
- (c) with at least 2 tests per facility, and at least 1 test per 100 m² of infiltration base area or per 50 m of trench length; and
- (d) by a person competent in geotechnical testing, with the results reported on the Infiltration Test Record (Form 8-2).

Tests made in the dry season shall be reported with the groundwater level at the time of test and the seasonal high level of Clause 8.8.1.

8.8.4 Design infiltration rate. The design infiltration rate is the measured rate divided by a safety factor:

- (a) 2.0 where the tests meet Clause 8.8.3(c) and the results vary by no more than a factor of 2; and
- (b) 3.0 otherwise.

8.8.5 Minimum rates.

- (a) Full infiltration (no underdrain) only where the design rate is at least 13 mm/h.
- (b) Partial infiltration, with an underdrain, where the design rate is 3 mm/h to 13 mm/h. Only the volume that infiltrates within 72 hours is credited as retention.
- (c) No infiltration credit where the design rate is below 3 mm/h.

8.8.6 **Setbacks for infiltration facilities.** Infiltration facilities receiving runoff from roads, parking or other paved surfaces shall be at least:

- (a) **3 m** from building foundations, and **5 m** from a basement;
- (b) **1.5 m** from a property boundary, unless the neighbour agrees in writing;
- (c) **30 m** from a drinking-water well or borewell;
- (d) **15 m** from a septic tank or soak pit; and
- (e) **6 m** from the crest of a slope steeper than 1V:3H, unless a geotechnical report shows the slope remains stable.

Roof-only runoff to recharge structures is subject to (a) and (b) only, and to Clause 8.11.3.

8.8.7 **Drawdown and verification.** Every infiltration facility shall empty within **72 hours** at the design rate (Chapter 4), and shall be tested after construction (Clause 10.9.3).

8.8.8 **Hotspots.** Runoff from the following shall not be infiltrated without treatment, and shall not be infiltrated at all where (d) or (e) applies:

- (a) fuel stations;
- (b) vehicle workshops, washing bays, and bus and truck depots;
- (c) industrial yards and loading areas where hazardous materials are handled or stored;
- (d) solid waste transfer stations and landfill areas; and
- (e) land known or suspected to be contaminated.

Treatment for (a) to (c) shall include an oil-grit separator and a lined filtering BMP before any infiltration.

8.8.9 **Sandy coastal aquifers.** This Clause applies only to coastal sand aquifers. Jammu and Kashmir has none, so the Clause has no effect in the Union Territory; it is kept only so that the clause numbers stay unchanged. The Kandi boulder-gravel fans and the river sands and gravels of the Jhelum, the Tawi and the Chenab are not coastal sand areas: Clause 8.8.1 applies there in full, and the reduced separation of item (d) does not. In coastal sand areas:

- (a) infiltration is the preferred means of meeting retention and the WQv wherever Clause 8.8.1 is met;
- (b) storm drains shall not be designed to lower the groundwater table: inverts below the seasonal high groundwater table shall be watertight, with no weep holes or subsoil drains that discharge groundwater to the outfall, unless a hydrogeological report shows no harm to the freshwater aquifer;
- (c) no long-term pumping of groundwater into storm drains shall be approved (for example basement dewatering); and
- (d) in notified coastal sand areas, **roof-only runoff** may be infiltrated with a separation of not less than **0.5 m** to the seasonal high groundwater table, provided a groundwater mounding check shows that the mound stays at least 0.3 m below the facility base and does not reach adjacent foundations or basements. No other runoff may use this reduced separation;
- (e) where neither the 1.0 m separation nor clause (d) can be met, the site shall use surface retention that does not infiltrate below ground (for example shallow vegetated depressions, disconnection of roofs onto lawns, and reuse), and detention under Chapter 4.

8.8.10 **Laterite and hard-rock areas.** In laterite and hard-rock terrain (for example the Siwalik and Murree sandstone and clay of the outer hills, as around Udhampur, Ramban, Reasi, Rajouri and Poonch, where the Geological Survey of India found "alternating layers of permeable sandstone and weak impermeable clay" at Pernote (2024), and the rocks of the inner Chenab hills and the Pir Panjal, as around Doda, Kishtwar, Bhaderwah and Banihal, where groundwater is held in joints, fractures and the weathered cover and comes out at springs and seepages; on any slope in these areas the hill limits of Clause 8.8.1 apply first):

- (a) tests shall be made at the facility base, below any surface crust or hardpan;
- (b) recharge into weathered or fractured rock is permitted only for roof runoff, or for runoff that has passed through a filtering BMP, because fractures give little treatment; and

- (c) infiltration on or above slopes shall be checked for slope stability.

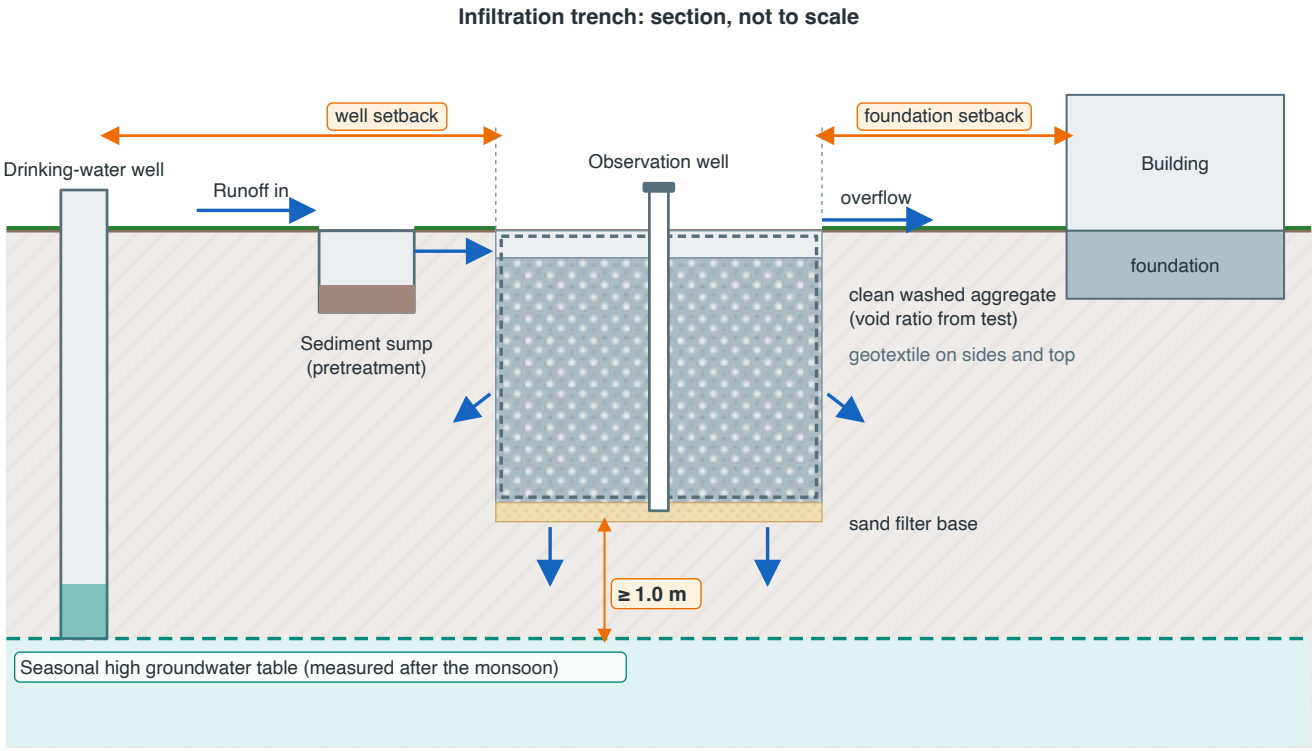
8.8.11 **Delta clays and black cotton soils.** In the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, where the water table stands 0 to 2 m below ground over the central and south-western valley and wells on both sides of the Jhelum flow (CGWB), the marls and varved clays of the Upper Karewa tablelands, with their perched water, the Sirowal of the Jammu plains, the beds and margins of lakes, nambals and talabs, and the clayey slide debris of the hills, and in expansive black cotton soils:

- (a) infiltration facilities will usually fail Clause 8.8.5 and need not be tested where the soil survey (Chapter 3) shows HSG D; and
- (b) where infiltration is used near buildings on expansive soils, the setback of Clause 8.8.6(a) shall be doubled.

Commentary. The 1.0 m groundwater separation is a core requirement of this Manual. The other values in this Clause (the 1.0 m bedrock separation, test numbers, safety factors, minimum rates and setbacks) are typical of US and UK practice and have no Jammu and Kashmir precedent. The well setback in Clause 8.8.6(c) applies to runoff from paved surfaces, not to roof water. Jammu and Kashmir RWH practice routes roof water into open wells and recharge wells, and Clause 8.11 keeps that practice.

No map of hydrologic soil groups for Jammu and Kashmir, and no measured infiltration rate usable for design, was found: the CGWB's aquifer-mapping reports for the Kashmir valley and for the outer plains of the Jammu province both record the soil infiltration rate as "Not Available on any Scale", and the infiltration rates reported for the Basantar catchment could not be verified and are not used. Every infiltration design needs the tests of Clause 8.8.3. The geology and depths below are from the CGWB's reports. The **Kandi** of the Jammu plains, "equivalent to Bhabar" and about 6 km wide, falls at 1 in 90 to 1 in 120 and is "underlain by boulder, gravel, which acts as a very good medium for the recharge"; its water lies 7 to 30 m below ground over most of the belt and 45 to 84 m in the deeper aquifers, with a transmissivity of 21 to 1,197 m²/d in Jammu and 692 to 2,613 m²/d in Kathua; its 365 ponds hold water because of "the role of clay in checking heavy seepage in the highly porous Kandi Belt". Below the spring line the **Sirowal** is finer and flatter (1 in 250 to 1 in 300), its water 2 to 5 m below ground over most of it, waterlogged in the south-west, with flowing wells at Hiranagar, Rajpura, Jangi Chak, Airwan and Nagri and more than half the wells of Kathua flowing. On the **Kashmir valley floor** the soils are **Gurti**, the clay of the Jhelum's flood plain south of Srinagar, whose "water retaining capacity is high", and **Nambal** peat near the river and round Wular, Manasbal and Anchar; the water table stood 0 to 2 m below ground over the central and south-western valley in November 2014; artesian wells are found "throughout the valley … on either sides of Jhelum River", with heads from 2 m above ground to 12 m below it; in Srinagar district the water stands 2.00 to 3.00 m below ground before the monsoon and 1.50 to 2.50 m after it, and "As depth to water level in the district is shallow there is no scope for artificial recharge to ground water"; and in May 2021, 55% of the observation wells of the Kashmir region and 81.8% of those in Baramulla stood within 2 m of the ground. The **Karewa** tablelands are lake deposits: the Upper Karewa marls, silts and varved clays have "Low permeability" and perched water, and the Lower Karewa "Moderately high" permeability, confined to flowing. In the **hills** of Ramban and Udhampur the Murree rocks are "alternating layers of permeable sandstone and weak impermeable clay" (Geological Survey of India, Pernote, 2024), with springs and seepages. The Union Territory draws 22.28% of its extractable groundwater, and all 149 assessment units were assessed Safe in 2024, including Srinagar, which had been Semi-critical (73.85%) in 2022; Jammu, Samba and Kathua have been Safe in every assessment from 2017 to 2024, so the Jammu plains are not a stressed aquifer; the change from 20 units to 149 in 2024 means the series are not directly comparable. Nitrate exceeded 45 mg/L in 9.2% of the 2024 samples (Baramulla, Jammu, Kathua, Kupwara, Rajouri and Samba) and arsenic exceeded 10 ppb in 0.8% (Baramulla and Kupwara). Water put into a hill slope is a hazard as well as a resource: at Pernote the Geological Survey of India found that "the surface water and spring water over the longer period of time is continuously percolating in jointed moderately weathered rock mass and loose unconsolidated overburden material", and at Thathri the committee before the National Green Tribunal found no planned drainage (as reported). This Manual's interim soil groups follow from these: the Kandi fans and khad beds A (B where clayey), the Sirowal C, the Siwalik and Murree hill slopes D for design, the Upper Karewa C to D, the Lower Karewa B to C, the valley floor D, and the high mountains C, or D when frozen (Chapter 3). **Jammu and Kashmir therefore needs opposite rules on its valley floor, its Kandi and its slopes.** On the Kandi, recharge comes first, with

pretreatment, a nitrate check and protection of the wells that supply Jammu. On the Kashmir valley floor, the Sirowal and every other ground where the water is within 2 m, no water is put into the ground, and rainwater harvesting is storage and reuse. On the hill slopes, in the subsidence zones and on the debris cover, no water is put into the ground on purpose, under the hill infiltration rule of Clause 4.11, which Clause 8.8.1 applies. Everywhere, runoff from roads and open land goes to surface systems and never directly to a recharge well, borewell or shaft (Clause 8.11.3(b)). Clause 8.8.9 has no effect in Jammu and Kashmir, which has no coast.



Test infiltration at the proposed base level. Design rate = measured rate ÷ safety factor. Empty within 72 h.
Setback distances and test methods: Clauses 8.8.3 to 8.8.6. Road and parking runoff is never piped into a well.
Sandy coastal soils: high rates, shallow groundwater. Laterite, hard rock: low rates. Delta clay: usually unsuitable.

Figure 8.3 — Infiltration trench in section: pretreatment sump, aggregate-filled trench in geotextile, observation well, overflow, the 1.0 m minimum separation to the seasonal high groundwater table, and setbacks to wells and foundations. Original drawing for this Manual, adapted from the Georgia Stormwater Management Manual, 2016 (Vol 2), and CIRIA, The SuDS Manual (C753), 2015.

8.9 Sewage cross-connections and dry-weather flow

8.9.1 **No sewage in storm drains.** No sewage or sullage (grey water from kitchens, bathrooms and laundries), septic tank effluent, or trade effluent shall be connected to, or discharged into, any storm drain, by any pipe, channel or opening.

8.9.2 **Condition of approval.** Before the completion certificate, the Applicant shall show, by a dye or smoke test witnessed by the Authority or the sewerage agency, that every sewage and sullage outlet on the site discharges to a sewer or to an approved on-site system, and that none discharges to a storm drain. Any existing cross-connection on the site shall be removed as a condition of approval, including on redevelopment and on additions to existing buildings.

8.9.3 **Where no sewer exists.** Where no sewer is available, sewage and sullage shall go to an approved on-site or decentralised treatment system. The treated effluent of such a system may be discharged to a storm drain only with the written consent of the Jammu and Kashmir Pollution Control Committee (JKPCC) and the drain owner.

8.9.4 **Public drains: DWF survey.** Every ULB in a Tier A area shall survey its storm drain outfalls to waterbodies for dry-weather flow at least once a year, before the SW monsoon, and record:

- (a) the outfalls with DWF;
- (b) the estimated DWF rate; and
- (c) the upstream sources found by tracing, CCTV, dye or smoke testing.

The results shall be published in the register of Clause 10.17.

8.9.5 **DWF interception.** Until the sources are removed, every outfall to a waterbody that carries DWF shall have a DWF interceptor that:

- (a) diverts the DWF to a sewer or a treatment plant;
- (b) does not reduce the capacity of the storm drain for the minor or major event (Chapter 6), with its weir or diversion head losses included in the hydraulic design (Chapter 9);
- (c) has a screen ahead of the diversion; and
- (d) is not a substitute for removing the source connections.

8.9.6 **Sewage overflows.** No new sewage overflow, emergency bypass or pumping station overflow shall be designed to discharge into a storm drain or waterbody, except where the sewerage agency shows that no alternative exists, and then only with screening and with the overflow frequency stated.

> **Commentary.** The prohibition of sewage connections and the removal of existing cross-connections as a condition of approval are core requirements of this Manual, and Clause 1.10.3 allows no variance from them. Sewage in storm drains is the single largest water quality problem of urban drainage in Jammu and Kashmir. It defeats every other measure in this chapter: BMPs designed for stormwater are overloaded, GPTs fill with sludge, and the receiving tanks and channels become sewage lagoons. CPHEEO (2019) notes that Indian drains carry night soil and urine (Part A §9.5). DWF interception (Clause 8.9.5) is an interim measure. It protects the waterbody while the sources are traced and removed, but it can become permanent if the source work is not done, which is why the annual survey and publication of Clause 8.9.4 are required. The annual survey frequency is set by this Manual.
>
> In Jammu and Kashmir the storm drains carry sewage, and in both cities the drains end in lakes, marshes and rivers that the cities depend on. In Srinagar about 193.34 MLD of sewage is generated and treatment exists for 62.01 MLD, so that "percentage of Sewage treatment before its discharge into surface water bodies" is 32.07%; a 60 MLD plant at Noorbagh, at its final stage of commissioning in 2024, would raise it to 63.10% (JKPCC, response of 14 August 2024 in NGT O.A. 504/2024). JKPCC counts six treatment plants of 53.8 MLD in the catchments of Dal and Nigeen, but other counts conflict (five plants of 36.7 MLD, as reported; two plants of 17.08 and 16.10 MLD at Brari Nambal alone, as quoted from the CPCB in NGT O.A. 190/2025), and "Untreated sewage gets entry into the Dal Lake from areas like Telbal, Lalbazar etc."; the roughly 910 houseboats on Dal and Nigeen discharge to the lakes without treatment, except at Nigeen, where houseboat sewage is directed to sumps. The Srinagar Master Plan 2035 proposes a "Green Infrastructure Plan" to reduce combined sewer overflows, which implies that the drains and sewers overflow into each other (a reading of this Manual). In Jammu "The BOD levels of waters in 90% of city drains indicate that the discharge is comparable to a range of weak to strong domestic sewage", "Storm water drains carry considerable quantities of raw and untreated effluents", and the roadside drains that serve as storm drains run "eventually into the Tawi River"; the plan expects 350 MLD of sewage by 2032 against 73 MLD of treatment (Jammu Master Plan 2032, §§5.1.3 and 11.1). The CPCB's list of polluted river stretches of October 2025 places seven stretches of the Union Territory in it: the Chunt Kol at Maulana Azad Bridge in Srinagar in Priority III; the Jhelum from the confluence of the Vishav Nallah to below Baramulla and the Tawi from Tawi Bridge to the Balol Nallah in Priority IV; and the Basantar below Samba, the Devak at Udhampur, the Gawkadal

> stretch at Srinagar and the Lidder from Lavender Park to Nunwan in Priority V; it withdrew the Chenab from the list (JKPCC, report of March 2026 in NGT O.A. 413/2025). JKPCC's mean BOD of the Jhelum rose from 2.36 mg/L in 2020–21 to 3.20 in 2023–24 and stood at 3.09 in 2024–25; its faecal coliform series is misaligned in the copy read and is not cited. On the slopes the sewage reaches the drains directly: at Thathri the committee before the National Green Tribunal found "unplanned PVC pipes for the purpose of sewerage disposal to the road side drainage downslope" (as reported), and at Pernote a site report annexed to JKPCC's compliance report in NGT O.A. 642/2024 asked that "the domestic sewage be channelised". No count of tapped and untapped drains for either city was found, and the Municipal Acts were not read for any power to require separate drains for sewage and rain-water [TBC]. **Lake outfalls.** Until its sources are removed, every storm drain outfall to Dal, Nigeen, Anchar or Wular, and to any other lake, nambal or Wildlife Conservation Reserve, carries a DWF interceptor under Clause 8.9.5 and a screen ahead of it, whether or not DWF has yet been measured in it, and comes first in the survey of Clause 8.9.4 and the programme of Clause 8.10.4; this requirement is set by this Manual, consistent with the ban in the Water Resources Act, 2010 on the discharge of sewage into the water of an irrigation work, and it adds to the sediment trap of Clause 7.10.6 (Figure 7.3). Every interceptor is a DWF interceptor under Clause 8.9.5, and Clause 8.9.5(b) applies to it in full: it is sized from the measured dry-weather flow of its drain, does not reduce the drain's capacity for the minor and major events or raise the flood level behind it, and passes the storm flow above its capacity on down the drain, never to the treatment plant or back into the town. On the valley floor an interceptor that lies ahead of a dewatering station is placed so that the station does not pump dry-weather flow to the Jhelum, its chambers are watertight against a water table at the ground and checked for flotation, and its bypass works with the river's gate shut; on a khad an interceptor and its chamber are placed above the 1% AEP flood level of the khad found under Clause 5.8.5(c), or protected against the scour and debris of that flood (Chapter 9). These conditions are set by this Manual.

8.10 Outfalls to waterbodies: first flush, gross pollutant traps and screens

8.10.1 **Requirement.** Every new storm drain outfall to a waterbody, and every existing outfall on a drain that is rebuilt, widened or extended, shall have:

- (a) a GPT designed under Clause 8.7.10; and
- (b) first-flush treatment: treatment of the WQv (or Q_wq) of the contributing catchment by the BMPs of Clause 8.7, either on the contributing sites or at the outfall.

8.10.2 **Where treatment at the outfall is impracticable.** Where land is not available at a public outfall, first-flush treatment may be provided by:

- (a) a proprietary first-flush or hydrodynamic device sized for Q_wq; or
- (b) a treatment wetland or forebay within the waterbody setback (Clause 7.5.1(b)), outside the waterspread.

8.10.3 **Screens and trash racks.** Screens at outfalls, culvert inlets and pump sumps shall:

- (a) be designed with **50% blockage** for hydraulic capacity;
- (b) have an overflow or bypass path so that a fully blocked screen does not flood property;
- (c) have bar spacing chosen for the hazard: closer spacing for litter capture, wider spacing where blockage would cause flooding; and
- (d) be cleanable from a safe platform, with vehicle access.

8.10.4 **Existing outfalls.** Each ULB shall prepare a programme to fit GPTs and DWF interceptors to its existing outfalls to waterbodies, starting with outfalls to tanks used for drinking water supply and to notified wetlands (Clause 7.12), and shall report progress in the register of Clause 10.17.

> Commentary. This Manual requires first-flush treatment and gross pollutant traps at outfalls to waterbodies. Gross pollutants are the most visible form of pollution in Jammu and Kashmir waterbodies, and plastics also block drains and culverts, which links water quality to flooding. The 50% screen blockage matches the grate clogging factor of Chapter 6. Clause 8.10.3(c) warns against fine screens on large drains, which block in the first hour of a storm and cause the flooding they were meant to prevent.

8.11 Rainwater harvesting integration

8.11.1 **RWH mandate continues.** The rainwater harvesting required by the Jammu and Kashmir Unified Building Bye-Laws 2021 (chapter 10, which makes a "complete proposal of rainwater harvesting" mandatory for every building on a plot of 100 m² or more (clause 10.1), with "emphasis on both storage and reuse" for plotted houses, recharge mandatory for buildings, including group housing, on plots of more than 500 m² (clause 10.5), storm water captured in public open spaces of more than 500 m² (clause 10.4), permeable paving for the open parking of group housing (Table 10-1), and inspection by a rainwater harvesting cell before the completion certificate or a service connection (clause 10.6), but no storage volume; the Srinagar Master Plan 2035, regulation 1-7-13, makes storage mandatory only on plots of 1,000 m² and above and for group housing, and the stricter threshold of the bye-laws applies) continues to apply, subject to the limits of Clause 8.8.1 (Chapter 1). This Clause sets how RWH structures are counted under this Manual.

8.11.2 **Three different functions.** The designer shall keep apart, on the drawings and in the calculations:

- (a) **harvesting**: storage for use (sumps and tanks);
- (b) **recharge**: recharge pits, trenches, shafts and wells that put water into the ground; and
- (c) **detention**: storage with an orifice outlet that is empty at the start of a storm (Chapter 4).

8.11.3 **Recharge structures.**

- (a) Roof runoff may be led to recharge wells, open wells, recharge pits and shafts after a filter or settling chamber.
- (b) Runoff from roads, parking and other paved areas shall not be led directly into any well, borewell or recharge shaft. It may be recharged only through an infiltration facility that meets Clause 8.8, with pretreatment.
- (c) Recharge structures shall meet the groundwater separation of Clause 8.8.1, measured from the base of the pit or the bottom of the filter media, except recharge wells that receive filtered roof water only.

8.11.4 **Credit toward retention and WQv.** A recharge structure counts toward the retention volume of Chapter 4 and the WQv only where:

- (a) its infiltration rate has been tested under Clause 8.8.3;
- (b) it empties within 72 hours at the design rate; and
- (c) it has pretreatment.

A harvesting sump counts toward retention only where its contents are used, by a demand stated in the drainage report, within 72 hours (Chapter 4).

8.11.5 **No credit as detention.** RWH storage does not count as detention unless it is a dedicated volume that is empty when a storm arrives, with an outlet. RWH sumps are assumed **full** at the start of every SW monsoon (JJAS) design storm (Chapter 4).

8.11.6 **Overflow.** Every RWH structure shall have an overflow that discharges at grade to the site drainage, never onto a neighbouring plot or into a sewer.

8.11.7 **Surface-runoff recharge in public spaces.** Recharge trenches, shafts and percolation pits in roads, medians, parks and other public spaces shall meet Clause 8.8 in full, including the hotspot rules for roads with heavy traffic, and shall have a GPT or silt trap at each inlet.

> Commentary. The rule that RWH storage does not count as detention is set in Chapter 4. Jammu and Kashmir's building rules make a rainwater harvesting proposal compulsory, but none of them sets a storage volume or a detention rule. Chapter 10 of UBBL-2021 provides that "All buildings having a plot size of 100 sq.m. Or more, while submitting the building plans for sanction, shall mandatorily include the complete proposal of rainwater harvesting", with "emphasis on both storage and reuse" for plotted houses; that "Recharging of ground water should be made mandatory … for all types of buildings, including Group Housing Societies having a plot area more than 500 sq. m. and above" (clause 10.5); that public open spaces of more than 500 m² "shall have arrangements for complete utilization and capture of storm water" (clause 10.4); that in group housing "Concrete paving to be avoided and permeable materials are to be used for all open parking spaces" (Table 10-1); and that a rainwater harvesting cell inspects the structures "before issuing Completion Certificates or NOCs for service connections" and checks every building above 1,000 m² each year (clause 10.6). The only quantity it gives is descriptive: "Rainwater can be harvested to the extent of 55,000 litres per 100 sq. m. area per Year from rooftops" (clause 10.1), about 550 mm a year (a reading of this Manual). The Srinagar Master Plan 2035 makes storage mandatory only "on plots of 1000 sq. mtr and above, and all group housing" (regulation 1-7-13); the bye-laws are later and apply across the Union Territory, and the stricter threshold of 100 m² applies. The Water Resources Act, 2010 lets the regulatory authority advise the Government on areas where rooftop harvesting should be made mandatory (section 122 [TBC]), which is advisory, not a rule, and no area was found notified. The Jammu Master Plan 2032 records that "Rainwater harvesting is not practiced in city" (§5.1.3). Enforcement is through the plan scrutiny of S.O. 304, which checks rainwater harvesting among its mandatory parameters, and the inspection before completion; no audit of how many structures were built, or how they are used, was found. The rules set no test of a recharge pit, no protection of the aquifer from road runoff, no storage to be empty before a storm, and no limit on recharge where the water table is at the ground or on a slope. Chapter 4 sets, for credit under this Manual, a minimum storage of 20 litres per m² of roof (set by this Manual). On the Kandi fans, recharge may be the main function of harvesting where Clause 8.8.1 allows it (Clause 8.11.2(b)); on the Kashmir valley floor, the Sirowal and every other ground where the water table is within 2 m, and on hill slopes, subsidence zones and debris cover, harvesting is for storage and use only, and its overflow goes to a lined drain (Clause 8.8.1). RWH serves water supply and recharge. It is usually full, or its soil saturated, by the time a late-August or September storm, such as those of September 2014 and August 2025, arrives after weeks of rain, which is why it cannot be counted as detention.
>
> Clause 8.11.3(b) has no direct precedent; this Manual sets it because road runoff carries oil, metals and pathogens. A recharge shaft or borewell bypasses the soil that would otherwise filter it and delivers it straight to the aquifer that supplies wells nearby. The CGWB *Manual on Artificial Recharge of Ground Water* (2007) gives recharge structure types and filter designs; this Manual adds the source-water restrictions.

8.12 Construction-stage erosion and sediment control

8.12.1 **ESC plan.** Every development with land disturbance of **0.1 ha** or more, and every public drainage or road work, shall have an Erosion and Sediment Control (ESC) plan, approved with the drainage report. It shall show:

- (a) the sequence of clearing, earthworks and stabilisation;
- (b) the area exposed at each stage;
- (c) the measures of Clause 8.12.3, with their locations and sizes;
- (d) the protection of infiltration and retention areas (Chapter 10);
- (e) stockpile, concrete washout and fuel storage locations; and
- (f) the inspection and maintenance schedule.

8.12.2 **Monsoon timing.** Earthworks shall be planned so that:

- (a) the area exposed during the SW monsoon (June to September) is as small as practicable;
- (b) all completed earthworks are stabilised by vegetation, mulch, matting or paving by **31 May**; and
- (c) any area exposed between 15 June and 31 October has sediment controls in place before it is cleared.

8.12.3 **Measures.**

- (a) **Silt fences** along the downslope edge of disturbed areas receiving sheet flow, with the area draining to each fence limited as set in Annex 8E.
- (b) **Sediment traps** for concentrated flow from disturbed areas of up to 2 ha.
- (c) **Sediment basins** for disturbed areas of more than 2 ha. The storage volume below the outlet shall be at least the greater of the runoff from the 50% AEP (2-yr) 24-hour storm and **250 m³ per hectare** of drainage area, with a dewatering outlet that draws water from the surface.
- (d) **Inlet protection** at every existing drain inlet that receives runoff from the site.
- (e) **Stabilised construction exits**, with wheel washing where vehicles enter public roads.
- (f) **Stockpiles** outside Zone 1 of any waterbody setback (Chapter 7), at least 10 m from any drain, and covered during the SW monsoon.
- (g) **Dewatering** discharges passed through a sediment basin, settling tank or filter bag, never pumped directly into a drain or waterbody.
- (h) **Concrete washout** in a lined pit, never into a drain.

8.12.4 **Design storm for temporary works.** Temporary ESC measures use the rainfall of Chapter 2 with a climate factor of 1.0 (Clause 2.8.2).

8.12.5 **Inspection.** ESC measures shall be inspected weekly and within 24 hours after every heavy-rainfall event (as defined in Chapter 10), repaired within 48 hours, and cleaned when half full of sediment.

8.12.6 **Removal.** Temporary measures shall be removed only after the area draining to them is stabilised. Sediment shall be removed from any permanent facility used for sediment control before its as-built survey (Chapter 10).

> Commentary. The 0.1 ha threshold is the applicability threshold of Chapter 1. The sediment basin volume of 250 m³/ha is the US EPA Construction General Permit minimum of 3,600 ft³ per acre drained, converted to SI (US EPA, 2022 CGP); the CGP allows the alternative of the 2-year, 24-hour runoff. This Manual requires the greater of the two, because Jammu and Kashmir's 2-year 24-hour depths are high and construction sites are commonly left exposed through the SW monsoon. The 2 ha division between traps and basins, the 31 May stabilisation date, the 10 m stockpile distance and the inspection frequency have no direct precedent and are set by this Manual. The 31 May date matches the pre-monsoon deadline of Chapter 10. Construction sediment is a direct flood hazard as well as a pollutant: it fills drains, culverts and tanks, and in Jammu and Kashmir sediment is the pollutant that takes the waterbodies' storage: the flood spill channel of the Jhelum silted from 17,000 to 4,000 cusecs "due to accumulation of sediment load from various nallahs which merge with the channel" (CAG Report No. 4 of 2016), 60% of Hokersar is reported under heavy siltation and Wular to have lost about 30 per cent of its volume to silt, and Dal's releases are reported limited by the silt in it (Clause 7.9, Commentary); in the hills, muck from road works has been dumped in khads and nallahs (as reported; Clause 6.3.6). In Jammu and Kashmir the outlet of a sediment basin or trap under Clause 8.12 discharges to a lined drain or a stable channel and never onto an unprotected slope or a Karewa scarp; no sediment basin or trap is designed to infiltrate where Clause 8.8.1 bars infiltration, which includes the whole Kashmir valley floor; no spoil, muck or debris from a site is placed in a khad, nallah, kol, khul, lake, nambal or talab or within its Zone 1; and a construction site in the catchment of a lake or nambal keeps its sediment out of every drain that reaches the lake. The reason given above for the larger basin volume, that the 2-year 24-hour depths are high, holds for the Jammu division, where the NIH-DHAARA reanalysis gives about 128 mm at Jammu and more at Udhampur, Katra and Kathua; it does not hold for the Kashmir valley, where the same source gives about 55 mm at Srinagar, and there the minimum of 250 m³ per hectare is likely to

govern over the 2-year runoff, so the rule of Clause 8.12.3(c) is kept unchanged. On the valley floor, the season of exposure is also the western-disturbance and snowmelt season of March to May, when the ground is wettest, so a site there has its sediment controls in place from 1 March as well as from 15 June (set by this Manual).

8.13 Monitoring

8.13.1 **Outfall monitoring.** Each Tier A authority shall monitor water quality at a representative set of its outfalls to waterbodies, including every outfall to a drinking-water tank or notified wetland. Monitoring shall include:

- (a) dry-weather sampling (Clause 8.9.4), at least once a year before the SW monsoon; and
- (b) wet-weather sampling of at least three events each SW monsoon at a set of index outfalls.

8.13.2 **Parameters.** At minimum: TSS, BOD, COD, faecal coliform, total nitrogen, total phosphorus, oil and grease, and, for industrial catchments, heavy metals. Results shall be compared with the CPCB water quality criteria for the designated best use of the receiving waterbody.

8.13.3 **Gross pollutant records.** The mass or volume of material removed from each GPT and screen at each cleaning shall be recorded in the O&M records (Chapter 10).

8.13.4 **BMP performance monitoring.** The State Stormwater Technical Committee shall run a BMP performance calibration programme and shall revise Table 8.3 and Annex 8C from its results.

8.13.5 **Publication.** Monitoring results shall be published in the register of Clause 10.17.

> Commentary. No Jammu and Kashmir programme of stormwater quality monitoring was found during research for this Manual, and CPHEEO (2019) sets no Indian targets. The monitoring in Clause 8.13 is the minimum needed to calibrate Table 8.3 and to show whether DWF interception and source removal are working. The parameter list follows the key pollutants named in CPHEEO's WSUD procedure (TSS, nitrogen, phosphorus and gross pollutants), with BOD and faecal coliform added because of sewage contamination. The monitoring frequencies are set by this Manual.

8.14 Submittal requirements

Every drainage report under this chapter shall include:

1. the **Water Quality Sheet (Form 8-1)**: P_ret, P_3m and P_wq; the WQv and Q_wq for each drainage area; the volume retained under Chapter 4; and the BMP serving each area;
2. for Tier A: the LoS calculation (ΔCN, required LoS) and the composite VR (Clause 8.6);
3. the design of each BMP to Clause 8.7 and Annex 8D, with pretreatment;
4. for infiltration and recharge: the **Infiltration Test Record (Form 8-2)**, the seasonal high groundwater level and its source, the design rate, the drawdown time, and the setbacks of Clause 8.8.6;
5. the sewage and sullage connection plan and the dye or smoke test record of Clause 8.9.2;
6. the GPT and first-flush design for any outfall to a waterbody (Clause 8.10);
7. the RWH layout, separating harvesting, recharge and detention (Clause 8.11); and
8. the ESC plan (Clause 8.12).

8.15 Review and update

8.15.1 This chapter shall be reviewed with the rest of the Manual (Chapter 1). Table 8.3 shall also be reviewed when the calibration programme of Clause 8.13.4 reports, and in any case within 5 years of notification.

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Annexes and forms

Annex / Form	Content
8A	3-month ARI 24-hour depth and IDF by zone
8B	Redevelopment LoS table and treatment-train composite VR
8C	Jammu and Kashmir BMP performance calibration
8D	BMP design sheets, media specification, plant lists
8E	Erosion and sediment control standard details
Form 8-1	Water Quality Sheet
Form 8-2	Infiltration Test Record

CHAPTER 9

Hydraulic Design of Structures

9.1 Purpose and scope

9.1.1 This chapter sets the hydraulic design methods for the structures used in the minor and major systems (Chapter 6), in retention and detention facilities (Chapter 4), at outfalls (Chapter 5) and at waterbodies (Chapter 7). It covers:

- (a) pipes and box drains (Clause 9.3);
- (b) culverts (Clause 9.4);
- (c) open channels (Clause 9.5);
- (d) energy dissipators, outlet protection and drop structures (Clause 9.6);
- (e) detention outlet structures (Clause 9.7);
- (f) trash racks and screens (Clause 9.8);
- (g) pumps and sumps (Clause 9.9);
- (h) tide gates, flap gates and non-return valves (Clause 9.10);
- (i) inlets and gratings (Clause 9.11);
- (j) manholes, junction chambers and access (Clause 9.12); and
- (k) materials and durability, including coastal and saline exposure (Clause 9.13).

9.1.2 **Structural design is outside the scope of this Manual.** Structures shall be designed structurally to the applicable Indian Standards and IRC codes, for example IS 456 (plain and reinforced concrete), IS 458 (concrete pipes), IRC:SP:13 (small bridges and culverts) and the IRC bridge codes. Where this chapter refers to a structural standard, it does so only for durability (Clause 9.13) or hydraulic performance.

9.1.3 Design flows, design AEPs and level-of-service limits come from Chapters 2 to 7. This chapter does not change them.

> **Commentary.** APWA Section 5600 places most structure hydraulics in its sections on inlets and manholes (5604), enclosed pipe systems (5606), engineered channels (5607) and detention (5608). CPHEEO (2019) spreads them across Chapters 5, 6, 8 and 11. This chapter gathers them in one place and points to the US Federal Highway Administration (FHWA) hydraulic circulars for methods that Indian codes do not cover in enough detail: HDS-5 for culverts, HEC-14 for energy dissipators, HEC-22 for inlets and access holes, and HEC-24 for pump stations. The FHWA editions cited are those listed in the FHWA hydraulics library as of October 2026.

9.2 General requirements

9.2.1 **Tailwater.** Every structure that discharges to a river, khad, nallah, lake, nambal, talab, flood spill channel, canal or reservoir whose level can rise above the outfall invert shall be analysed with the tailwater conditions of Chapter 5: the non-tidal tailwater of Clause 5.6 for minor- and major-system design; the riverine backwater of Clause 5.8, including the flood released from any dam or barrage upstream, such as Baglihar and Salal on the Chenab, Ranjit Sagar on the Ravi and the Tawi barrage at Jammu; the outfall-closed check of Clause 5.10 wherever the receiving water can rise above

the outfall invert, which is the normal case on the Kashmir valley floor, where the drains of Srinagar, Anantnag, Bijbehara, Pampore, Sopore, Baramulla and Sumbal reach a Jhelum held between embankments above the land behind them and are closed to gravity flow from the flood-declaration stage (18 ft on the I&FC gauge at Ram Munshi Bagh, whose zero is not published), so that they drain only through storage and pumping stations (Clause 5.12), and the case also for the drains of Jammu that outfall to the Tawi, of Akhnoor to the Chenab, of Kathua to the Ujh and the Ravi and of Samba to the Basantar; for an outfall to the Jhelum, the levels of Clause 5.8.5(a): at Ram Munshi Bagh not below the CWC danger level of 1,585.48 m for the minor system and not below the high flood level of 8 September 2014 for the major system and storage, given as 1,588.99 m in CWC's list of 2022 and 1,589.65 m in that of 2018, the higher governing until CWC confirms one; at Sangam 1,590.88 m and 1,595.7 m (1,595 m in the 2022 list), with 1,595.43 m at Khanabal in 2025; and at Safapora 1,579.66 m and 1,582.1 m (CWC levels as transcribed by SANDRP, as reported; the datum is not stated), with any I&FC reading in feet named as such and never converted to metres; for an outfall to a lake, nambal or talab, among them Dal through the Dal Gate and Nallah Amir Khan, Nigeen, Anchar, Hokersar, Wular (danger level 1,578 m, as reported), Manasbal and Mansar–Surinsar, the level at its outlet and the level at which its gate closes, on a named datum [TBC]; for an outfall to a reservoir or barrage pond, its maximum water level, or its full reservoir level plus the surcharge in the design flood, as Chapter 5 sets it (Baglihar, full reservoir level 840 m; Salal, 487.68 m; Ranjit Sagar, 527.91 m or 527.13 m, two published values that conflict, of which the higher is used until the operator states one on a named datum; the pool level of the Tawi barrage [TBC]; all as reported); for an outfall to a khad or nallah that has no gauge, among them the khads that cross Jammu, Samba and Kathua on the Kandi fans and the nallahs of the hill towns, the level of the 1% AEP flood in the reach, computed with the sediment and debris allowances of Chapter 6 and checked against surveyed flood marks and the debris lines of 2014 and 2025, with the outfall invert above the highest surveyed bed (Clause 5.8.5(c)); for a river reach without a CWC site, which is every reach outside the seven CWC sites in the Union Territory, the flood-mark profile of the reach; the level held in a drain by any gate, lock, weir, flood spill channel, city channel or pumping station downstream of the outfall, taken as a fixed control at its gate-closed level, its weir crest or the start level of its pumps; and the joint case of Clause 2.12. On the Tawi at Jammu (Sidhra) CWC publishes a high flood level only, 321.1 m of 26 August 2025, which replaced 318.85 m of 2014, and on the Chenab at Akhnoor 324.29 m of 10 September 1992 (as reported). No document found sets a design river, lake, reservoir, khad or nallah level at any outfall in Jammu and Kashmir, no flood basin has been found notified under Part VI of the Jammu and Kashmir Water Resources (Regulation and Management) Act 2010, and the Flood Plain Zones Act 2005 has not been found brought into force; until such levels are published, the levels of Chapter 5 apply.

9.2.2 **Climate factor.** Design flows shall include the climate factor of Clause 2.8.

9.2.3 **Maintenance access.** Every structure shall be accessible for inspection and cleaning by the methods in Clause 9.12 and Chapter 10, without manual entry into confined spaces wherever practicable.

9.2.4 **Design life.** Structures shall be designed for a service life of at least 50 years for concrete and masonry works, and at least 25 years for mechanical and electrical equipment, unless the approving authority agrees otherwise.

9.2.5 **Blockage.** Where a structure can be blocked by debris, it shall be checked in the blocked condition set out in this chapter, and a safe overflow route shall exist for that condition (Chapter 6, Clause 6.3.2).

> Commentary. The design-life values in Clause 9.2.4 have no direct precedent; this Manual sets them because they are needed to decide when the climate factor applies (Clause 2.8.2 applies it to elements with a design life over 25 years).

9.3 Pipes and box drains

9.3.1 **Capacity and roughness.** Pipe and box-drain capacity shall be computed by Manning's equation with the design n of Chapter 6, Table 6.6. For precast or cast-in-situ RCC box drains, the design n shall be at least 0.015.

9.3.2 **Partly full flow.** Depth, velocity and discharge in partly full circular pipes shall be computed from the hydraulic-element relationships for circular sections (for example CPHEEO 2019, Table 5.5). The minimum velocity of Clause 6.7.3 applies at the design flow.

9.3.3 **Pressure flow.** Where a pipe runs full or surcharged, the HGL shall be computed under Chapter 6, Clause 6.8, with friction and structure losses.

9.3.4 **Steep pipes.** Where the design flow in a pipe is supercritical (Froude number above 1), the designer shall:

- (a) locate any hydraulic jump and show that it occurs in a structure designed to contain it, not in a pipe run;
- (b) provide air venting where the jump can seal the pipe; and
- (c) meet the maximum velocity of Clause 6.7.3(b).

9.3.5 **Changes of size and direction.**

- (a) Pipe size shall not decrease downstream.
- (b) Pipes shall join only at manholes or junction chambers, except that inlet connections may join pipes of 1,200 mm or more through a factory-made junction.
- (c) Changes of direction greater than 90° in a single structure are not permitted.

9.3.6 **Flotation.** Pipes and box drains in high groundwater shall be checked for flotation (Chapter 6, Clause 6.7.7).

> **Commentary.** The design n of 0.015 for box drains is set by this Manual to match the "fair" concrete value in Table 6.6. Clauses 9.3.4 and 9.3.5 follow common practice in FHWA HEC-22 and other manuals. A jump inside a pipe run causes pressure surges and can blow off manhole covers.

9.4 Culverts

9.4.1 **Method.** Culverts shall be designed by the methods of FHWA *Hydraulic Design of Highway Culverts*, HDS-5, 3rd edition (2012), or by software that implements them (for example FHWA HY-8). The design headwater is the **greater** of the headwater under inlet control (HWi) and the headwater under outlet control (HWo).

9.4.2 **Inlet control.** HWi shall be computed from the HDS-5 inlet-control equations or nomographs for the barrel shape, material and inlet edge condition actually built.

9.4.3 **Outlet control.** HWo shall be computed as:

> HWo = ho + H − L·S

> H = [1 + ke + (19.63 n² L) / R^1.33] · V² / 2g (SI units, full barrel)

> ho = the greater of TW and (dc + D)/2

where ho is the outlet water depth used for control (m), H is the total head loss through the barrel (m), L is the barrel length (m), S is the barrel slope (m/m), ke is the entrance loss coefficient (Table 9.1), n is the barrel roughness, R is the hydraulic radius (m), V is the barrel velocity (m/s), TW is the tailwater depth above the outlet invert (m), dc is the critical depth (m) and D is the barrel rise (m). Part-full barrels under outlet control shall be analysed by backwater calculation as set out in HDS-5.

Table 9.1 — Entrance loss coefficients ke (outlet control, full or partly full)

Barrel and inlet	ke
Concrete pipe, projecting from fill, socket (groove) end	0.2
Concrete pipe, projecting from fill, square-cut end	0.5
Concrete pipe, headwall or headwall with wingwalls, socket end	0.2
Concrete pipe, headwall or headwall with wingwalls, square edge	0.5
Concrete pipe, headwall, rounded entrance (radius = D/12)	0.2
Concrete pipe, mitred to conform to fill slope	0.7
Concrete pipe, bevelled edges	0.2
Corrugated metal pipe, projecting from fill	0.9
RCC box, headwall parallel to embankment, square edge on three sides	0.5
RCC box, headwall parallel to embankment, three edges rounded or bevelled	0.2
RCC box, wingwalls at 30°–75° to barrel, square-edged crown	0.4
RCC box, wingwalls at 10°–25° to barrel, square-edged crown	0.5
RCC box, wingwalls parallel (extension of sides), square-edged crown	0.7

Source: FHWA HDS-5 (2012), entrance loss coefficient table (Appendix C).

9.4.4 **Tailwater.** TW shall be the higher of:

- (a) the normal or backwater depth in the downstream channel at the design flow; and
- (b) the tailwater level of Clause 9.2.1, for culverts within tidal or river backwater reach.

9.4.5 **Headwater limits.** At the design AEP of Chapter 6, Table 6.1:

- (a) HW/D shall not exceed 1.2;
- (b) the headwater shall be at least 0.3 m below the edge of the road shoulder at the upstream face; and
- (c) the headwater shall not raise water levels at any upstream building or property boundary above the limits of Chapter 6, Clause 6.12.2(d).

9.4.6 **Road overtopping.** Flow over the road in the check and 1% AEP events shall be computed with the broad-crested weir equation:

> Qr = Cd · L · h^1.5

where Qr is the overtopping flow (m³/s), L is the length of the overtopping section (m) and h is the depth of the headwater above the road crest (m). Cd shall be taken from HDS-5 for the road surface and the ratio of h to road width, and shall not exceed 1.66 (SI). The culvert and overtopping flows shall be balanced at a common headwater. The overtopping depths and hazard shall meet Chapter 6, Clause 6.12.

9.4.7 **Outlet velocity.** The outlet velocity at the design AEP and at the 1% AEP shall be computed and the outlet protected under Clause 9.6.

9.4.8 **Barrels and debris.**

- (a) Multi-barrel culverts shall be avoided in debris-prone urban drains. Where they are used, one barrel shall carry the dry-weather flow, and the inlet shall have a debris fin or deflector.
- (b) Culverts shall meet the minimum size and blockage checks of Chapter 6, Clauses 6.12.4 and 6.12.5.
- (c) Culvert inverts shall match the bed of the drain. They shall not be set above the bed, which traps silt and water upstream.

9.4.9 **Headwalls and cut-offs.** Inlets and outlets shall have headwalls, wingwalls and cut-off walls designed to prevent piping and undermining.

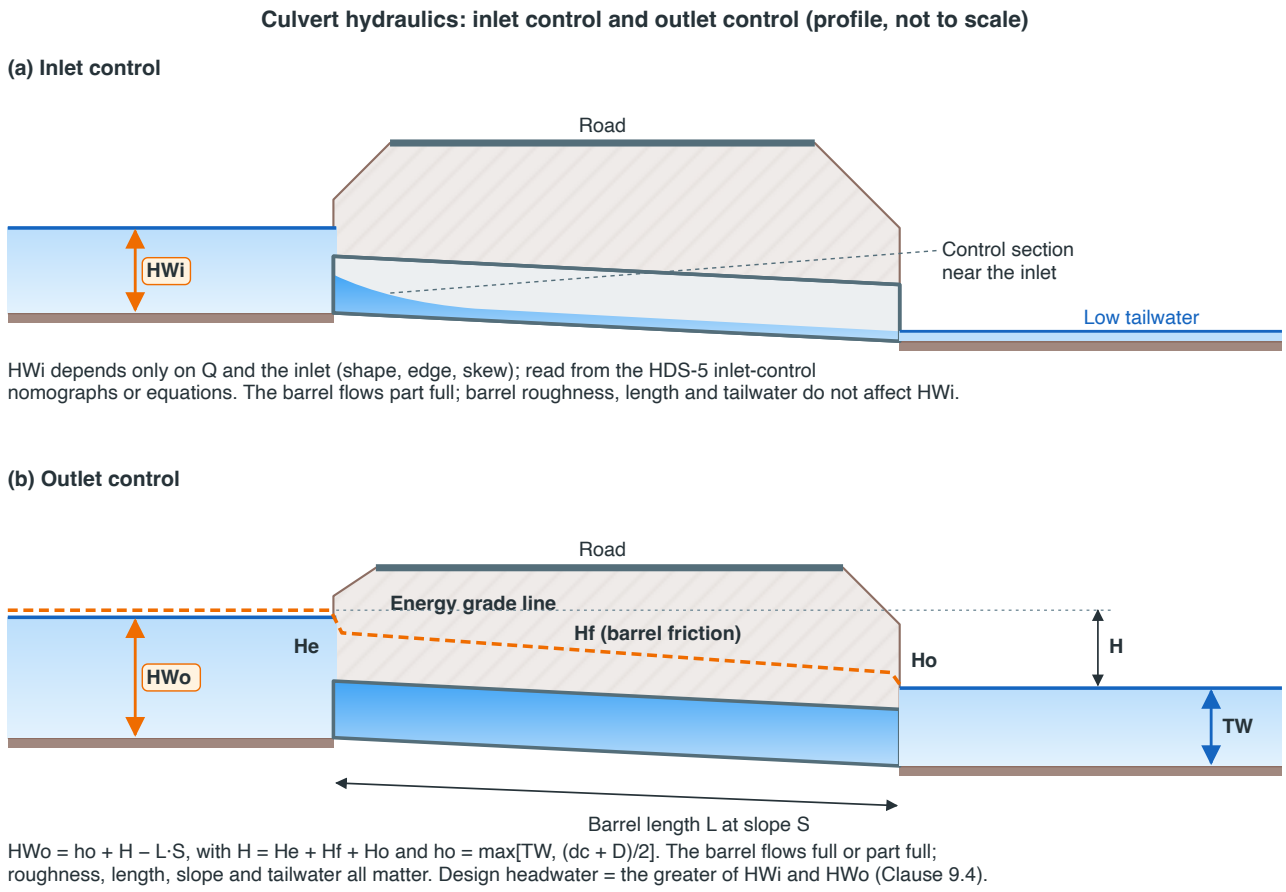

Figure 9.1 — Culvert hydraulics: inlet control and outlet control. Original drawing for this Manual, adapted from FHWA, Hydraulic Design of Highway Culverts, HDS-5 (3rd ed., 2012).

Commentary. HDS-5 (3rd ed., FHWA-HIF-12-026, April 2012) merged the culvert design material of HEC-5, HEC-10 and HEC-13 and is the current FHWA culvert manual. The outlet-control equation in Clause 9.4.3 is the HDS-5 energy equation in SI units: the friction coefficient 19.63 equals 2g. The ke values in Table 9.1 are reproduced from HDS-5. The weir coefficient cap of 1.66 (SI) is the conversion of the APWA 5600 (2006) limit of C ≤ 3.0 (US units) for overtopping calculations. The headwater limits of Clause 9.4.5 are set by this Manual: HW/D ≤ 1.2 keeps the inlet from operating far into submerged-orifice flow at the design event, where small increases in flow give large increases in headwater. Clause 9.4.8(c) has no direct precedent; it is included because raised culvert inverts are common in Jammu and Kashmir where a road is rebuilt on top of an old culvert, and they hold standing water and silt upstream.

9.5 Open channels

9.5.1 **Flow computation.** Open channels shall be designed by Manning's equation for uniform flow, with the n of Table 6.6. Water levels shall be computed by gradually varied flow (standard step) analysis where tailwater, bridges, culverts, bends or changes of section affect them, which on the drains of the Kashmir valley floor, flat and held up by the Jhelum, its lakes and nambals and the gates and pumping stations at their outfalls, on the drains of the Sirowal backed up by the Tawi, the Chenab, the Ujh and the Basantar, and on the steep khads of the Kandi fans and the nallahs and streets of Udhampur, Katra, Ramban, Batote, Doda, Kishtwar, Rajouri, Poonch and the other hill towns, stepped by drop structures and chutes and passing through critical depth at every step, is the normal case.

9.5.2 **Flow regime.** At the design flow, the Froude number shall not exceed 0.8 (CPHEEO 2019, §5.3), unless the channel is designed as a supercritical chute. Flows with a Froude number between 0.8 and 1.2 are not permitted at the design flow in any channel.

9.5.3 **Permissible velocities.** Mean velocity at the design flow shall not exceed the limits of Table 9.2.

Table 9.2 — Maximum permissible mean velocities in channels

Lining or soil	Maximum velocity (m/s)	Source
Concrete lining	3.0	CPHEEO 2019 Table 5.11
Riprap lining	1.8	CPHEEO 2019 Table 5.11
Grassed lining	1.2	CPHEEO 2019 Table 5.11
Stabilised earthen channel (modified natural channel)	2.0, or the critical velocity if less	CPHEEO 2019 §5.10.3
Unlined, fine sand	0.46	Fortier and Scobey (1926), clear water
Unlined, sandy loam	0.53	As above
Unlined, silt loam	0.61	As above
Unlined, firm loam	0.76	As above
Unlined, stiff clay	1.14	As above
Unlined, fine gravel	0.76	As above
Unlined, coarse gravel	1.22	As above

Flexible linings (vegetation, riprap, geosynthetics) may instead be designed by the permissible shear stress method of FHWA HEC-15, *Design of Roadside Channels with Flexible Linings*, 3rd edition (2005).

9.5.4 **Longitudinal slope.** In engineered channels, the longitudinal slope shall not exceed 0.4% for natural linings and 0.2% for concrete linings, unless drop structures (Clause 9.6.6) or a chute are provided (CPHEEO 2019, Table 5.11).

9.5.5 **Freeboard and bends.** Freeboard shall meet Chapter 6, Table 6.7, measured above the water level that includes superelevation at bends. Bend radii shall meet Chapter 6, Clause 6.7.10.

9.5.6 **Side slopes.** Unless a structural or geotechnical design supports a steeper slope:

- (a) unlined earth channels shall have side slopes no steeper than 1V:2H; and
- (b) grassed channels that are mown shall have side slopes no steeper than 1V:3H.

9.5.7 **Low-flow channel.** Channels with a bed width of 3 m or more shall have a defined low-flow channel that carries the dry-weather flow at the self-cleansing velocity of Clause 6.7.3.

9.5.8 **Transitions.** Changes of section shall use gradual transitions. Abrupt expansions and contractions are not permitted in supercritical flow.

9.5.9 **Linings in high groundwater.** Lined channels in areas of high groundwater or tidal influence shall have weep holes with filters, or shall be designed to resist uplift with the channel empty.

9.5.10 **Natural channels.** Natural channels shall be preserved where possible (CPHEEO 2019, §5.10.3 note; Chapter 7). Where a natural channel must be modified, its capacity shall meet the design AEP of Chapter 6 and its velocities shall meet Table 9.2.

> Commentary. The lined-channel velocities and slopes are CPHEEO (2019) Table 5.11 values. The unlined-soil values are the classic Fortier and Scobey (1926) permissible velocities for clear water, as reproduced in Chow (1959). They are given for soils common in Jammu and Kashmir (the boulder gravels and coarse sands of the Kandi fans and khad beds of the Jammu plains, the finer silts and clays of the Sirowal below the spring line, the sandstones, clays and weathered debris of the Siwalik and Murree hills around Udhampur, Ramban, Doda and the other hill towns, the clays, silts and sands of the Karewa tablelands, and the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, on which the boulders a khad carries in the Jammu division, and the soft, saturated ground of the valley floor in Kashmir, decide what a channel bed and lining must withstand (this Manual's reading)). The ban on Froude numbers between 0.8 and 1.2 extends CPHEEO's advice to avoid critical flow, where the water surface "becomes unstable and wavy" (§5.3). This extension is made by this Manual. The side slopes and the low-flow channel are also set by this Manual, because many Jammu and Kashmir urban channels carry sewage-mixed dry-weather flow until the cross-connections of Chapter 8 are removed. A wide flat bed then deposits sludge across its whole width, and a low-flow channel keeps the dry-weather flow concentrated.

9.6 Energy dissipators, outlet protection and drop structures

9.6.1 **When required.** Outlet protection or an energy dissipator shall be provided at every pipe, culvert and channel outlet where the outlet velocity at the design AEP or the 1% AEP exceeds the permissible velocity of the receiving channel in Table 9.2, and at every outlet to an unlined channel, tank or waterbody.

9.6.2 **Method.** Energy dissipators and outlet protection shall be designed by the methods of FHWA HEC-14, *Hydraulic Design of Energy Dissipators for Culverts and Channels*, 3rd edition (2006), selecting the dissipator type by its range of application.

9.6.3 **Riprap aprons.** For a circular outlet discharging to a flat apron, the median riprap size shall be computed with the HEC-14 apron equation:

$$D_{50} = 0.2 \cdot D \cdot \left[Q / \left(g^{0.5} \cdot D^{2.5} \right) \right]^{(4/3)} \cdot (D / TW)$$

where D_{50} is the median stone size (m), D is the culvert diameter or rise (m), Q is the design discharge (m³/s), $g = 9.81$ m/s² and TW is the tailwater depth (m). Where TW is not known, it shall be taken as $0.4D$.

Apron length and thickness shall follow the HEC-14 riprap-class table (Table 9.3). The apron width at the outlet shall be at least $3D$ and shall flare to the downstream channel.

Table 9.3 — Riprap classes and apron dimensions (HEC-14)

Class	D50 (mm)	Apron length	Apron thickness
1	125	4D	3.5 D50
2	150	4D	3.3 D50
3	250	5D	2.4 D50
4	350	6D	2.2 D50
5	500	7D	2.0 D50
6	550	8D	2.0 D50

Source: FHWA HEC-14 (2006), §10.2 and Table 10.1, as reproduced in state-agency design worksheets. Where the computed D50 exceeds Class 6, a riprap basin or a structural stilling basin shall be used.

9.6.4 **Riprap filter and grading.** Riprap shall be placed on a granular filter or a geotextile. Stone shall be angular, durable and graded so that the D50 of Clause 9.6.3 is met.

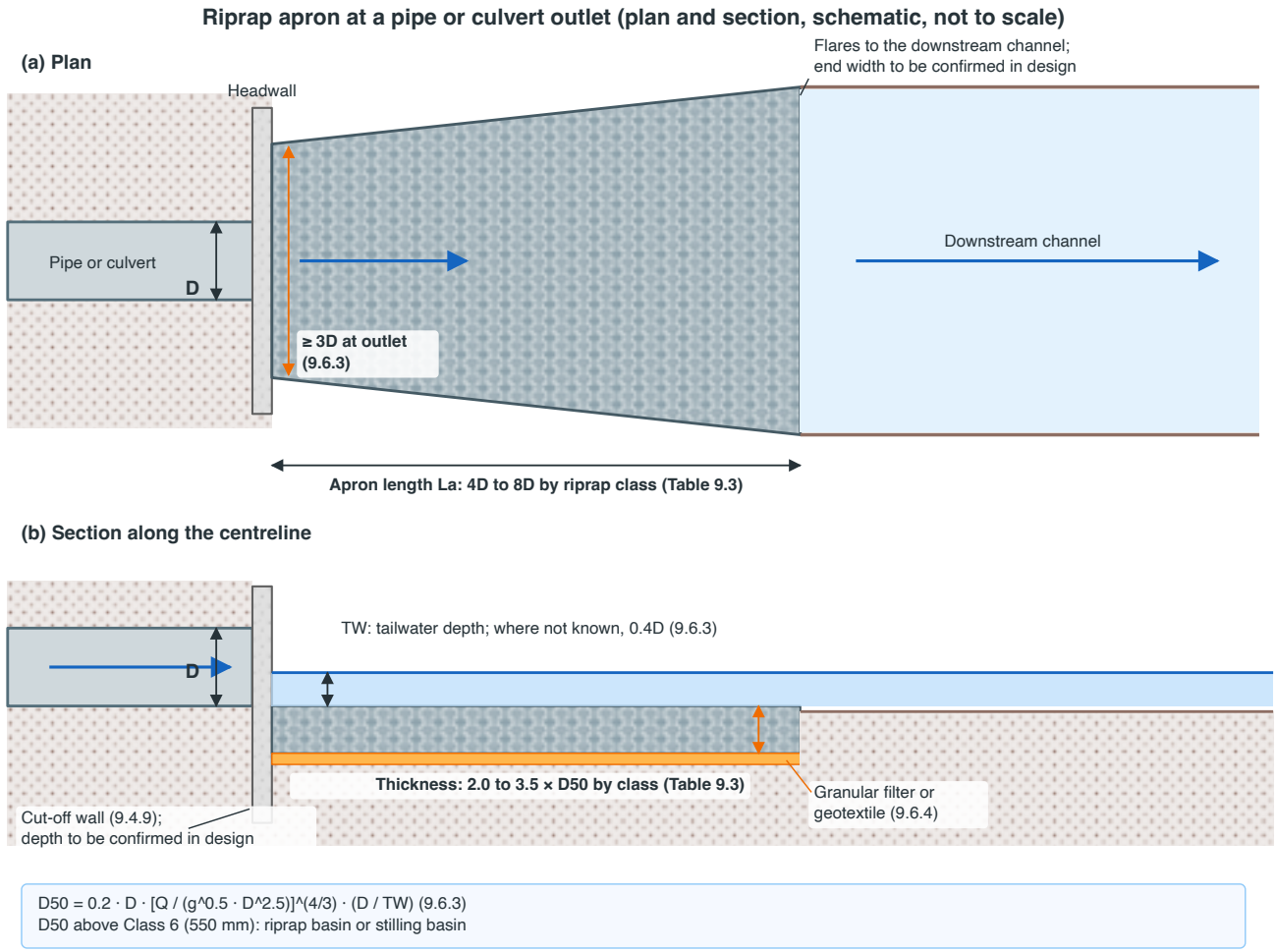

Figure 9.2 — Riprap apron at a pipe or culvert outlet: apron width at least 3D at the outlet, flaring to the downstream channel; length and thickness from Table 9.3; stone on a granular filter or geotextile (Clauses 9.6.3 and 9.6.4). Original drawing for this Manual, adapted from FHWA, Hydraulic Design of Energy Dissipators for Culverts and Channels, HEC-14 (3rd ed., 2006), §10.2.

9.6.5 **Stilling basins.** Where velocities or Froude numbers are above the range of riprap aprons and basins, a structural stilling basin or impact basin shall be designed from HEC-14 or from the US Bureau of Reclamation basin types it describes.

9.6.6 **Drop structures.** Drop structures shall be used where the channel slope would otherwise exceed Clause 9.5.4 or the velocity limit of Table 9.2.

- (a) For a straight vertical drop, the drop number $D = q^2 / (g\,h^3)$ shall be computed, where q is the unit discharge (m^2/s) and h is the drop height (m). The pool geometry shall be set from the Rand (1955) relationships: drop length Ld/h = 4.30 D^0.27; pool depth Yp/h = 1.00 D^0.22; sequent depths y1/h = 0.54 D^0.425 and y2/h = 1.66 D^0.27.
- (b) Baffled chutes and stepped drops shall be designed by HEC-14 or US Bureau of Reclamation methods.
- (c) The height of a single vertical drop in a public drain shall not exceed 1.5 m. Drops shall have edge protection under Chapter 6, Clause 6.13.8.

9.6.7 **Coastal and beach outfalls.** Outfalls onto beaches or into estuaries shall be protected against wave action and scour. Where littoral sand can close the outfall, the outfall shall be designed so that it can be reopened by machine, and the drainage system shall be checked with the outfall closed under Chapter 5.

> Commentary. HEC-14 (3rd ed., FHWA-NHI-06-086, July 2006) is the current FHWA energy-dissipator manual. The apron equation and the class table are from HEC-14 §10.2 (Equation 10.4 and Table 10.1). The equation and table are given here as reproduced in secondary design documents (a Tennessee handbook and a state-agency riprap worksheet). The 3D apron width is from the same sources. A Purdue study (JTRP) found the HEC-14 apron method somewhat conservative within its range of application. The Rand (1955) drop relationships are standard and are reproduced in Chow (1959). The 1.5 m limit on a single vertical drop has no direct precedent; this Manual sets it for public safety in urban drains.

9.7 Detention outlet structures

9.7.1 **Primary outlet.** The primary outlet of a detention facility shall:

- (a) produce the release rates and drawdown times of Chapter 4;
- (b) work without mechanical parts or operator action, except in pumped facilities (Clause 9.9);
- (c) have no orifice smaller than **50 mm**, and every orifice shall be protected by a trash screen (Clause 9.8.5); and
- (d) be accessible for cleaning from the surface.

9.7.2 **Orifices.** Orifice flow shall be computed as:

> $Q = C_d \cdot A \cdot (2\,g\,h)^{0.5}$

where A is the orifice area (m^2) and h is the head (m) on the centroid of the orifice, or the difference between the upstream and downstream water levels where the orifice is submerged. Cd shall be 0.60 for a sharp-edged orifice in a thin plate. Other edge conditions shall use published tested values.

9.7.3 **Weirs.** Weir flow shall be computed as $Q = C_w \cdot L \cdot H^{1.5}$, with:

- (a) sharp-crested rectangular weirs: Cw = 1.84 (SI), with the effective length reduced by 0.1 H for each end contraction;
- (b) V-notch weirs: $Q = 1.38 \cdot \tan(\theta/2) \cdot H^{2.5}$ (SI), where θ is the notch angle; and

- (c) broad-crested weirs and spillway crests: Cw = 1.44 to 1.70 (SI), selected from published tables for the crest shape and head.

Submerged weirs shall be corrected for submergence from published relationships.

9.7.4 **Stage–discharge rating.** For multi-stage outlets (orifices and weirs in a riser, with an outlet pipe), the designer shall compute, at each stage, the discharge under every possible control (each orifice, each weir, riser crest, and the outlet pipe under inlet and outlet control) and use the **smallest** combined value. The rating shall be tabulated from the outlet invert to the emergency spillway crest plus the design head.

9.7.5 **Tailwater.** Ratings shall be computed with the tailwater of Clause 9.2.1. Where the receiving water can rise above the outlet, the outlet shall have a flap gate or non-return valve under Clause 9.10, and the storage shall meet the outfall-closed check of Chapter 5.

9.7.6 **Emergency spillway.** The emergency spillway shall pass the 1% AEP inflow with the primary outlet assumed blocked and the basin full at the start, with **0.3 m** freeboard to the embankment crest. High-hazard basins shall also be checked for the 0.2% AEP inflow (Chapter 4).

9.7.7 **Outlet pipes through embankments.** Outlet pipes through embankments shall have a filter diaphragm or seepage collars to prevent piping along the pipe, and a flared or headwalled inlet.

9.7.8 **Anti-vortex.** Riser outlets with a design head above the riser crest greater than the riser diameter shall have an anti-vortex plate.

> Commentary. The 50 mm minimum orifice with a trash screen, the emergency-spillway criterion and the drawdown times are core criteria of this Manual (Chapter 4). The minimum orifice is smaller than the APWA 5600 (2006, 5608.4) minimum of 3 in (about 75 mm). It allows the low release rates of the Chapter 4 mixed-frequency rule on small sites, and it relies on a good screen (Clause 9.8.5). The "no mechanical parts" rule follows APWA 5600 (2006, 5608.4), which requires the primary outlet to function unattended. The orifice and weir coefficients are standard textbook values (for example Brater and King, *Handbook of Hydraulics*; Chow 1959). The 1.84 sharp-crested coefficient and the 0.1H end-contraction correction are the Francis formula in SI units. The broad-crested range 1.44–1.70 is the SI equivalent of the US range 2.6–3.1 commonly tabulated. Clauses 9.7.7 and 9.7.8 follow common dam and detention practice.

9.8 Trash racks and screens

9.8.1 **Where required.** Trash racks or screens shall be provided:

- (a) where an open drain enters a pipe, covered drain or culvert longer than 30 m (Chapter 6, Clause 6.13.4);
- (b) at every detention outlet orifice (Clause 9.7.1);
- (c) at the inlet of every pump sump (Clause 9.9); and
- (d) at outfalls to waterbodies, as part of the gross pollutant trap of Chapter 8.

9.8.2 **Conduit-entrance racks.** Racks at the entrance to conduits and culverts shall have:

- (a) clear bar spacing not less than 75 mm and not more than half the smallest internal dimension of the conduit;
- (b) a gross area at least 4 times the conduit's cross-sectional area;
- (c) a mean velocity through the rack at the design flow, with 50% of the rack blocked, of not more than 1.0 m/s; and
- (d) an inclination no steeper than 1V:2H where the rack is to be raked by hand, with a working platform and handrail.

9.8.3 **Head loss.** Head loss through a clean rack shall be computed with the Kirschmer equation:

$$h_r = \beta \cdot (t / b)^{(4/3)} \cdot (V^2 / 2g) \cdot \sin\theta$$

where t is the bar thickness, b is the clear bar spacing, V is the approach velocity, θ is the angle of the rack from the horizontal, and β is the bar shape factor (2.42 for sharp-edged rectangular bars; 1.79 for circular bars). The HGL and headwater shall be checked with the rack **50% blocked** (head loss computed with half the open area).

9.8.4 **Overflow when blocked.** Every rack shall have an overflow route so that a fully blocked rack does not flood buildings or exceed the limits of Chapter 6.

9.8.5 **Detention outlet screens.** Screens over detention orifices shall have openings smaller than the orifice they protect, and an open area at least 10 times the orifice area.

9.8.6 **Pump sump screens.** Bar screens at pump-station inlets shall have a clear spacing smaller than the largest solid the pumps can pass, as stated by the pump manufacturer. Screens shall be built in removable modules, and a mechanically raked screen shall be used where the design inflow exceeds 1 m³/s.

9.8.7 **Safety.** Racks at the entrance to long conduits shall prevent people from being drawn in. They shall be designed for the hydrostatic load of a fully blocked rack.

> Commentary. CPHEEO (2019, §8.3.1.3) describes pump-station bar screens with a spacing of "approximately 58 mm", built in modules, with an emergency overflow in case of clogging. Clause 9.8.6 follows that approach but links the spacing to the pump's solids-passing size, which varies by pump. The 50% blockage check matches the grate clogging factor of Chapter 6. The Kirschmer equation and its shape factors are standard (Kirschmer 1926, as reproduced in hydraulic handbooks). The rack spacing, area ratio, through-velocity, the 30 m conduit length trigger, the 10× screen area for orifices and the 1 m³/s trigger for mechanical raking have no direct precedent and are set by this Manual.

9.9 Pumps and sumps

9.9.1 **When pumping is used.** Pumping shall be used only where gravity drainage cannot meet the requirements of Chapters 5 and 6, for example at road underpasses (Chapter 6, Clause 6.10.5), basements, low-lying areas and outfalls that are tide-locked under the outfall-closed check of Chapter 5.

9.9.2 **Design inflow and storage.** The station shall be designed with the inflow hydrograph routed through the catchment and any upstream storage. Pump capacity and storage shall be chosen together:

- (a) the station shall meet the design AEP of the element it serves (for underpasses, the 2% AEP with a 1% AEP check);
- (b) where the station serves a tidal outfall, storage plus pumps shall hold the 48 h design volume with the outfall throttled for the tidal-lock duration (default: two consecutive high tides of 6 h each), as required by Chapter 5; and
- (c) the pumps shall be selected for the full range of static head between the lowest sump level against the lowest tailwater, and the highest tailwater (HAT plus surge plus 0.3 m).

9.9.3 **Wet-well volume.** The effective wet-well volume (between the pump-stop and the lowest pump-start level) shall be the greatest of:

- (a) where variable-speed drives and automatic controls are installed, 5 minutes of the minimum inflow (CPHEEO 2019, §8.3.3);

- (b) otherwise, 10 to 15 minutes of the peak inflow, or the volume needed for the pump manufacturer's minimum cycle time, from $V = Q \cdot t$ (CPHEEO 2019, Eq. 8.1); and
- (c) for constant-speed pumps, the volume $V = \Theta \cdot q / 4$ for each pump, where Θ is the minimum cycle time recommended by the motor manufacturer and q is the pump capacity (FHWA HEC-24, 2001).

9.9.4 **Duty and standby.**

- (a) Duty pumps shall be of the same size where practicable (CPHEEO 2019, §8.3.3).
- (b) Standby capacity shall be at least equal to the largest duty pump, and not less than 50% of the number of duty pumps.
- (c) Duty and standby roles shall alternate automatically.

9.9.5 **Pump type.** Pumps shall be solids-handling (non-clog) types suited to stormwater with sand and debris. Axial-flow pumps shall be used only behind a screen that meets Clause 9.8.6, because they cannot handle debris (CPHEEO 2019, §8.3.2).

9.9.6 **Sump and intake design.** Sump geometry, pump spacing, minimum submergence and approach flow conditions shall follow the pump manufacturer's requirements and ANSI/HI 9.8 (Rotodynamic Pumps for Pump Intake Design). A physical hydraulic model study shall be carried out where any pump exceeds 1 m^3/s, or where the sump does not follow standard ANSI/HI 9.8 geometry. The minimum clear space between adjacent pumps or motors is 0.6 m for small and medium units and 1.0 m for large units (CPHEEO 2019, §8.2.5).

9.9.7 **Silt and screens.** A silt trap and a bar screen shall be provided upstream of the wet well (Clause 9.8.6; Chapter 6, Clause 6.13.3).

9.9.8 **Controls and monitoring.**

- (a) Pumps shall be controlled by a primary level sensor (ultrasonic, radar or pressure) with an independent float-switch back-up.
- (b) High-level and pump-fault alarms shall be sent by telemetry to the local body's control room.
- (c) Sump levels, pump run hours and power status shall be logged and kept for at least 5 years.

9.9.9 **Power supply.**

- (a) The station shall have two independent power sources: the grid supply and a standby generator (or a second independent grid feeder) able to run all duty pumps at once (CPHEEO 2019, §2.4.2.3(j)).
- (b) Fuel for at least **72 hours** of continuous operation of all duty pumps shall be stored on site, above the flood level of Clause 9.9.10.
- (c) Changeover to standby power shall be automatic.

9.9.10 **Flood protection of the station.** The floor of the electrical and control room, the generator and the transformer shall be at least 0.5 m above the 1% AEP flood level at the station (Chapter 6, Clause 6.11). Access to the station for maintenance vehicles shall remain usable in the 1% AEP event.

9.9.11 **Discharge.** Each pump shall have its own rising main, or a non-return valve and an isolating valve where mains combine. Rising mains shall discharge into a delivery chamber or outfall fitted with a flap gate or non-return valve under Clause 9.10. Discharge piping shall be sized by a recognised friction formula (CPHEEO 2019, §8.3.9).

9.9.12 **Emergency connections.** Every station shall have a hard-standing area and a quick-coupling connection for mobile pumps to discharge into the delivery chamber.

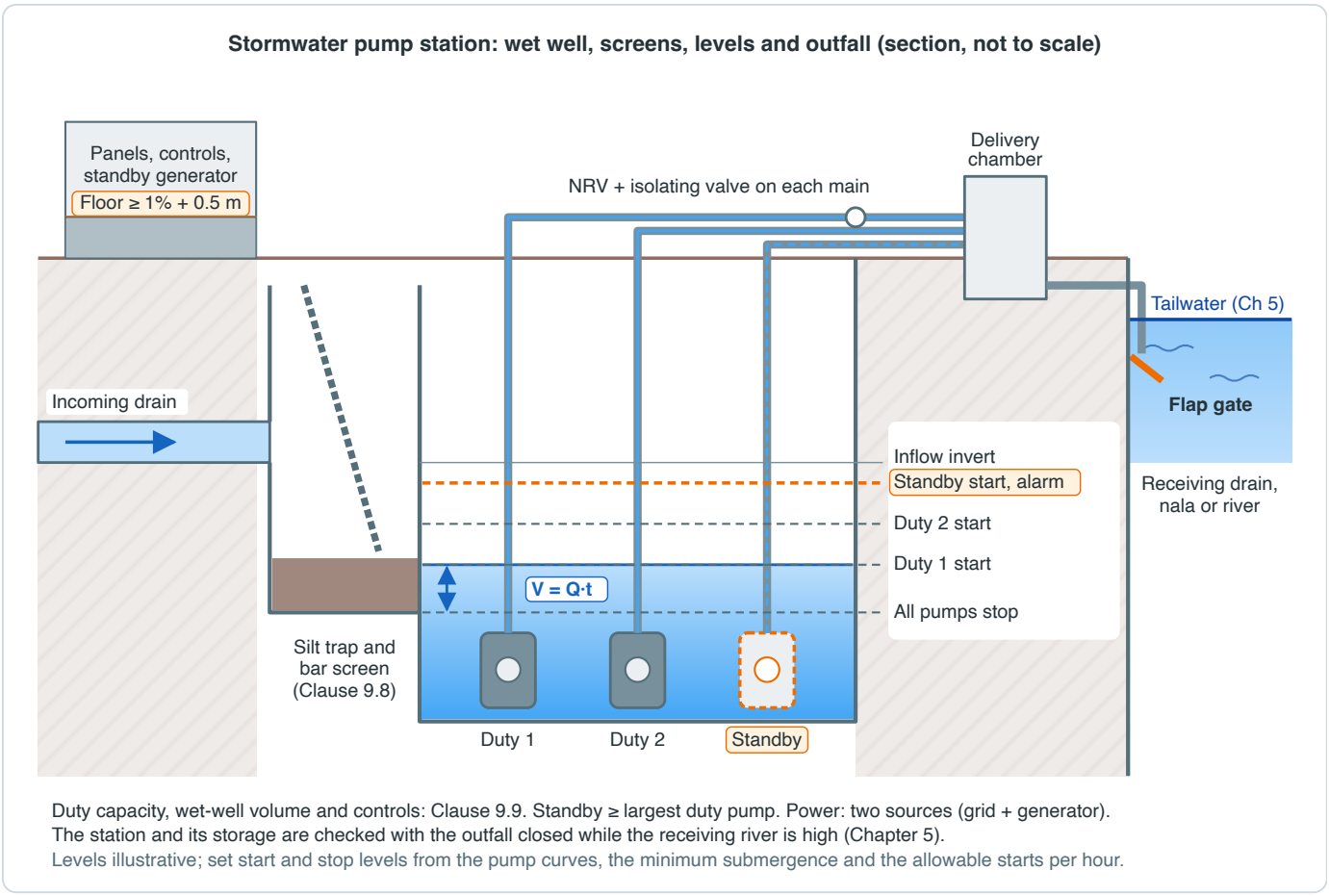

Figure 9.3 — Stormwater pump station: wet well, screens, levels and outfall. Original drawing for this Manual, adapted from CPHEEO, Manual on Storm Water Drainage Systems (2019), Chapter 8, and FHWA, Highway Stormwater Pump Station Design, HEC-24 (2001).

> **Commentary.** CPHEEO (2019) Chapter 8 covers stormwater pumping: wet-well sizing (§8.3.3), pump types (§8.3.2), trash screens (§8.3.1.3), space requirements (§8.2.5) and the need for generator sets "as standby for emergency operation during failure of electricity" (§2.4.2.3). It recommends standby units of "minimum 50% of the duty pump units". Clause 9.9.4(b) is stricter: the standby must at least equal the largest duty pump, so the station still meets its design duty with its largest pump out of service. This stricter rule is set by this Manual. FHWA HEC-24 (*Highway Stormwater Pump Station Design*, FHWA-NHI-01-007, 2001) is the FHWA pump-station manual. The 72 h fuel storage is set by this Manual to match the 72 h design storm of Chapter 2. The model-study trigger, the telemetry and data-retention requirements, and the emergency connection have no direct precedent and are set by this Manual.

9.10 Tide gates, flap gates and non-return valves

9.10.1 **Where required.** Flap gates, tide gates or non-return valves shall be provided on every outfall whose invert is below the 1% AEP still-water level of the receiving water (Chapter 5).

9.10.2 **Types.** Acceptable devices are:

- (a) hinged flap gates (cast iron, ductile iron, stainless steel, HDPE or composite);
- (b) elastomeric in-line or end-of-pipe check valves (duckbill type); and
- (c) penstocks or sluice gates, manual or motorised, as a secondary closure.

9.10.3 **Secondary closure.** Outfalls of 900 mm or more, and every outfall serving a pumped or storage system, shall have a penstock or stop-log slot upstream of the flap gate so that the gate can be maintained, and as a back-up if the gate jams open.

9.10.4 **Hydraulics.** The head loss through the device in the open position shall be taken from the manufacturer's tested data and included in the HGL (Chapter 6, Clause 6.8.7). Flap gates shall open at a small head difference (CPHEEO 2019, §6.3.10.1).

9.10.5 **Sand and debris.** At beach, estuary and creek outfalls where sand or debris can hold a gate open or shut:

- (a) the gate shall be housed in a chamber with surface access, or elastomeric check valves shall be used; and
- (b) the gate shall be inspected after every high-tide or surge event during the monsoon season (Chapter 10).

9.10.6 **Materials.** Hinges, pins, links and fixings shall be of corrosion-resistant material (CPHEEO 2019, §6.3.10.1). In coastal and tidal locations this means stainless steel grade 316, bronze or a non-metallic material (Clause 9.13).

9.10.7 **Storage behind gates.** Where gates close during a storm, the storage or pumping behind them shall meet the outfall-closed check of Chapter 5.

> Commentary. CPHEEO (2019, §6.3.10.1) describes flap gates and flood gates at outfalls to tidal waters. It notes that "adequate storage may be necessary if pumping is to be avoided during the closure of the gate" and that hinge pins and links "should be of corrosion-resistant materials". Jammu and Kashmir has no coast, so no outfall in the Union Territory is closed by the tide, and the beach, estuary, tidal and coastal provisions of Clauses 9.6.7, 9.10.5 and 9.13.6, and the coastal and tidal rows of Table 9.5, do not arise. Clause 9.9.2(b) is read for the river: where a station serves an outfall that the Jhelum, the Tawi, the Chenab or a lake can close, storage plus pumps shall hold the design volume with the outfall closed for the lock duration of the outfall-closed check of Clause 5.10, and in Clause 9.9.2(c) the highest tailwater is the highest river, lake or reservoir level of Chapter 5. Gates and pumps are the normal case on the Kashmir valley floor. Srinagar lies on flat ground beside a Jhelum held between embankments; when the river reaches its flood-declaration stage (18 ft on the I&FC gauge at Ram Munshi Bagh, with a danger stage of 21 ft; the gauge zero is not published, as reported) its gravity outfalls are closed, and the city drains only through its dewatering stations, which lift storm water over the bund. The counts of these stations differ with the date and with what is counted, and are not merged here: about 56 storm-water pumping stations to be rehabilitated under the World Bank's Jhelum and Tawi Flood Recovery Project (environmental and social management framework, 2015); 89 drainage pumping stations, 38 lift, 21 gravity and 30 lift-cum-gravity, in the Srinagar Master Plan 2035 (2019), which also speaks of 69 permanent or temporary dewatering stations among them; and 104 permanent dewatering stations of about 2,300 cusecs, with 281 mobile units and a network of about 650 km, in H&UDD's reply in the Legislative Assembly of 12 February 2026 (as reported). Single stations are small, 45 cusecs at Indra Nagar, 30 at Shivpora and 16 at Sonwar Bagh (as reported). About 2,300 cusecs, some 65 m³/s, over the 767 km² of the Srinagar drainage master plan is about 0.085 m³/s per km², or 0.3 mm of runoff an hour (this Manual's reading), so while the Jhelum is high the city drains by storage and pumps alone, and the capacity of the stations and the river stage, not the storm, govern the design of a Srinagar drain (Clause 2.3.6(g)). In September 2014 Srinagar's own rain was only about 140–152 mm in four days at its automatic stations (Ray et al., 2015), yet 262 km², 34% of the planning area, was flooded from the river (Srinagar Master Plan 2035, §4.2). Anantnag, Bijbehara and Pampore on the upper Jhelum and Sopore, Baramulla and Sumbal on the lower Jhelum and Wular stand behind the same river and are designed the same way. For every outfall that the Jhelum, the Tawi, the Chenab, a lake or a reservoir can close, the following are set by this Manual: (a) no outfall shall have its invert below the design river or lake level of Clause 5.8.5 unless it has a flap gate, a penstock and a pumping station, with storage behind them, that together meet the outfall-closed check of Clause 5.10; (b) each pumping station shall be designed for stated duty points, the discharge of every pump at the lowest static head and at the highest, the highest being set by the high flood level of the governing gauge plus 0.3 m (at Ram Munshi Bagh the level of 8 September 2014, 1,589.65 m in CWC's list of 2018 and 1,588.99 m in that of 2022, the higher governing until CWC confirms one; CWC levels as transcribed by SANDRP, as reported), and its pump curves, sump levels and the river stage at which its gravity gate shuts shall be entered on the drain register (Clause 10.17); (c) the 72

hours of fuel of Clause 9.9.9 are a minimum on the valley floor, where the river stayed above its flood-declaration stage for days in 2014, and a station whose outfall can stay closed for longer than that stores fuel, or has a second independent feeder, for the lock duration of Clause 5.10, which on the Jhelum is not less than 7 days; (d) mobile pumps, of which Srinagar is reported to keep 281, are counted only as backup, never as duty or standby capacity under Clause 9.9.4 or as pumped capacity in the outfall-closed check, which credits the permanent pumps less the largest, and every station shall have the emergency connection of Clause 9.9.12 so that they can be used; and (e) every gate or pump on the Jhelum, the flood spill channel or a city channel needs the consent of I&FC, which controls the bed and banks of all water sources, city channels and flood spill channels (Water Resources (Regulation and Management) Act 2010, s.81; section number to be confirmed [TBC]), and one on Dal–Nigeen or Wular that of LCMA or WUCMA. The Dal Gate shows the principle. Dal, 20.37 km² with a catchment of about 314 km², drains through two regulated outlets, the Dal Gate, a weir and lock that discharges through the Tsunth Kol to the Jhelum, and Nallah Amir Khan, through Nigeen, Gilsar and Khushalsar to Anchar (JKPCC before the National Green Tribunal, 2024); Grierson's dictionary records the *Ḍal-darwāza*, "the flood-gate of the Ḍal lake", whose gates stay open when the river is low, but "when the river rises to a certain height, they automatically close, thus preventing inundation of the land round the lake" (Grierson, *A Dictionary of the Kashmiri Language*, p. 210). A drain that outfalls to Dal, or to any channel behind such a gate, is therefore checked with the gate closed, at the lake level then reached; no operating rule for the gate and no datum for the lake gauge have been published, and the Dal level of "10.5 feet" reported in September 2025 is not used as a level [TBC]. The flood spill channel, which leaves the Jhelum near Ram Munshi Bagh for Wular and was cut after the great flood of 1902 or 1903 (the sources differ), was designed for 17,000 cusecs and could carry 4,000 by 2014 (CAG, Report No. 4 of 2016), so an outfall to it is checked against its own level as well as the river's. In the Jammu division the rivers are not embanked in the same way, but they are dammed and they rise fast: the Tawi at Sidhra set a new high flood level of 321.1 m on 26 August 2025, 2.25 m above that of 2014, the Chenab at Akhnoor stands at 324.29 m from 10 September 1992 (61 ft on the I&FC gauge), and Salal opens its gates monthly in the monsoon to flush sediment and opened all of them on 12 August 2025, after Baglihar had opened its spillways on 1 August (as reported); since the Indus Waters Treaty was held in abeyance in April 2025, such operations may no longer be announced (as reported), so a gate on a Chenab outfall below the dams is designed for an unannounced release. The Tawi, the Basantar, the Ujh and the Chenab cross into Pakistan within 10–30 km of Jammu, R.S. Pura, Samba and Akhnoor, and their levels beyond the border are not monitored, so outfalls in these towns take the flood-mark profile of their reach. Most of the Jammu division drains steeply. The khads of the Kandi, "transformed into gushing torrents" in the rains (Jammu Master Plan 2032, §2.4), cross the fans of Jammu, Samba and Kathua at about 1 in 90 to 1 in 120, more than 100 small and big dry khads in the Jammu planning area alone carry flash floods (§7.3.2), and the nallahs and streets of Udhampur, Katra, Reasi, Ramban, Batote, Doda, Kishtwar, Rajouri and Poonch fall far more steeply (this Manual's reading of the terrain), beyond the 0.4% and 0.2% of Clause 9.5.4, so drop structures (Clause 9.6.6), stepped channels, baffled chutes and stilling basins (Clauses 9.6.5 and 9.6.6(b)) and supercritical chutes designed under Clause 9.5.2 are the normal case, not the exception. IRC:SP:42-2014 (§8.5.1) says the same of hill roads: their side drains are lined because the slope is high and "rolling stones cause high friction", culverts are needed at closer intervals than on the plains, and stepped chutes or baffles are provided where the bed slope exceeds critical. In Jammu and Kashmir the following are also set by this Manual for a structure on a drain whose catchment includes an undeveloped hill slope, khad or nallah: (f) a drop or stepped channel shall have each pool shaped to drain dry and reachable by machine, and no single vertical drop shall exceed the 1.5 m of Clause 9.6.6(c); (g) where such a drain enters a pipe, covered drain or culvert, at the catchment size and with the sediment bulking and blockage factors that Chapter 6 sets (Clause 6.3.6), a debris rack, inclined so that the flow lifts debris onto it, shall stand upstream of the inlet, with a clear bar spacing chosen from a survey of the boulders in the bed and not less than that of Clause 9.8.2(a), and a debris basin or sediment trap upstream of the rack; the basin volume shall be estimated from the debris deposited at the site in past floods and a stated debris-yield method, counting every muck dump, slide scar and road cut in the catchment as a source, because no Indian guidance on sizing debris basins was found [TBC]; its spillway shall pass the 1% AEP inflow with the basin full of debris, as for Clause 9.7.6, and it shall have a ramp for the machines that empty it; (h) a culvert on a khad shall have a single barrel where possible (Clause 9.4.8(a)), an armoured headwall and apron at the inlet with a deflector against boulders, an invert that follows the bed (Clause 9.4.8(c)), and an outlet protected under Clause 9.6 and led to a stable natural channel, never onto an unprotected slope; (i) every lined drain that

receives runoff from unpaved slopes, hill roads, muck dumps or building sites shall have a sediment trap before it joins a public drain, a zamindari khul, a talab, a lake or a reservoir; and (j) a lining in a steep drain shall be designed for the abrasion of the gravel and boulders it carries as well as for the velocity of Table 9.2, and shall not leak into the slope. The need is shown by the record. At Pernote, in Ramban, the Geological Survey of India found that "ingress of surface runoff through these cracks may have developed the pore pressure" in the slide of April 2024, and recommended "diverting the surface runoff away from the affected/active part of the slope", that "Drains present in the affected slope should be lined/trained", and "No new construction" (note of 25 April 2024, annexed to JKPCC's report in O.A. No. 642 of 2024 before the National Green Tribunal); at Thathri Nai Basti, in Doda, the committee before the Tribunal found in 2023 no planned drainage and sewage pipes discharging to the roadside drains downslope (as reported); and the floods of the Chenab and the Tawi in August 2025 were reported to have been made worse by muck dumped along their tributaries (as reported). No structure of this chapter is designed to pass a debris flow, a glacial-lake outburst or the flood of a cloudburst: in sub-area JK-D, and on any drain with a glacier, a glacial lake or a mapped debris-flow fan above it, the screening of Clause 2.3.6(i) comes first, and a structure is sited out of the hazard, as the flows at the Amarnath cave on 8 July 2022 and at Chasoti in Kishtwar on 14 August 2025, where more than 60 people were reported killed, came down channels no drain could have carried; neither storm was measured at a cloudburst rate (the AWS below the Amarnath cave recorded 25 mm in an hour, which "does not satisfy the criteria for cloud burst", MoES, 2022, and no gauge recorded Chasoti). Screens matter as much as gates, because the drains also carry silt, solid waste and sewage: CPCB placed the Chunt Kol at Maulana Azad Bridge in Priority III, the Jhelum from the Vishav confluence to Baramulla and the Tawi from Tawi Bridge to the Balol Nallah in Priority IV, and the Basantar at Samba, the Devak at Udhampur, the Gawkadal stretch at Sherghari in Srinagar and the Lidder from Lavender Park to Nunwan in Priority V of its polluted river stretches (October 2025, as filed by JKPCC before the Tribunal), so a rack on a nallah in Jammu and Kashmir is checked in the blocked case of Clause 9.8.4. No inventory of the flap gates, penstocks, debris racks, sediment traps and dewatering stations on the drains of any town in Jammu and Kashmir, with their duty points, sump levels, standby power and the river stage at which each gravity gate shuts, no operating rule for the Dal Gate or for the gates of the Union Territory's dams and barrages linked to the towns below them, and no design river, lake, reservoir, khad or nallah level at any outfall was found in the public domain; the station lists of UEED and SMC are the first data request [TBC]. Clauses 9.10.3 and 9.10.5 are set by this Manual because a flap gate, sluice or penstock that fails, or is jammed open by silt, gravel, boulders, weed, solid waste or debris, lets the Jhelum, a lake or a river in flood back into the drain network, and one jammed shut blocks it. The drains of Srinagar carry silt, solid waste and sewage to their gates and pumps: only 62.01 MLD of the 193.34 MLD of sewage generated in the city could be treated in 2024 (32.07%), and untreated sewage reaches Dal from Telbal and Lal Bazar (JKPCC before the National Green Tribunal, 14 August 2024); the flood spill channel had lost three-quarters of its capacity, from 17,000 to 4,000 cusecs, to the sediment of the nallahs that join it (CAG, Report No. 4 of 2016); and the khads and nallahs of the Jammu division and the hill towns carry boulders, gravel, slide debris and muck as well, so a gate, its screen, the debris rack above it and the pump sump behind it are exposed to the same load and must be kept clear together; and because the Jhelum stood above its flood-declaration stage for days in September 2014, when parts of Srinagar stayed under water for up to 25 days (as reported), and rose to its danger stage at Ram Munshi Bagh again in August 2025 (I&FC gauge, as reported), a gate that leaks or jams can be exposed for the whole of a river flood.

9.11 Inlets and gratings

9.11.1 **Hydraulics.** Inlet capacity, spacing and clogging shall follow Chapter 6, Clause 6.6.

9.11.2 **Load class.** Gratings, covers and frames shall be rated for the traffic at their location. Load classes shall be those of IS 1726 (cast iron manhole covers and frames) or EN 124 (gully tops and manhole tops), at least:

- (a) carriageways and medians: EN 124 class D400 or the equivalent heavy-duty IS class;
- (b) kerb-side channel inlets within 0.5 m of the kerb: class C250 or equivalent; and

- (c) footpaths and cycle tracks: class B125 or equivalent.

9.11.3 **Grate pattern.**

- (a) Grates in carriageways, cycle tracks and footpaths shall not have openings parallel to the direction of travel wider than 25 mm.
- (b) Grate types without tested capacity data shall be rated by the weir and orifice methods of FHWA HEC-22 (2024), with the clogging factors of Chapter 6.

9.11.4 **Kerb openings.** Kerb-opening inlets shall have a clear opening height of at least 100 mm and a length of at least 1.0 m. Where a kerb inlet discharges through the wall of a covered drain (Chapter 6, Clause 6.13.1), the opening shall be at road level.

9.11.5 **Security.** Gratings and covers on public land shall be hinged or locked to their frames, so that they cannot be removed without a tool.

9.11.6 **Inlet chambers.** Inlet chambers shall have the silt sump of Chapter 6, Clause 6.6.7, and shall be sized so that the sump can be emptied by a suction or grab machine.

> **Commentary.** NDMA (2010, §4.13) cites IS 5961 for cast-iron gratings for drainage inlets. The load classes are based on the EN 124 classes used internationally. The 25 mm limit on parallel openings is set for cyclist and pedestrian safety. APWA 5600 (2006, 5604.2) requires kerb openings of at least 4 ft (about 1.2 m) long and 6 in (about 150 mm) clear height. Clause 9.11.4 sets smaller minimums suited to the narrower roads and lower kerbs common in Srinagar, Jammu and the other towns of Jammu and Kashmir.

9.12 Manholes, junction chambers and access

9.12.1 **Location and spacing.** Manholes shall be provided at the locations and spacings of Chapter 6, Clause 6.7.11 and Table 6.8. Where pipes are too large for a standard manhole, a junction chamber with a riser to the surface shall be used (CPHEEO 2019, §11.3.7.3).

9.12.2 **Minimum internal size.** Manholes shall have at least the internal dimensions of Table 9.4 (CPHEEO 2019, §11.3.7.6):

Table 9.4 — Minimum internal size of manholes

Shape and depth	Minimum internal size
Rectangular, depth below 0.9 m	900 mm × 800 mm
Rectangular, depth 0.9–2.5 m	1,200 mm × 900 mm
Circular, depth above 0.9 m and up to 1.65 m	900 mm diameter
Circular, depth above 1.65 m and up to 2.30 m	1,200 mm diameter
Circular, depth above 2.30 m and up to 6.0 m	1,500 mm diameter
Circular, depth above 6.0 m and up to 9.0 m	1,800 mm diameter

The manhole shall also be large enough to fit the largest pipe connected plus the benching on each side.

9.12.3 **Access openings.** The clear access opening of manholes and access chambers on public drains shall be at least 600 mm, so that cleaning equipment can be lowered.

9.12.4 **Drops.** Where the difference between incoming and outgoing inverts exceeds 0.6 m, a drop connection shall be provided. Below 0.6 m, the difference shall be taken up by adjusting the slope of the incoming pipe or the benching (CPHEEO 2019, §11.3.7.5). The invert drop across a manhole where pipe size changes shall be at least the following fraction of the difference in diameters (CPHEEO 2019, Table 11.6):

- conduits below 400 mm: one-half;
- 400 mm to 900 mm: two-thirds;
- above 900 mm: four-fifths.

9.12.5 **Benching.** Manhole floors shall be benched to at least the crown of the outgoing pipe, with channels shaped to guide flow from each incoming pipe.

9.12.6 **Surcharge.** Manholes on mains where the 1% AEP HGL can rise above the cover (Chapter 6, Clause 6.8.4) shall have bolted, locked or hinged covers designed for that pressure.

9.12.7 **Mechanical cleaning.** Manholes, chambers and covered drains shall be designed for cleaning by machine (suction, jetting, grab or robotic equipment) from the surface. Fixed ladders shall be of corrosion-resistant, encapsulated material where provided.

> **Commentary.** The size and drop requirements are from CPHEEO (2019) Chapter 11. The 600 mm access opening, the benching rule and the bolted covers are set by this Manual. Designing for mechanical cleaning supports the prohibition on hazardous manual cleaning under *The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013*.

9.13 Materials and durability

9.13.1 **Exposure classes.** Concrete structures shall be designed for the exposure class of IS 456: 2000, Table 3. In Jammu and Kashmir the minimum classes of Table 9.5 apply unless a site investigation shows a more severe condition:

Table 9.5 — Minimum IS 456 exposure classes for Jammu and Kashmir locations

Location	Minimum IS 456 exposure class
Inland drains and structures	Moderate
Drains and structures in the coastal environment, and any drain that carries or may carry sewage-mixed flow	Severe
Structures exposed to sea-water spray, or in contact with saline or aggressive groundwater	Very severe
Structures in the tidal zone	Extreme

9.13.2 **Concrete.** Minimum concrete grade, maximum water–cement ratio, minimum cement content and nominal cover to reinforcement shall be those of IS 456 for the exposure class. For the reader's convenience, IS 456 sets the minimum reinforced-concrete grades as M25 (moderate), M30 (severe), M35 (very severe) and M40 (extreme), and the nominal covers as 30, 45, 50 and 75 mm respectively.

9.13.3 **Aggressive ground.** Groundwater and soil at every structure in coastal and delta areas shall be tested for chlorides and sulphates. Cement type and concrete mix shall be chosen to suit the results under IS 456.

9.13.4 **Sewage-mixed flow.** Pipes and covered drains that carry, or may carry, sewage-mixed flow shall be protected against sulphide (crown) corrosion, by a sacrificial concrete thickness, a corrosion-resistant lining or a non-concrete pipe material.

9.13.5 **Pipes.** Concrete pipes shall comply with IS 458, with the class selected by structural design. Other pipe materials (for example ductile iron, HDPE or structured-wall plastic pipes) shall comply with the applicable Indian Standard and be approved by the approving authority.

9.13.6 **Metalwork.** Within 5 km of the coast, and in all tidal and saline locations:

- (a) fixings, hinges, ladders, handrails and screen frames shall be stainless steel grade 316, or hot-dip galvanised steel with a protective coating, or a non-metallic material; and
- (b) dissimilar metals shall be isolated from each other.

9.13.7 **Masonry.** New public drains in Tier A bodies shall be in reinforced or plain concrete. Brick or stone masonry may be used for drains in Tier B bodies only if it is plastered on the wetted face and meets the n value of Table 6.6.

> **Commentary.** The IS 456 exposure classes and the grade and cover values are quoted from IS 456: 2000 (Tables 3, 5 and 16) for convenience. The standard governs, and designers shall use its current amendment. Assigning Jammu and Kashmir locations to exposure classes, the sulphide-corrosion requirement and the ban on new masonry drains in Tier A bodies have no direct precedent and are set by this Manual. Drains that receive sewage cross-connections (a common condition, Chapter 8) generate hydrogen sulphide, which attacks unprotected concrete above the water line.

9.14 Submittal requirements

Every structure design shall be submitted with a **Hydraulic Structures Report** (Form 9-1) containing, as applicable:

1. culvert calculations (HDS-5 or HY-8 output) with HWi, HWo, outlet velocity, tailwater, overtopping and the blockage check;
2. channel water-surface profiles, velocities, Froude numbers and freeboard;
3. outlet protection and dissipator design, with riprap sizing;
4. detention outlet stage–discharge tables and the emergency spillway check;
5. screen and rack design with the 50% blocked check;
6. a pump station design report: inflow hydrograph, storage, pump curves and system curves, wet-well volume, controls, power supply and the Chapter 5 outfall-closed check;
7. gate and valve selection with head-loss data;
8. inlet, grate and cover load classes; and
9. an exposure class and materials statement (Clause 9.13).

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Annexes and forms

Annex / Form	Content
9A	HDS-5 inlet-control coefficients and worked culvert example in SI units
9B	Standard drawings: headwalls, riprap aprons, drop structures, trash racks, detention risers
9C	Pump station design checklist and standard control philosophy

Annex / Form	Content
Form 9-1	Hydraulic Structures Report checklist

CHAPTER 10

Submittals, Review, Operation & Maintenance and Enforcement

10.1 Purpose and scope

10.1.1 This chapter sets out how compliance with this Manual is shown, checked, built, kept working and enforced. It covers:

- (a) the submittal stages and their contents (Clauses 10.3–10.4);
- (b) the compliance calculator (Clause 10.5);
- (c) professional certification and review (Clauses 10.6–10.7);
- (d) construction inspection and as-built certification (Clauses 10.8–10.9);
- (e) maintenance declarations, O&M plans, inspection and access (Clauses 10.10–10.13);
- (f) handover of public assets (Clause 10.14);
- (g) enforcement (Clause 10.15); and
- (h) monitoring, post-event review and data publication (Clauses 10.16–10.17).

10.1.2 This chapter applies to every development and public work to which Chapters 4 and 5 apply under Clause 1.5.2. Clauses 10.3.1 (Stage 0), 10.15 and 10.17 also apply to development that is subject only to Clause 1.5.4.

> Commentary. A criterion that is not checked at approval, built as approved, and maintained afterwards has no effect. In Jammu and Kashmir the failure is one of missing criteria, of drains that have not kept up with the towns, and of statutory routes that have never been used. No document of H&UDD, the Jal Shakti Department, SMC, JMC, UEED or a Smart City company stating a design return period, intensity or runoff coefficient for the storm drains of any town was found (Chapter 11), and Jammu's own master plan records that roadside drains serve as its storm drains and that only 20% of its roads have them (Jammu Master Plan 2032, §5.1.3). The approval route shapes this chapter. Building permission in the urban local bodies and development authorities follows UBBL-2021, adopted body by body on a common text (the original H&UDD notification was not found [TBC]) and amended by H&UDD under s.395(d) of the J&K Municipal Corporation Act 2000 and s.202 of the J&K Municipal Act 2000 (S.O. 304 of 1 December 2025; a draft of 9 September 2026 cites s.397 instead, as reported). S.O. 304 moved approvals online: plans are auto-scrutinised against the master plan and the bye-laws, rainwater harvesting among the parameters; an application not decided in 15 days is deemed rejected; and the no-objections of the Revenue Department, PHE, PDD, PWD, Sewerage & Drainage, JDA, SDA, LCMA, the Town Planning Organisations, the Forest Department, NHAI, the Pollution Control Board and I&FC, among others, are given online. The bye-laws already ask for much of what a drainage submittal needs: a site plan showing "the approximate location and size of any water body, flood affected areas and contours at an interval of 0.3m in case of the site which has a slope more than 1:20" (cl. 2.6(b)(xi)); a service plan with the rainwater-harvesting system (cl. 2.6(d)); a certificate of the registered technical person (RTP) that "the site is clear from any provisions related to water supply, electric lines, sewers and drains, water bodies" (cl. 2.18); a complete rainwater-harvesting proposal for every plot of 100 m² or more (cl. 10.1); and inspection of the rainwater-harvesting structures "before issuing Completion Certificates or NOCs for service connections", with 100% annual checks above 1,000 m² (cl. 10.6). Building near an irrigation or hydraulic work needs the prior permission of I&FC, which also controls the bed and banks of every water source, city channel and flood spill channel (Water Resources (Regulation and

Management) Act 2010, ss.66 and 81; section numbers to be confirmed against an official copy [TBC]). The ULBs run their drains under the J&K Municipal Corporation Act 2000 and the J&K Municipal Act 2000, whose drain sections were not read [TBC]. No rule asks for a drainage report, limits peak runoff, requires on-site detention, sets a "zero runoff" condition or regulates the flooding of basements, and the only flood-related level in the bye-laws is the plinth, not less than 45 cm (cl. 6.1) with the ground floor finished 300 mm above the centre of the road (Table 5-9), which the Manual's flood-level rule of Chapter 6 exceeds. Every stormwater item in this chapter is therefore written so that the architect, engineer or RTP on record can certify it on Forms 1-1, 2-1, 10-2 and 10-3, and the Authority can check it with the OBPS submission, alongside the site plan and the rainwater-harvesting proposal that the bye-laws already require; through the online no-objections of I&FC (outfalls, levels and the flood check), Sewerage & Drainage (connections), LCMA (the Dal–Nigeen catchment) and the Pollution Control Board, which S.O. 304 already routes; and at completion, when cl. 10.6 already calls for an inspection. This chapter is the process.

10.2 Definitions

Term	Meaning in this chapter
Submittal	A set of documents lodged with the Authority at one of the stages of Clause 10.3.
Drainage report	The preliminary (Stage 1) or final (Stage 2) report required by Clause 10.4.
Stormwater facility	Any retention, detention, water quality, conveyance, pumping, gate or outfall element required by this Manual, public or private.
Hold point	A construction stage at which work shall not proceed until the Authority or the certifying professional has inspected it (Clause 10.8).
As-built certificate	The certificate of Clause 10.9 that the facility was built as approved and performs as designed.
Owner	The person or body responsible for a facility under its maintenance declaration, or the ULB for a handed-over asset.
O&M plan	The operation and maintenance plan of Clause 10.11.
Facility register	The public register of facilities of Clause 10.17.

Other terms are defined in Clause 1.4.

10.3 Submittal stages

10.3.1 Submittals shall be made in the following stages, linked to the approval steps of the Jammu and Kashmir Unified Building Bye-Laws 2021 (Table 10.1):

Table 10.1 — Submittal stages and linked approvals

Stage	Submittal	When	Linked approval
0	**Pre-application** meeting and **Form 1-1** (Applicability Determination)	Before the planning permission or layout application	None (advisory record)
1	**Preliminary drainage report**	With the planning permission or layout application	Planning permission / layout approval
2	**Final drainage design**	Before building permit, or before commencement where the permit is issued with the planning permission	Building permit / commencement

Stage	Submittal	When	Linked approval
3	**Construction inspections** at hold points	During construction	None (records filed)
4	**As-built certificate** and verification tests	Before the completion certificate	Completion / occupancy certificate
5	**Maintenance declaration** registered, or **handover** of public assets	Before or with the completion certificate	Completion certificate; asset acceptance
6	**Annual declarations** and inspection reports	Every year after completion	Continuing compliance

10.3.2 **Stage 0 is mandatory** for:

- (a) sites of 2 ha or more;
- (b) sites in a flood-sensitive catchment;
- (c) sites proposing a variance, waiver, regional facility or fee-in-lieu; and
- (d) sites draining to a tidal outfall or adjoining a waterbody.

For other sites, Stage 0 is optional, and Form 1-1 is lodged with Stage 1.

10.3.3 **Combined stages.** For sites of less than 1 ha outside flood-sensitive catchments, the Authority may accept Stages 1 and 2 as one submittal.

10.3.4 **Public works.** For a public work, Stage 1 is the drainage section of the DPR and Stage 2 is the drainage section of the tender drawings. The sanctioning authority shall not sanction or tender the work until the relevant stage has been reviewed under Clause 10.7.

10.3.5 **Changes after approval.** Any change that alters impervious area, levels, storage, outlet or outfall after Stage 2 shall be resubmitted, with the compliance calculator re-run, before the change is built.

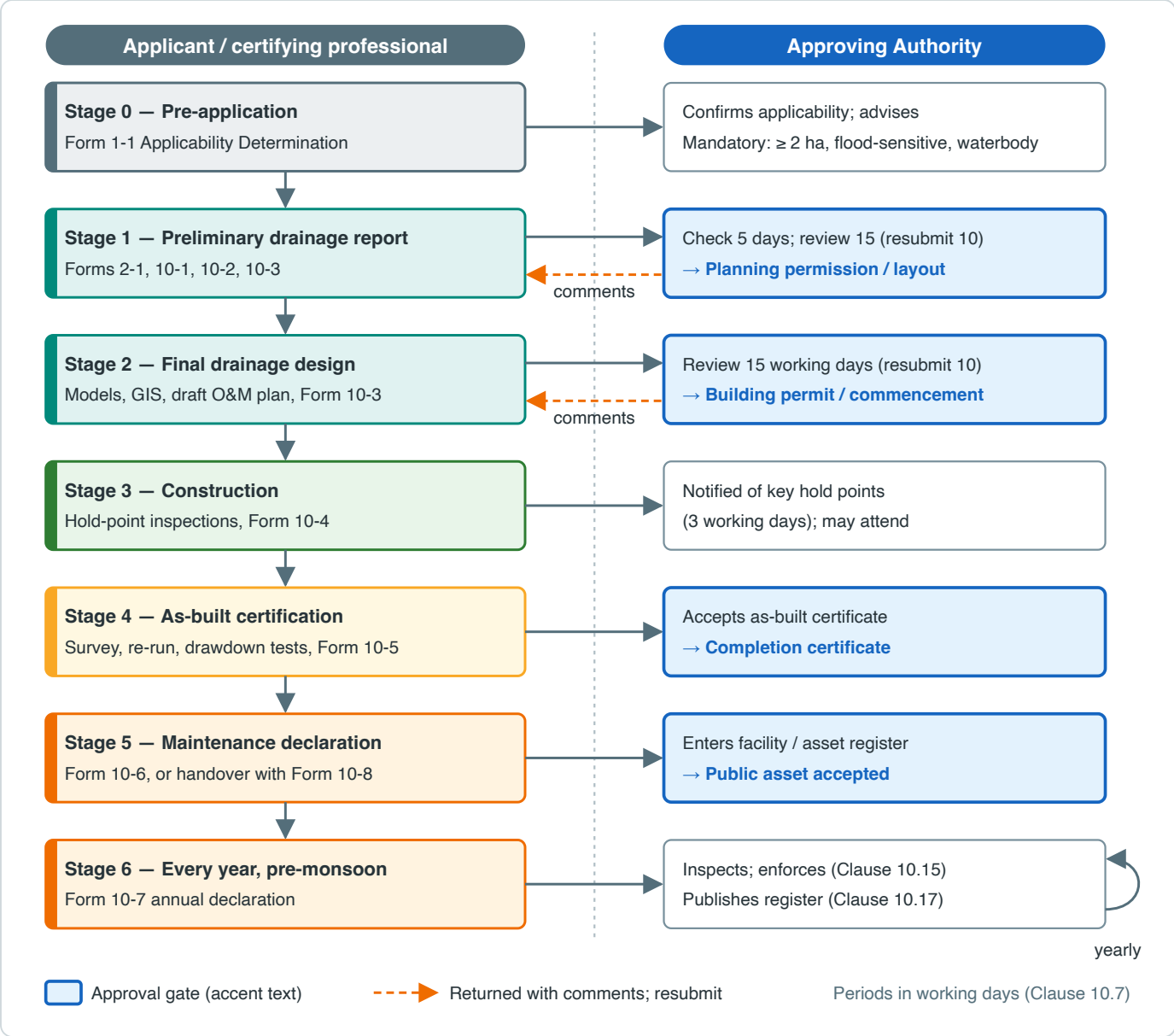

Figure 10.1 — Submittal, review and approval workflow (Clauses 10.3–10.10). Original drawing for this Manual.

> **Commentary.** The stages follow the APWA 5600 sequence of preliminary and final stormwater studies, construction inspection and maintenance agreements (APWA 5600, 2006, §5608 and §5609), mapped onto the UBBL-2021 steps a Jammu and Kashmir applicant already follows. Linking Stage 4 to the completion certificate copies the MBBL 2016 RWH model, which requires inspection before the completion certificate (MBBL 2016, §9.6). The 2 ha and 1 ha limits in Clauses 10.3.2 and 10.3.3 have no direct precedent and are set by this Manual.

10.4 Required contents and checklists

10.4.1 **Preliminary drainage report (Stage 1).** The report shall contain at least:

- (a) Form 1-1 and, where applicable, Form 1-2 (Variance / Waiver Request);
- (b) a site plan with existing and proposed levels, impervious areas, and the catchment boundaries draining to and through the site;
- (c) soils (HSG), the seasonal high groundwater table, and infiltration test results or a test plan (Chapter 3);

- (d) the **Design Rainfall Sheet (Form 2-1)**, completed as Clause 2.13 requires;
- (e) the pre-development condition and hydrologic method (Chapter 3);
- (f) how the hierarchy of Clause 1.2 has been applied: areas preserved, retention method, detention concept and conveyance;
- (g) preliminary retention, water quality and detention volumes, and release rates, from the compliance calculator (Clause 10.5);
- (h) the downstream extent and tailwater case (Chapter 5);
- (i) waterbodies, setbacks and the 1% AEP level (Chapters 6 and 7); and
- (j) the land reserved for facilities and maintenance access (Clause 10.13).

10.4.2 **Final drainage design (Stage 2).** The final design shall contain, in addition to updated Stage 1 contents:

- (a) the final calculations for every storage duration of Clause 2.5.2 and every AEP required by Chapter 4, including the outfall-closed check of Chapter 5;
- (b) stage–storage–discharge tables for each facility, and the emergency spillway design (Chapter 4);
- (c) hydraulic design of conveyance elements, inlets and structures (Chapters 6 and 9);
- (d) the water quality design and the first-flush or gross pollutant trap where required (Chapter 8);
- (e) construction drawings, details and specifications of every facility;
- (f) the construction sequence, including protection of retention and infiltration areas from sediment and compaction (Clause 10.8.3);
- (g) the hold-point schedule (Clause 10.8);
- (h) the draft O&M plan (Clause 10.11) and draft maintenance declaration (Clause 10.10);
- (i) the model input files and the GIS data of Clause 10.4.4; and
- (j) the certificates of Clause 10.6.

10.4.3 **Checklist.** Each submittal shall include the **Drainage Report Checklist (Form 10-1)**, showing for each item of Clauses 10.4.1–10.4.2 the page or sheet where it is addressed, or the reason it does not apply. The Authority shall not start technical review of a submittal without a completed Form 10-1.

10.4.4 **Digital submittal.**

- (a) Reports and drawings shall be submitted as searchable PDF.
- (b) Hydrologic and hydraulic models shall be submitted in their native, runnable format (for example SWMM .inp, HEC-HMS or HEC-RAS project files), with the version of the software used.
- (c) Facilities, outfalls, flow paths and catchment boundaries shall be submitted as GIS data (GeoPackage or shapefile) in WGS 84 (EPSG:4326) or the applicable UTM zone (43N, EPSG:32643, which covers the whole Union Territory, from about 73.75° E at Karnah to about 76.78° E in Kishtwar district, with no exception; to be confirmed against the Survey of India boundary), with attributes as listed in Annex 10B.
- (d) Levels shall be stated relative to a named vertical datum. The relationship to the river datums of the CWC gauges on the Jhelum, the Chenab, the Tawi and the Lidder, the zeros of the I&FC staff gauges read in feet (stated once I&FC publishes them, and never assumed), the lake and reservoir levels of LCMA, WUCMA, I&FC, JKSPDC, NHPC and the other operators, and the flood marks surveyed on ungauged khads and nallahs used in Chapter 5 shall be stated.

10.4.5 **Summary of forms used in submittals** (Table 10.2):

Table 10.2 — Forms used in submittals

Form	Title	Stage
1-1	Applicability Determination	0 or 1
1-2	Variance / Waiver Request	1
2-1	Design Rainfall Sheet	1, 2

Form	Title	Stage
10-1	Drainage Report Checklist	1, 2
10-2	Compliance Calculator Summary	1, 2, 4
10-3	Professional Design Certificate	1, 2
10-4	Hold-Point Inspection Record	3
10-5	As-built Certificate	4
10-6	Maintenance Declaration	5
10-7	Annual Maintenance Declaration and Inspection Report	6
10-8	Asset Handover Certificate	5

Commentary. Runnable models and GIS data cost the applicant little and let the Authority check the work, and later build a city-wide picture of private storage. Jammu and Kashmir has no notified design return period or design storm for its urban drains, and no document of H&UDD, SMC, JMC, UEED, I&FC or a Smart City company stating a return period, a runoff coefficient or a drain standard was found. The drainage master plan and project report for 767 km² of Srinagar prepared by Egis India, for "a stormwater drainage system that is separate from the sewage system" and modelled in SewerGEMS, publishes no return period, intensity or runoff coefficient (Bentley case study, 2023, as reported); the World Bank's Jhelum and Tawi Flood Recovery Project designed its roads and bridges to the guidelines of the Indian Roads Congress and states no drainage return period (2015); the Srinagar Master Plan 2035 sets benchmarks of 100% coverage and zero waterlogging without a design storm (§13.3); and Jammu's storm-water project report was still to be prepared after its master plan was approved (Jammu Master Plan 2032, §11.1.3). The rainfall studies do not supply one either: IMD's national IDF study (Das et al., 2022) has panels for Srinagar and Jammu, but both repeat a generic curve, about 109 mm/h for one hour at 100 years against the 32–40 mm recorded in an hour at Srinagar, and are not used; and the IDF equation published for Kupwara (Dar et al., 2016) does not reproduce its own tabulated intensities and is not used. The bursts on record are modest, 62 mm in an hour at the Gulmarg self-recording gauge on 9 September 1980 and 32 mm at Srinagar on 28 August 1975 (CWC Flood Estimation Report, zone 7), and 35 mm in an hour and 101 mm in three hours at the Kawa AWS in Udhampur on 6 September 2014 (Ray et al., 2015), but the 24-hour falls are not: 380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30 IST on 27 August 2025 (IMD), against a previous Jammu record of 299.2 mm (31 July 1961; IMD), and Srinagar's city centre was waterlogged after 26.4 mm on 1 August 2019 (as reported). The Union Territory's design values are therefore those of the CWC Flood Estimation Report for zone 7 (Western Himalayas), which covers all of it, with the interim provisions of Chapter 2, including the 24-hour record check that raises the 1% AEP depth near Jammu to 380 mm (Clause 2.3.6(h)), and each submission must state its own design basis. Form 2-1 and Form 10-2 ensure that every design states its inputs.

10.5 Compliance calculator

10.5.1 The State Stormwater Technical Committee shall issue and maintain a **compliance calculator**: a version-controlled spreadsheet or web tool that, for a given site:

- (a) applies the applicability tests of Clause 1.5;
- (b) computes the retention volume from the Annex 2E depth, and the water quality volume (Chapter 8);
- (c) applies the credits for preserved areas and retained volume against detention (Chapter 4);
- (d) on the design-aid route (Clause 1.7, S-1), gives retention and detention volumes from the unit-storage tables;
- (e) on alternative S-2, gives the permissible site discharge for each AEP; and
- (f) produces the **Compliance Calculator Summary (Form 10-2)**.

10.5.2 **Use.**

- (a) Every Stage 1, 2 and 4 submittal shall include Form 10-2 from the current version of the calculator.
- (b) On the design-aid route, the calculator may be the only storage calculation.
- (c) Outside the design-aid route, the calculator is a summary and a screening check. It does not replace the hydrograph analysis of Chapter 3. Where a model result differs from the calculator screen by more than the tolerance stated in the calculator guide, the report shall explain why.

10.5.3 **Version control.** The calculator shall record its version in every output. A new version applies to new submittals 6 months after release, in line with Clause 2.14.2. A submittal shall use one version throughout Stages 1 to 4, unless the Applicant elects a later one.

10.5.4 **Openness.** The calculator, its user guide, and the source of every table in it shall be published free of charge.

> Commentary. The Mid-America Regional Council issued a Compliance Calculator (.xlsm) and a Calculator Start-Up Guide with APWA 5600 Version 2025.01, together with a site activity plan template and the Policy Supplement (MARC stormwater management page, 2025). The calculator turns a layered standard with credits into one consistent set of numbers that a reviewer can check quickly. Singapore achieves a similar effect with a much simpler rule: a single allowable C value of 0.55 for 10-yr storms up to 4 h, applied by formula (PUB Code of Practice, cl. 7.1.5). A Jammu and Kashmir calculator serves Tier B authorities in particular, where it may be the whole calculation.

10.6 Professional certification

10.6.1 **Who may sign.** Drainage reports and designs shall be prepared and signed by a registered professional (Clause 1.4) competent in hydrology and hydraulics. For any of the following, the signatory shall be a civil engineer **empanelled as a Stormwater Design Professional** by the Authority or H&UDD:

- (a) Tier A sites of 1 ha or more;
- (b) any site in a flood-sensitive catchment;
- (c) any facility with an embankment, or a high-hazard basin checked for the 0.2% AEP (Chapter 4); and
- (d) any pumped facility, tide gate or regional facility.

10.6.2 **Empanelment criteria** shall be issued by H&UDD and shall include a civil engineering degree, relevant experience in drainage design, and completion of a training course on this Manual.

10.6.3 **Certificate.** The signatory shall complete the **Professional Design Certificate (Form 10-3)**, certifying that:

- (a) the design complies with this Manual, except for variances listed and approved;
- (b) the rainfall, soils and tailwater inputs are as recorded in Forms 2-1 and 10-2; and
- (c) the models submitted reproduce the results reported.

10.6.4 **Independent check.** Facilities under Clause 10.6.1(c) and (d) shall be checked by a second empanelled professional who is independent of the designer. That professional shall sign Form 10-3 as checker.

10.6.5 **False certification.** A false or negligent certificate is an offence under Clause 10.15.

> Commentary. Singapore requires that its ABC Waters design features used for peak control be endorsed by an ABC Waters Professional who is also a Professional Engineer (Civil) (PUB Detention Tank Guide, 2024). India has no statutory register of professional engineers comparable to Singapore's, so this clause uses the UBBL-2021

registration and adds empanelment for the higher-risk cases. The 1 ha limit is set by this Manual.

10.7 Review procedure and timelines

10.7.1 **Completeness check.** The Authority shall check each submittal against Form 10-1 within **5 working days** and either accept it for review or return it with a list of missing items.

10.7.2 **Technical review.** The Authority shall complete technical review and issue approval, conditional approval or a single consolidated list of comments within:

- (a) **15 working days** of acceptance for a first submittal; and
- (b) **10 working days** of acceptance for a resubmittal.

10.7.3 **No new comments.** On resubmittal, the Authority shall not raise new comments on matters that were unchanged and not commented on in the earlier review, unless the matter affects safety.

10.7.4 **Review capacity.** A Tier B authority, or a Tier A authority for overflow work, may use an empanelled reviewer from the H&UDD list. The empanelled reviewer shall not have worked on the same site. The Authority remains the decision-maker.

10.7.5 **Concurrent clearances.** Where the permission of I&FC under the Jammu and Kashmir Water Resources (Regulation and Management) Act 2010 for a building in the vicinity of an irrigation or hydraulic work (s.66) or for a work on, or a discharge to, the bed or banks of a river, nallah or other water source, a city channel, the flood spill channel or an embankment (s.81; section numbers to be confirmed against an official copy [TBC]), given as its online no-objection under S.O. 304 of 1 December 2025, the no-objection of Sewerage & Drainage (UEED) for a connection to a public drain or sewer, of LCMA for a site in the Dal–Nigeen catchment or of WUCMA for one that drains to Wular, of the Pollution Control Board (JKPCC) and of SDA or JDA in their areas, the permission of SMC, JMC or the Municipal Council or Committee to connect to a municipal drain or to build over one (J&K Municipal Corporation Act 2000 and J&K Municipal Act 2000, whose drain sections were not read [TBC]), the consent of PW (R&B) or NHAI for a discharge to a side drain or culvert of one of their roads, the views of the J&K Wetland Authority or the Wildlife Department for a work in or next to a Ramsar site or wetland conservation reserve, such as Wular, Hokersar, Hygam, Shallabugh or Surinsar–Mansar, the consent of JKSPDC, NHPC or another operator for a work that drains to its reservoir, the consent of the body that owns or runs the receiving drain where that body is not the Authority (for example Srinagar Smart City Ltd or Jammu Smart City Ltd until its drains are handed over), or another agency's concurrence is required (Chapter 7), the Authority shall forward the submittal on the day it is accepted for review, and the review periods shall run concurrently.

10.7.6 **Fit with permit timelines.** The periods in Clauses 10.7.1–10.7.2 run within, and do not extend, the overall time limits for planning permission and building permits set by the Government.

10.7.7 **Reasons.** Every refusal or condition shall state the clause of this Manual on which it is based.

> Commentary. The review periods have no direct precedent and are set by this Manual. A single consolidated comment list and the "no new comments" rule follow common good practice for engineering review.

10.8 Construction inspection

10.8.1 **Hold points.** The approved hold-point schedule (Form 10-4) shall include at least:

- (a) the excavated base of each retention, infiltration and detention facility, before any media, liner or structure is placed;
- (b) the outlet structure, orifice and trash screen, before backfill or before the facility is first allowed to fill;
- (c) the infiltration tests of Clause 10.9.3;
- (d) the outfall, flap or tide gate and non-return valve, before the downstream connection is made; and
- (e) pumps and controls, at commissioning.

10.8.2 Each hold point shall be inspected by the certifying professional and recorded on Form 10-4 with dated, geotagged photographs. For sites under Clause 10.6.1, the Authority shall be given at least 3 working days' notice of hold points (a) and (b), and may attend.

10.8.3 **Protection during construction.**

- (a) Retention and infiltration areas shall be fenced off from construction traffic and stockpiles.
- (b) Infiltration facilities shall not be brought into service until the area draining to them is stabilised.
- (c) Sediment shall be removed from any facility used for temporary sediment control before the as-built survey.

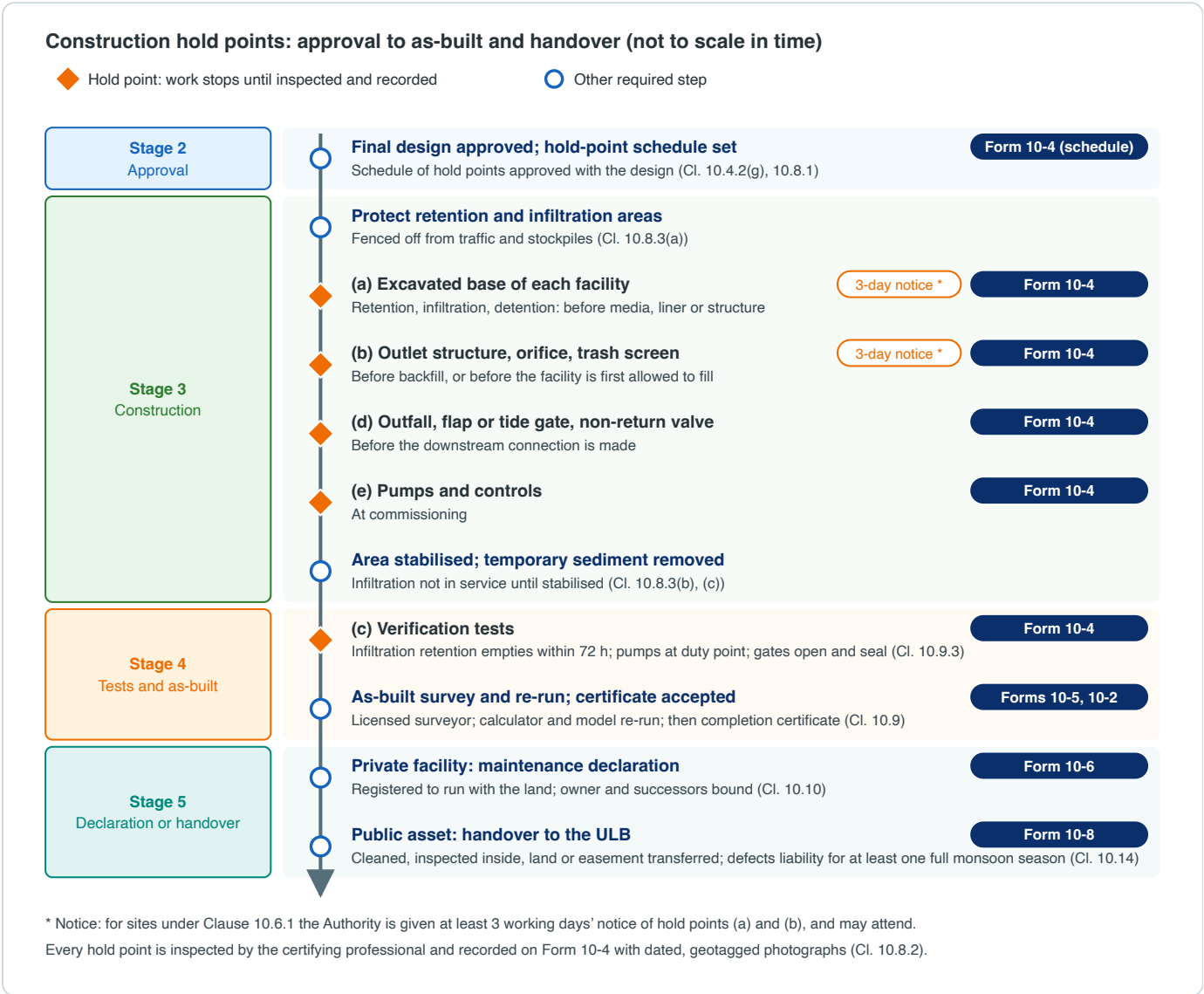

Figure 10.2 — Construction hold points from approval to as-built certification and handover, with the form used at each step (Clauses 10.8–10.10 and 10.14). Hold points are lettered as in Clause 10.8.1. Original drawing for this Manual, adapted from the construction-inspection and maintenance-agreement sequence of APWA Section 5600 (2006), §5608.

> Commentary. Infiltration facilities fail most often in construction, when they are compacted or filled with silt before they ever operate. Hold points (a) and (c) target that failure. The 3-day notice is set by this Manual.

10.9 As-built certification

10.9.1 Before the completion certificate is issued, the certifying professional shall submit the **As-built Certificate (Form 10-5)** with:

- (a) an as-built survey by a licensed surveyor of each facility's levels, storage volume, outlet dimensions and inverts, and the outfall;
- (b) a re-run of the compliance calculator, and of the model where one was used, with as-built values;
- (c) the completed hold-point records (Form 10-4); and
- (d) the final O&M plan and the executed maintenance declaration or handover documents (Clauses 10.10 and 10.14).

10.9.2 **Acceptance.** The as-built facility is accepted where:

- (a) the as-built storage volume at each design level is not less than the volume required by Chapter 4;
- (b) the outlet dimensions and inverts match the approved design; and
- (c) the re-run shows compliance with every criterion of Chapters 4 and 5.

Any deviation shall be corrected, or re-certified as compliant under Clause 10.3.5.

10.9.3 **Verification tests.** Every retention facility that relies on infiltration shall be tested after construction to show that it empties within **72 hours**, as Chapter 4 requires. Pumped facilities shall be tested at their design duty point. Tide gates and non-return valves shall be shown to open and seal.

10.9.4 The Authority shall not issue the completion certificate until Form 10-5 is accepted.

> Commentary. The 72-hour retention drawdown is the criterion of Chapter 4. This Manual requires it to be tested after construction, rather than relying on pre-construction tests alone, because compaction during construction can cut infiltration rates far below the design values.

10.10 Maintenance declarations and covenants

10.10.1 **Declaration.** The owner of every private stormwater facility shall execute a **Maintenance Declaration (Form 10-6)** before the completion certificate is issued. The declaration shall:

- (a) identify each facility, its location and the approved O&M plan;
- (b) bind the owner and successors in title to operate, inspect and maintain the facility under the O&M plan;
- (c) grant the Authority a right of entry to inspect, and to carry out works in default under Clause 10.15;
- (d) prohibit removal, filling, covering, reduction or change of use of the facility without the Authority's approval; and

- (e) be registered so that it runs with the land and is disclosed to purchasers.

10.10.2 **Multi-owner developments.** For apartments, layouts and gated communities, the declaration shall name the association or body responsible after handover by the developer. The developer remains responsible until that body is legally constituted and has accepted the declaration in writing.

10.10.3 **Annual declaration.** Every owner of a facility in a Tier A area, and of any pumped facility, tide gate or regional facility anywhere, shall submit an **Annual Maintenance Declaration and Inspection Report (Form 10-7)** by **31 May** each year. The report shall be signed by the owner and, for facilities under Clause 10.6.1(c) and (d), by an empanelled professional. It shall state that the pre-monsoon inspection of Clause 10.12 has been done and any defects corrected.

10.10.4 **Transfer.** On sale or transfer, the seller shall disclose the declaration and the latest Form 10-7. The purchaser takes on the obligations from the date of transfer.

> Commentary. Singapore requires owners of pumped detention systems to file yearly declarations and documents with PUB (PUB Detention Tank Guide, citing Code of Practice §13.2). Addendum No. 3 to the Code of Practice (16 Apr 2025) introduced annual maintenance declarations for flood barriers and pumped detention tanks, following amendments to the Sewerage and Drainage Act. APWA 5600 (2006, §5608) required easements and maintenance provisions for detention facilities. A registered declaration matters in Jammu and Kashmir because detention tanks under podiums and in basements are easy to convert to parking or storage once the building is occupied. The 31 May date is set by this Manual to fall before the south-west monsoon (June–September), when most Jammu and Kashmir extreme rainfall occurs.

10.11 O&M plans

10.11.1 Every stormwater facility shall have an O&M plan, approved at Stage 2 and finalised at Stage 4. The plan shall include:

- (a) an inventory and a plan drawing of each facility, with design levels, volumes and outlet details;
- (b) routine tasks and their frequency: inspection, debris and sediment removal, vegetation care, screen cleaning;
- (c) the trigger for sediment removal, stated as a depth or a percentage of design volume;
- (d) inspection checklists matching Form 10-7;
- (e) for pumped systems, gates and valves: the operating rules, test schedule, standby power, and actions on a cyclone or heavy-rainfall warning;
- (f) actions to prevent standing water and mosquito breeding, consistent with the drawdown times of Chapter 4;
- (g) safety measures for confined spaces, deep water and public access;
- (h) access routes and equipment needed (Clause 10.13);
- (i) an annual cost estimate and who pays it; and
- (j) the records to be kept, and for how long.

10.11.2 **Public facilities.** For facilities owned by a ULB or department, the O&M plan shall be included in the asset register (Clause 10.14.3) and funded in the annual maintenance budget.

> Commentary. Jammu and Kashmir has no dated UT or municipal order fixing pre-monsoon desilting. JMC's practice is known from the press: a first phase of desilting "before the end of June" (2017), 191 nallahs and 143 deep drains to be cleaned before the monsoon (2020), and a round-the-clock drive on 29 major nallahs on 18 July 2026; in Srinagar the Divisional Commissioner directed SMC to "start de-silting work of drains … immediately" in August 2018, and SMC ran a city-wide de-watering drive after the snowfall and snowmelt of January 2026 (all as reported); the Srinagar Master Plan 2035 asks only for "periodical desilting". The drains are run by several hands: UEED, whose mandate is "planning, designing and construction of works of sewerage and drainage in urban

areas", with the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir in Srinagar (Srinagar Master Plan 2035, §13.3) and its Sewerage and Drainage Division (West) within JMC's limits in Jammu; SMC, JMC and the Municipal Councils and Committees for the municipal drains; I&FC for the rivers, nallahs, embankments, the flood spill channel and the city channels; LCMA for Dal and Nigeen and WUCMA for Wular; PW (R&B) and NHAI for the road drains and culverts; and the Smart City companies of Srinagar and Jammu for the drains they build. Srinagar's dewatering stations have been rebuilt by projects rather than run by a rule: about 56 were to be rehabilitated under the Jhelum and Tawi Flood Recovery Project (2015), and 49 upgrades were reported financed under it (as reported). The gates that matter most are run by rules made for other purposes: Baglihar, run by JKSPDC, opened all its spillways on 1 August 2025; Salal, run by NHPC, opens its gates monthly in the monsoon to flush sediment and opened all of them on 12 August 2025; and Ranjit Sagar on the Ravi reached its full reservoir level on 27 August 2025 (all as reported); the Dal Gate closes by itself when the Jhelum rises (Grierson). No operating rule for any flap gate, lock or pumping station in a town of Jammu and Kashmir, linking it to a river stage, a dam release or a rainfall warning, was found in the public domain; the nearest are the flood-declaration and danger stages that I&FC announces on its feet gauges. Every gate and pump in this Manual needs a written rule for what happens when a warning is issued.

10.12 Inspection frequencies

10.12.1 **Owner inspections.** Owners shall inspect facilities at least as set out in Table 10.3:

Table 10.3 — Minimum owner inspection frequencies

Facility type	Routine	Pre-monsoon (by 31 May)	After a heavy-rainfall event
Retention / infiltration (soakaways, trenches, bioretention, permeable paving)	Every 6 months	Yes	Yes
Surface detention basin or multi-use open space area	Every 6 months	Yes	Yes
Underground or podium detention tank, gravity outlet	Every 6 months	Yes	Yes
Pumped detention, pumps and controls	Monthly test run	Yes, with full duty test	Yes
Flap / tide gate, non-return valve	Every 3 months	Yes, with seal test	Yes
Gross pollutant trap / first-flush device	Every 3 months	Yes	Yes
Private drains and inlets	Every 6 months	Yes	—

A heavy-rainfall event, for this Clause, is a day on which the nearest approved gauge records rainfall at or above the IMD "heavy rainfall" category, or a day for which a red alert is issued for the district. In Jammu and Kashmir, the pre-monsoon inspection of flap gates, penstocks, non-return valves, debris racks, sediment traps, debris basins, culvert inlets and pumped facilities, including every dewatering station of Srinagar and of the other embanked towns of the Kashmir valley floor, the Dal Gate, and the gates on outfalls that the Jhelum, the Tawi, the Chenab or a lake can close, with the desilting and the clearance of boulders, debris and muck from every drain, inlet, rack, trap, basin and culvert and the pump duty and gate seal tests, shall be completed by **31 May**; inlets, trash and debris racks, culverts, outfall gates and pumped facilities, with their standby generators and fuel, shall be certified ready by **15 June**, before the normal onset of 28 June at Jammu (the monsoon was declared on 13 June in 2021, as reported), with every gate on an

outfall to a river or lake operated through its full travel. Pumps, their standby power and the gates shall then be kept on standby, with the monthly test run, until **31 October**, after the normal withdrawal of 21 September at Jammu and the withdrawal from most of the Union Territory by 1 October, because storms come after it, as at Jammu (160.0 mm) and Basohli (229 mm) in October 1955, and at an outfall to the Jhelum, the Tawi or the Chenab until the river at the governing gauge has fallen below its flood-declaration or danger stage and the gravity outfalls have reopened, if that is later. On the Kashmir valley floor (sub-area JK-C of Annex 2A), where most rain falls with the western disturbances of December to April and snowmelt follows, inlets, gratings and outfalls shall in addition be cleared of snow, ice and sediment, and every pumping station given a full duty test, by **15 March**; the pumps shall be on standby from **1 March to 31 October**, and on call in winter whenever snow melts; and every public drain, inlet, outfall and pump sump shall be cleared a second time by **15 August**, before the late-August and September storms that brought the floods of 1992, 2014 and 2025. In the hill towns of sub-areas JK-B, JK-B1 and JK-D, and on every drain with an undeveloped hill catchment, every public drain, inlet, debris rack, sediment trap, debris basin and culvert shall be cleared a second time, of the sediment, slide debris and muck of the monsoon, by **31 October**. In towns above about 1,500 m, inlets, gratings, catch-water drains and culvert entrances shall be kept clear of snow and ice from **December to March**, and checked after every snowfall and every winter storm.

10.12.2 **Authority inspections.** The Authority shall inspect:

- (a) every facility on a site of 1,000 m² or more, or under Clause 10.6.1(c) or (d), at least once every 2 years, and every year in a flood-sensitive catchment; and
- (b) a random sample of at least 10% of other facilities each year.

10.12.3 The results of Authority inspections shall be entered in the facility register (Clause 10.17).

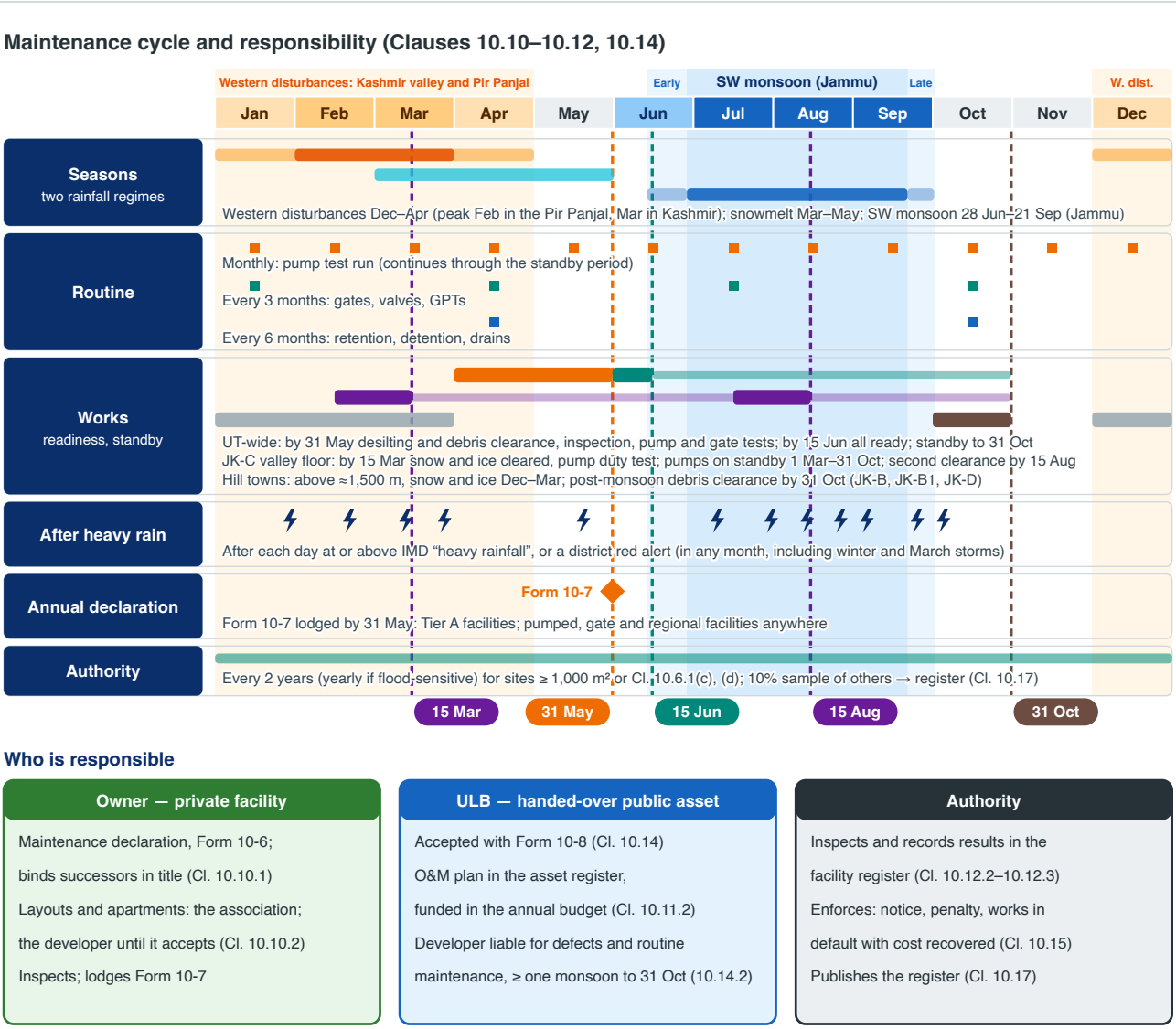

Figure 10.3 — Annual maintenance cycle and who is responsible: routine, pre-monsoon (by 31 May) and post-event inspections, the annual declaration (Form 10-7) and Authority inspections (Clauses 10.10–10.12 and 10.14). Original drawing for this Manual. The timing follows the south-west monsoon (June–September); tick positions within the year are illustrative.

Commentary. The split in Clause 10.12.2 follows the MBBL 2016 inspection regime for RWH, which requires 100% monitoring of buildings over 1,000 m² and a 10% random check below that (MBBL 2016, §9.6). The inspection intervals in Table 10.3 are set by this Manual. The dates are set by this Manual for a Union Territory with two rainfall regimes. The 31 May deadline is set for the onset of the south-west monsoon in the Jammu division at the end of June: the normal onset at Jammu is 28 June and the normal withdrawal 21 September (IMD normals from 2020), the monsoon covering most of Jammu and Kashmir by 30 June and withdrawing from most of it by 1 October (IMD), but it was declared on 13 June in 2021 (as reported), and heavy falls come in June, among them 147.9 mm at Katra on 30 June 2017 and 120.0 mm at Banihal on 21 June 1996 (IMD; Jammu's June record is 92.3 mm on the Meteorological Centre's page and 114.8 mm in IMD's *Extremes*, a conflict). Inlets, racks, culverts, gates and pumps must in addition be certified ready by 15 June, about two weeks before the normal onset. Pumps and gates are kept on standby to 31 October (Figure 10.3), because storms come after the withdrawal, as at Jammu (160.0 mm) on 5 October 1955 and Basohli (229 mm) on 14 October 1955 (IMD; CWC Flood Estimation Report, zone 7), and because the pumps of the Kashmir valley floor are needed until the Jhelum falls, a later date

than the storms of the Jammu division alone would need. The Kashmir valley needs more. Srinagar receives 697.5 mm a year, only 30% of it in June–September, and is wettest in March (IMD normals 1991–2020); the Flood Estimation Report found that it receives "only 28% of the annual rainfall during south west monsoon season as against over 55% in the months of December - April in association with western disturbances"; Gulmarg, Qazigund, Kupwara, Kokernag and Pahalgam are wettest in March, and Banihal, Batote and Bhaderwah in February; Srinagar's largest 24-hour fall, 147.8 mm, came on 31 January 1930, Gulmarg's 293.4 mm on 20 February 1967, and Katra's 261.9 mm with 145.2 mm at Jammu on 13 March 2007 (IMD); the water table of the valley is shallowest in May, after the winter rain and snow (CGWB); and SMC had to dewater the city after the snowmelt of January 2026 (as reported). The valley floor is therefore cleared of snow, ice and sediment, and its pumps given a full duty test, by 15 March, ahead of the March–April maximum and the snowmelt, with the pumps on standby from 1 March to 31 October. NDMA (2010) sets 31 March for pre-monsoon desilting nationally; this Manual allows until 31 May UT-wide so that dry-season work can be finished, and sets 15 March on the valley floor, where the wet season begins earlier. The largest floods of both divisions came in September, when monsoon moisture met a western trough (1988, 1992, 2014), and the largest 24-hour falls of the Jammu division in late August (1996, 1997, 2025), so the valley's drains, inlets and pump sumps are cleared a second time by 15 August. Hill drains fill with sediment, slide debris and muck during the monsoon, so in the hill towns of sub-areas JK-B, JK-B1 and JK-D a second clearance is made by 31 October; and above about 1,500 m inlets are kept clear of snow and ice from December to March. No dated UT or municipal order fixing any of these dates was found, and JMC's practice of finishing desilting before the end of June (as reported) is later than this Manual's. The reporting year runs from 1 June to 31 May, so that each year's declaration covers one full monsoon and one full winter. The post-event inspections of Table 10.3 cover storms at any time of year.

10.13 Maintenance access

10.13.1 Every facility shall have permanent access for inspection and maintenance, shown on the approved drawings and protected by the maintenance declaration or, for public facilities, by an easement or land transfer.

10.13.2 **Surface facilities.** Basins, ponds and open channels shall have a vehicle access route to the inlet, the outlet and the base, and a maintenance strip along at least one side. Ramps into basins shall be suitable for the plant needed to remove sediment.

10.13.3 **Underground facilities.** Tanks shall have:

- (a) an access opening over the inlet, the outlet and each chamber;
- (b) fixed ladders or steps, and ventilation for confined-space entry;
- (c) a sump or low point for sediment removal; and
- (d) headroom sufficient for manual cleaning.

10.13.4 **Outlets.** Orifices and screens shall be reachable for cleaning without entering a full facility.

10.13.5 Access routes shall not be built over, fenced off or used for parking in a way that prevents access.

Commentary. APWA 5600 (2006, §5608) required a 15-ft (about 4.5 m) maintenance access strip for detention facilities. Plot sizes in Srinagar, Jammu and the other cities and towns of Jammu and Kashmir make a fixed width hard to apply to every site, so this Manual sets functional requirements. Annex 10C covers maintenance access dimensions.

10.14 Handover of public assets to the ULB

10.14.1 Drains, roads, open space facilities, regional facilities and other stormwater assets that a developer builds for transfer to a ULB shall be handed over only when:

- (a) the as-built certificate (Clause 10.9) has been accepted;
- (b) the facility has been cleaned, and pipes and culverts have been inspected internally (for example by CCTV or manual entry), with the record handed over;
- (c) the land, or an easement over it, has been transferred to the ULB;
- (d) the O&M plan, drawings, GIS data and warranties have been handed over; and
- (e) the **Asset Handover Certificate (Form 10-8)** has been signed by both parties.

10.14.2 **Defects liability.** The developer shall remain responsible for defects and for routine maintenance for a defects liability period that includes at least **one full monsoon season, from 15 June to 31 October,** after handover. The ULB may hold a security deposit for this period.

10.14.3 **Asset register.** On acceptance, the ULB shall enter the asset in its GIS drainage asset register and in the facility register of Clause 10.17.

10.14.4 **Private facilities.** A private facility remains the owner's responsibility under its maintenance declaration unless the ULB formally accepts it under this Clause.

> Commentary. NDMA (2010) calls for a GIS inventory of drains. Requiring the developer's GIS data at handover builds that inventory as the city grows, at no cost to the ULB. The defects period spans one monsoon because many defects in Jammu and Kashmir drainage show up only in the first SW monsoon.

10.15 Enforcement

10.15.1 **Offences.** The following are contraventions of this Manual:

- (a) building without an approved drainage design where one is required;
- (b) building a facility other than as approved;
- (c) removing, filling, covering, reducing or changing the use of a facility without approval;
- (d) failing to maintain a facility, or to submit Form 10-7;
- (e) a sewage connection to a storm drain;
- (f) building or filling in a waterbody setback or no-fill zone (Chapter 7);
- (g) obstructing a natural drainage path or major-system flow path; and
- (h) false or negligent certification.

10.15.2 **Graduated response.** The Authority shall respond in the following order, moving to a later step where an earlier one fails or where the contravention is serious (Table 10.4):

Table 10.4 — Graduated enforcement response

Step	Action
1	Written notice stating the contravention, the clause breached, the remedy and a compliance period.
2	Stop-work order, or withholding of the completion certificate, for development not yet complete.
3	Penalty under the applicable Act or rules.
4	Works in default by the Authority, with the cost recovered from the owner.

Step	Action
5	Disconnection of the private drain connection to the public system, where this causes no hazard to others.
6	Report of the certifying professional to the registering authority, and suspension from the empanelled list.

10.15.3 **Immediate action.** Where a contravention puts life or property at risk during a monsoon, the Authority may carry out works in default at once and recover the cost later.

10.15.4 **Security deposits.** For sites under Clause 10.6.1, the Authority may require a security deposit or bank guarantee, released after the as-built certificate is accepted, to cover works in default.

10.15.5 **Record.** Every notice and action under this Clause shall be entered in the facility register.

> Commentary. Penalties are referred to generically. This Manual cannot itself create offences or fines, and the powers come from the Acts under which the Jammu and Kashmir Unified Building Bye-Laws 2021 are made and from the municipal Acts. The graduated steps are set by this Manual. In Jammu and Kashmir the High Court has become the working regulator of the Jhelum and its water bodies. In the cases on the floods of 2014 it held that "A duty is cast upon the Chief Engineer and other statutory authorities to ensure removal of all encroachments from the banks of River Jhelum along its entire course" (24 November 2014), directed a committee under the Divisional Commissioner to ensure "that the original width of the river Jhelum is restored" and the statutory authorities under the Water Resources Act 2010 to remove all encroachments, declaring that "the Court is Custodia Legis of river Jhelum and other water bodies" (24 February 2015), directed the Deputy Commissioners "to ensure that no construction of any kind is raised near the water bodies" (10 June 2016) and ordered the demarcation of the wetland reserves (2017); in its order of 29 May 2024 it asked for affidavits of compliance on the encroachments removed and the utilisation of the central assistance (*Environmental Policy Group v. Union of India*, PIL 8/2017 with PIL 2/2014 and PIL 18/2018). Around Dal it has kept a bar on construction within 200 m of the lake since 19 July 2002 (PIL 159/2002, as quoted; a judgment of 30 October 2025 is reported to keep it, text not read), and in November 2020 it barred construction within 200 m of Wular (as reported). The National Green Tribunal supervises Dal (O.A. No. 504 of 2024), Brari Nambal (O.A. No. 190 of 2025), the valley's wetlands (O.A. No. 239 of 2024, where on 13 November 2026 it found areas taken from the revenue records "insufficient" and asked for the area on the ground, as reported), the Jhelum and the Chenab (O.A. No. 413 of 2025), the land sinking at Pernote (O.A. No. 642 of 2024) and Thathri (O.A. No. 93 of 2023). The statutes carry powers that are little used: the Water Resources (Regulation and Management) Act 2010 lets the Government prohibit obstructions to irrigation and flood-control works, and its Executive Engineers remove them and recover the cost (ss.52–53), bars waste in channels (s.73), vests the bed and banks of all water sources in I&FC (s.81) and punishes construction that changes the behaviour of a water source or stands on an embankment with fines of up to ₹5,000 for a first offence, ₹10,000 for a second and then up to one year in prison or ₹15,000 or both (s.168) (section numbers assigned from a title index, to be confirmed [TBC]); but no flood basin has been found declared under its Part VI, the Flood Plain Zones Act 2005 has not been found brought into force, and the flood zonation maps to which UBBL-2021 defers (cl. 7.12(a)) have not been found notified, so no flood-zoning restriction can yet be enforced on the ground. Building rules are enforced under the J&K Municipal Corporation Act 2000 and the J&K Municipal Act 2000, under which UBBL-2021 are made (their penalty sections were not read [TBC]), and the bye-laws leave the incentives and penalties for rainwater harvesting to be framed locally (cl. 10.6). The CAG found that the flood spill channel had silted from 17,000 to 4,000 cusecs, that two schemes to restore the Jhelum's capacity had treated 68–81% of their lengths and excavated 43–84% of their volumes, and that "Had the two schemes been progressed and implemented as per the approved DPRs, the impact of the floods of September 2014 may have been mitigated", and that the State Disaster Management Authority had met only once in 2010–15 (Report No. 4 of 2016); and in its audit of the Prime Minister's Development Package it found "a significant shortfall of targets in terms of dredging" in Phase I of the Comprehensive Plan for Flood Management of the Jhelum, with "Critical areas of the FSC" still under excavation (year ended March 2019, published 2021). This

shows that a rule without routine enforcement does little, and that where the Government has not drawn a line on the ground the courts have. Professional accountability (step 6) is often more effective than fines on owners, because it acts on the person who signs the design.

10.16 Monitoring and post-event review

10.16.1 **Monitoring network.** Tier A authorities shall maintain, or have access to, recording rain gauges and water-level gauges at their main outfalls and regional facilities. Data shall be archived at intervals of 15 minutes or less.

10.16.2 **Event reports.** After any event that floods buildings within a ULB area, the ULB shall prepare a short event report within **3 months**, recording:

- (a) rainfall at the nearest approved gauges, by duration, compared with the design depths of Chapter 2;
- (b) the level of the receiving river at the governing gauge, named, with its datum: on the Jhelum the CWC levels in metres at Khanabal, Sangam, Ram Munshi Bagh and Safapora and the I&FC readings in feet at Sangam, Ram Munshi Bagh and Asham, kept as two separate series and never converted one into the other until I&FC publishes its gauge zeros; on the Tawi the CWC level at Sidhra and the I&FC gauges at Jammu and Udhampur; on the Chenab the levels at Akhnoor; and, for an ungauged khad or nallah and for every river reach outside the CWC sites, the flood marks surveyed after the event and the boulders, debris and muck deposited at crossings; the level of the receiving lake, nambal or reservoir (Dal, Anchar, Wular, Salal, Baglihar, the Tawi barrage) as its manager records it, on a named datum; the times at which each gravity outfall, the Dal Gate and the outlet of each lake closed and reopened; the state of every flap gate, penstock, debris rack, sediment trap, debris basin and pumping station on the outfall and on the drain upstream of it, with the volume of debris removed from each, the hours each pump ran, the number of mobile pumps deployed and where, and any loss of power or fuel; and the gate openings and releases of any dam or barrage that set the receiving level, such as Baglihar, Salal or the Tawi barrage;
- (c) flooded locations, depths and durations, with flood marks surveyed where possible;
- (d) the performance of public and inspected private facilities, including any blocked outlets, failed pumps or closed gates; and
- (e) recommended actions.

10.16.3 **Post-event review.** Where an event exceeds the 1% AEP 24-hour or 72-hour design depth at two or more approved gauges in the State (Clause 2.14.1), J&K SDMA, with the State Stormwater Technical Committee, shall lead a post-event review within **12 months**. It shall assess whether the criteria of this Manual were adequate, and shall feed into the review of Clause 1.12.

10.16.4 **Facility performance sampling.** The Authority shall, at least every 5 years, monitor a sample of private retention and detention facilities through a monsoon, to test whether they perform as designed.

Commentary. The post-event trigger is the review trigger already set in Clause 2.14.1. Jammu and Kashmir's floods have been audited and litigated more than they have been reviewed. The CAG's audit of disaster management recorded that the rain of 28 August to 10 September 2014 caused floods in Srinagar and the Jammu division in which 304 people died (Jammu 217, Kashmir 87), 2,40,004 houses were damaged and crops were lost on about 4,91,967 ha (Report No. 4 of 2016); other counts give 277 or 284 deaths and more than 1.6 lakh structures damaged (Malik, 2021; H&UDD reply in the Legislative Assembly, February 2026, as reported), and these conflicts are not resolved. In Srinagar 262 km², 34% of the planning area, was under water (Srinagar Master Plan 2035, §4.2), up to 16 ft deep and for up to 25 days in places (as reported); the Jhelum carried about 1,15,218 cusecs at Sangam and 72,585 cusecs at Ram Munshi Bagh (Malik, 2021), against a channel capacity of about 31,800 and 27,000 cusecs before the works that followed (I&FC, as reported). The locations and dates of the embankment breaches, the duration of dewatering and the number of pumps that ran were not found. In 2025 the

Jammu division had the largest 24-hour falls on record, 380 mm at Jammu and 630 mm at Udhampur IAF on 26–27 August (IMD), the Tawi set a new high flood level at Sidhra, the cloudburst at Chasoti on 14 August killed more than 60 people and the landslide on the route to Vaishno Devi on 26 August between 30 and 35, and more than 110 people were reported dead across the Union Territory in two weeks (all as reported; the counts differ). The CAG also found the Jhelum's dredging under the Prime Minister's Development Package behind its targets (2021), and the Government told the Legislative Assembly in 2026 that the safe discharge of the Jhelum in the Srinagar reach had risen from about 31,800 to 41,000 cusecs after Phase I of the Comprehensive Plan (as reported). No review of any flood in a town of Jammu and Kashmir, no record of flood extents, depths or durations kept by any ULB or by J&K SDMA, and no official toll for 2022 or 2025 was found; the Ramban flash flood of 2025 and the floods of September 1992 were not researched in detail. NDMA (2010) called for automatic rain gauges at "1 in every 4 sq km" in Class I, II and III cities. Clause 10.16.1 asks only for gauges where they serve design and review. The report and sampling intervals are set by this Manual.

10.17 Data publication

10.17.1 Each Authority shall publish, on a public website, and update at least quarterly:

- (a) a **facility register**: location, type, design volume, release rate, owner, date of as-built acceptance, and the latest inspection result for every facility approved under this Manual;
- (b) a summary of each approved drainage report, with Forms 2-1 and 10-2;
- (c) the register of variances and waivers (Clause 1.10);
- (d) the alternatives adopted under the Policy Supplement (Clause 1.7);
- (e) enforcement actions (Clause 10.15.5); and
- (f) event reports and post-event reviews (Clause 10.16).

10.17.2 The State Stormwater Technical Committee shall publish the compliance calculator, all Annexes, the flood-sensitive catchment maps and the State-level summary of facility registers as open data.

10.17.3 Personal data other than the name of a corporate owner or association shall not be published. Security-sensitive details of critical infrastructure may be withheld, with the reason recorded.

10.17.4 Published data shall be machine-readable (for example CSV and GeoPackage) and released under the Government Open Data Licence – India or an equivalent open licence.

Commentary. Transparency is a design criterion in its own right here. Some of Jammu and Kashmir's drainage records are public: UBBL-2021 as gazetted on 24 December 2021 and S.O. 304 of 2025, on the H&UDD and OBPS portals; the Srinagar Master Plan 2035 and the Jammu Master Plan 2032; the Reorganisation Act 2019 and the Water Resources Act 2010; the High Court's order of 29 May 2024 in the Jhelum cases; the reports of JKPCC and the Forest, Ecology and Environment Department to the National Green Tribunal on Dal, the wetlands, the Jhelum and the Chenab, and Pernote, with the note of the Geological Survey of India on Pernote; the CAG's audits; IMD's press releases and the station pages of the Meteorological Centre Srinagar; CGWB's groundwater reports; and MoEFCC's list of Ramsar sites. Much else could not be found in the public domain: the original H&UDD notification of UBBL-2021, the text of S.O. 58 of 2026 and the annexure of the draft amendments of September 2026; the texts of SRO 160 of 2019 and SRO 90 of 2017; the drain sections of the municipal Acts; the design basis of the Egis drainage master plan for Srinagar and of any Smart City drain; Jammu's storm-water project report; the flood zonation maps of I&FC to which UBBL-2021 defers, and any notification under the Flood Plain Zones Act 2005 or Part VI of the Water Resources Act 2010; the zeros of the I&FC feet gauges and the datum of CWC's levels; the operating rule of the Dal Gate and the datum of the Dal gauge; the pool level of the Tawi barrage and the operating rules of the Union Territory's dams; J&K SDMA's procedures for urban floods; the gauge records of

2014; and a list of the dewatering stations of Srinagar, with their capacities and the river stages at which their gravity gates shut. Publishing inputs and facility records lets the public, researchers and other agencies check that the city's growing stock of private storage actually exists. The open-format requirement is set by this Manual.

10.18 Review of this chapter

10.18.1 This chapter shall be reviewed with the Manual under Clause 1.12. The forms and the compliance calculator may be revised by the State Stormwater Technical Committee between reviews, under Clause 10.5.3.

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Annexes and forms

Annex / Form	Content
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Annex / Form	Content
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Form 10-8	Asset Handover Certificate
Form 2-1	Design Rainfall Sheet (Chapter 2)

CHAPTER 11

Basin and City Stormwater Master Plans

11.1 Purpose and scope

11.1.1 Chapters 2 to 10 control one project at a time. This chapter sets the requirements for the plan that ties those projects together: the **Basin Stormwater Master Plan (BSMP)**. A BSMP is prepared for each drainage basin of a city or urban area. A city's set of BSMPs makes up its **City Stormwater Master Plan**.

11.1.2 A BSMP shall:

- (a) map flood hazard for the basin under existing and future conditions;
- (b) set the level of service each part of the drainage system must achieve (Clause 11.6);
- (c) identify the works, storage and land needed to reach that level of service, and rank them (Clauses 11.7 and 11.8);
- (d) reserve land for regional storage, talab and tank restoration, and major flow paths in the statutory land-use plan (Clause 11.9);
- (e) set the basin-specific inputs that site designs under Chapter 4 depend on: regional facilities, the fee-in-lieu unit rate, and any basin release rate stricter than Chapter 4 (Clause 11.8.3); and
- (f) recommend catchments for notification as flood-sensitive (Clause 4.5.4).

11.1.3 **Relationship to site design.** Site criteria (Chapters 4 to 8) apply whether or not a BSMP exists. A BSMP may make the site criteria **stricter** for its basin. It shall not relax them, except through the regional detention and fee-in-lieu routes of Clauses 4.13 and 4.5.6.

> Commentary. Jammu and Kashmir's cities have drainage plans, schemes and benchmarks, but no published storm-drainage master plan with a design storm. In Srinagar the master plan commits the city to "stormwater performance standards … with 100% coverage and zero incidence of waterlogging", recommends source controls that "store stormwater onsite and release it at a controlled rate", and divides the city into the three drainage zones of the "Drainage Master Plan of Srinagar City", with about 50 drainage schemes, 118,663 m of primary and secondary drains and 89 drainage pumping stations, but it gives no return period, runoff coefficient or intensity (Srinagar Master Plan 2035, §13.3); the drainage master plan and project report that Egis India prepared for 767 km² of the city, "separate from the sewage system", has not been published with its design basis (as reported). For the Jhelum the same plan proposes the watershed mapping of the Lidder, Veshaw, Brengi, Sandran, Rambiara, Arpath, Rumshi, Veth, Sindh, Arizal and Doodhganga, records that "A supplementary Flood Spill Channel from Dogripora to Wullar, designed for 55,000 Cusecs has been conceived by Department of Irrigation and Flood Control", aims at a river capacity of 55,000 cusecs "with 25,000 cusecs to be diverted through the Flood Spill Channel", and envisages the demarcation of the 25-year flood plain from Lelhar to Lasjan, to be notified "as Protected Natural Flood Absorption Basin" (§14.4.4.2); this is a proposal of the plan, and no such notification has been found. The 25-year flood plain is the only design-flood frequency found in any planning text of the Union Territory, and it is a planning line, not a drain-design storm. The Comprehensive Plan for Flood Management Works on the Jhelum was taken up in two phases, Phase I of ₹399.29 crore and Phase II of ₹5,411.54 crore, of which Part A, ₹1,623.43 crore, was approved in 2022, with regulating gates at Hokersar (as reported); the CAG found Phase I's dredging well short of its targets (2021). In Jammu the master plan records that roadside drains serve as storm drains, that only 20% of roads have them, covering about 40% of the city, and that "Storm water

drains carry considerable quantities of raw and untreated effluents" (Jammu Master Plan 2032, §5.1.3); it asks that a storm-water project report be prepared "immediately after the approval of this Master Plan" (§11.1.3), and none was found; only the names and costs of single drains, such as the Digiana–Gangyal storm drain, were seen (as reported). No published document sets a design return period for the storm-drain network of any town in Jammu and Kashmir. This chapter supplies the design storm, levels of service, storage and buffer criteria that such a plan needs, with the design storms of Chapter 2 and the levels of service of Clause 11.6; it has not been adopted by H&UDD, the Jal Shakti Department (I&FC), SMC, JMC, SDA, JDA, UEED, LCMA, WUCMA, J&K SDMA or any other body. A site-level manual cannot fix basin-level problems: lost tank storage, lakes, nambals and flood-absorption marshes built over on the valley floor, city drains that close against the Jhelum and empty only by pumps, as Srinagar's did in September 2014, khads narrowed by building and by the release of Gair Mumkin Khad land in Jammu, slopes that open drains and sewage pipes saturate, as at Thathri and Pernote, drains that carry sewage into Dal, the Jhelum and the Tawi, and single drains split between a Municipal Corporation, UEED, I&FC, LCMA, PW (R&B) and a Smart City company, and drains that are adequate on their own but overload the next reach. Comparable manuals pair site criteria with basin planning:

- Denver's Mile High Flood District prepares major drainageway master plans that set regional facilities and release rates.
- The Kansas City APWA criteria rest on regional watershed studies (MARC).
- England's Surface Water Management Plans (Defra, Surface Water Management Plan Technical Guidance, 2010) set a phased method of preparation, risk assessment, options and implementation.
- Malaysia's MSMA requires drainage master plans for urban areas.

This chapter adapts that method to Jammu and Kashmir, the third mountain edition in the series and its first with two rainfall regimes and a valley-floor city behind river embankments: to Srinagar and the other towns of the Kashmir valley floor, flat, with the water table 0–2 m below the ground, whose drains close against the Jhelum in flood and then empty only by pumps, and whose flood storage lies in lakes and nambals, Dal, Anchar, Hokersar, Narkara and Wular among them, into which the towns have grown since the plan of 1971–91 (Srinagar Master Plan 2035); to Jammu and the towns of the Kandi and the Sirowal, whose khads cross boulder fans to the Tawi, the Chenab, the Ujh and the Basantar and are narrowed by building and by the release of land recorded as Gair Mumkin Khad; to the hill towns of the Pir Panjal and the Chenab, Udhampur, Ramban, Doda and Kishtwar among them, where water put into the ground moves the ground, as at Pernote and Thathri; to drains run by SMC, JMC, UEED, I&FC, LCMA, PW (R&B) and Smart City companies, beside nallahs and khads that no rule assigns; to a Union Territory with flood-zoning statutes that have never been used, building bye-laws with wide watercourse buffers but no drainage standard, and master plans with benchmarks but no design storm; to the western disturbances and snowmelt of the Kashmir valley and the monsoon of the Jammu division, whose largest floods both came in September; and to storms that outrun the design maps, 380 mm at Jammu and 630 mm at Udhampur in the 24 hours to 27 August 2025 (IMD), and cloudbursts and debris flows, as at Chasoti in 2025, that no drain can carry, so that in the high mountains a BSMP begins with the hazard, not the storm (Clause 11.3.3).

11.2 Definitions

Term	Meaning in this Manual
Basin	The land draining to one outfall to the sea, a river, or a major waterbody, as delineated under Clause 11.3.
Basin Stormwater Master Plan (BSMP)	The plan for one basin prepared under this chapter.
Lead Authority	The body responsible for preparing a BSMP (Clause 11.4).

Term	Meaning in this Manual
Level of service (LoS)	The flood performance a part of the drainage system must achieve, expressed as an AEP and an outcome (Clause 11.6).
Flood hazard map	A map of flood extent, depth, velocity and hazard class (H1–H6, Chapter 6) for a stated AEP and scenario.
Regional facility	A storage, conveyance or outfall work serving more than one development, identified in a BSMP.
Capital Improvement Programme (CIP)	The ranked, costed list of works in a BSMP (Clause 11.8.4).

11.3 Planning unit: the basin, not the ward

11.3.1 BSMPs shall be prepared **by hydrological basin**, not by ward, zone or local-body boundary. Where a basin crosses local-body boundaries, one BSMP shall cover the whole basin.

11.3.2 Basin boundaries shall be delineated from the digital elevation model of Clause 11.5.2, checked against the drain network, road embankments, canals and tank supply channels. Diversions between basins, whether by canal, drain or surplus course, shall be mapped and represented in the model.

11.3.3 No basin delineation has been published for any town in Jammu and Kashmir. For the urban areas where the evidence identifies them, the basins are at least the following, grouped under the flood-sensitive catchments of Clause 4.5.3.2:

- **Srinagar, Dal catchment and Telbal:** the catchments that drain to Dal and Nigeen, among them the Telbal Nallah from Dachigam and the Mearkh Shah, Bota Koul and Pishpow nallahs, with the Dal Gate and Nallah Amir Khan as controlled outlets, the chain from Nigeen through Gilsar and Khushalsar to Anchar in the 1D network, the lake at its level with the gate shut as the boundary condition [TBC: level and datum], and the sewage inflows from Telbal and Lal Bazar shown;
- **Srinagar, the city behind the Jhelum embankments:** the three drainage zones of the Srinagar drainage master plan, with every drainage scheme, gravity outfall and dewatering station in the model, its sump levels and the stage at which its gate shuts, and the Jhelum at Ram Munshi Bagh as the boundary (Clause 5.8.5(a)), the outfall-closed case of Clause 5.10 a design case;
- **Srinagar west and north, the flood-basin chain:** the catchments that drain to the flood spill channel and to the flood-absorption marshes west and north of the city, Rakh-e-Gund Aksha, Hokersar, Nambal Narkur (Narkara), Shallabugh and Rakh-e-Arth, with the Lelhar–Lasjan floodplain that the master plan proposes to protect (not notified) mapped;
- **Doodhganga:** the catchment of the Doodhganga, with the Sukhnag, draining to Hokersar and the Jhelum, with the high flood level set at Kralpora in 2025 (1,594.3 m, as reported) as a boundary;
- **Sindh–Anchar:** the catchments that drain through the Sindh Nallah to Anchar, Shallabugh and the Haran forest and on to the Jhelum below Srinagar, with the drains that reach Anchar from Dal through Khushalsar;
- **Anantnag–Bijbehara–Pampore, upper Jhelum:** the catchments of the towns and of the tributaries of the master plan's watershed list, the Lidder, Veshaw, Brengi, Sandran, Rambiara, Arpath, Rumshi, Veth and Arizal, with the Jhelum at Khanabal and Sangam as the boundary;
- **Sopore–Baramulla–Sumbal–Bandipora, lower Jhelum and Wular:** the catchments that drain to the Jhelum below Srinagar and to Wular, with Safapora and the Wular level (1,578 m, as reported) as the boundary and the outlet at Ningli as a control;
- **Jammu, the Tawi and its khads:** the catchments that drain to the **Tawi**, the **Devak** and the **Basantar** and through the **Balol**, **Thather** and **Bhalwal** khads and the other khads of the Jammu planning area, with the land recorded as Gair Mumkin Khad mapped against the functional khad, the Tawi at Sidhra (high flood level 321.1 m, 2025) and the Tawi barrage [TBC] as the boundary, and the localities flooded in 2025 and 2026 checked;

- **Kathua–Hiranagar and Samba:** the catchments that drain to the Ujh and the Ravi, with Ranjit Sagar's level as the Ravi boundary, and to the Basantar;
- **R.S. Pura–Bishnah–Arnia, Sirowal:** the flat, waterlogged catchments of the Sirowal, whose drains reach rivers that cross into Pakistan within 10–30 km, so that the level beyond the border is unknown and the flood-mark profile of the reach is the boundary;
- **Akhnoor, Chenab:** the catchments of the town, with Akhnoor's high flood level (324.29 m, 1992) and the releases of Salal as the boundary;
- **Udhampur and Katra:** the catchments on the Tawi and the Devak at Udhampur, with the I&FC gauge at Udhampur, and the nallahs of Katra, with debris racks and basins at the foot of the hills and the 1% AEP level with debris as the boundary; and
- **the hill towns of the Chenab valley, Ramban–Batote–Banihal and Doda–Thathri–Kishtwar:** the catchments of each town and of every nallah that crosses it, with the subsidence and sliding zones of Pernote, Duksar and Thathri mapped, surveyed flood marks where CWC has no site, and the levels and releases of Baglihar, Dul Hasti and Ratle where they set the river below the town.

Hazard first in the high mountains (set by this Manual). In sub-area JK-D (High mountains and snow-fed catchments; Gulmarg–Pahalgam–Sonamarg–Gurez–Paddar) of Annex 2A, and in any basin with a glacier, a glacial lake or a mapped debris-flow fan above it, the BSMP begins with a hazard screening for glacial-lake outbursts, debris flows, landslide dams and cloudburst floods, made with J&K SDMA, and uses site-specific hydrology in place of the zone-7 report (Clause 2.3.6(i)). The cloudburst at Chasoti on the Machail Mata yatra route on 14 August 2025, where more than 60 people were reported killed, and the flood at the Amarnath cave on 8 July 2022, where 16 were reported killed, came from storms that no gauge measured at a cloudburst rate, down channels that no drain could have carried; the Chenab's headwaters, the Marusudar and the Warwan carry snowmelt and the risk of outbursts towards Kishtwar, Doda and the Chenab reservoirs. The hazard zones are shown on the 1% AEP map, no drain, storage or pumping station is sited in them, and no work in the CIP is sized to carry a debris flow or an outburst. Other local bodies, among them those of Anantnag, Baramulla, Sopore, Kathua and Udhampur, shall define their basins in the first BSMP that covers them. Where CWC, I&FC, LCMA, WUCMA, a dam operator, a master plan or a court has a high flood level, a lake or reservoir level, a flood line or an operating rule for a gate, dam, barrage or pumping station, the BSMP shall take its boundary conditions from it, naming the gauge and its datum, and show those levels against its own 1% AEP map.

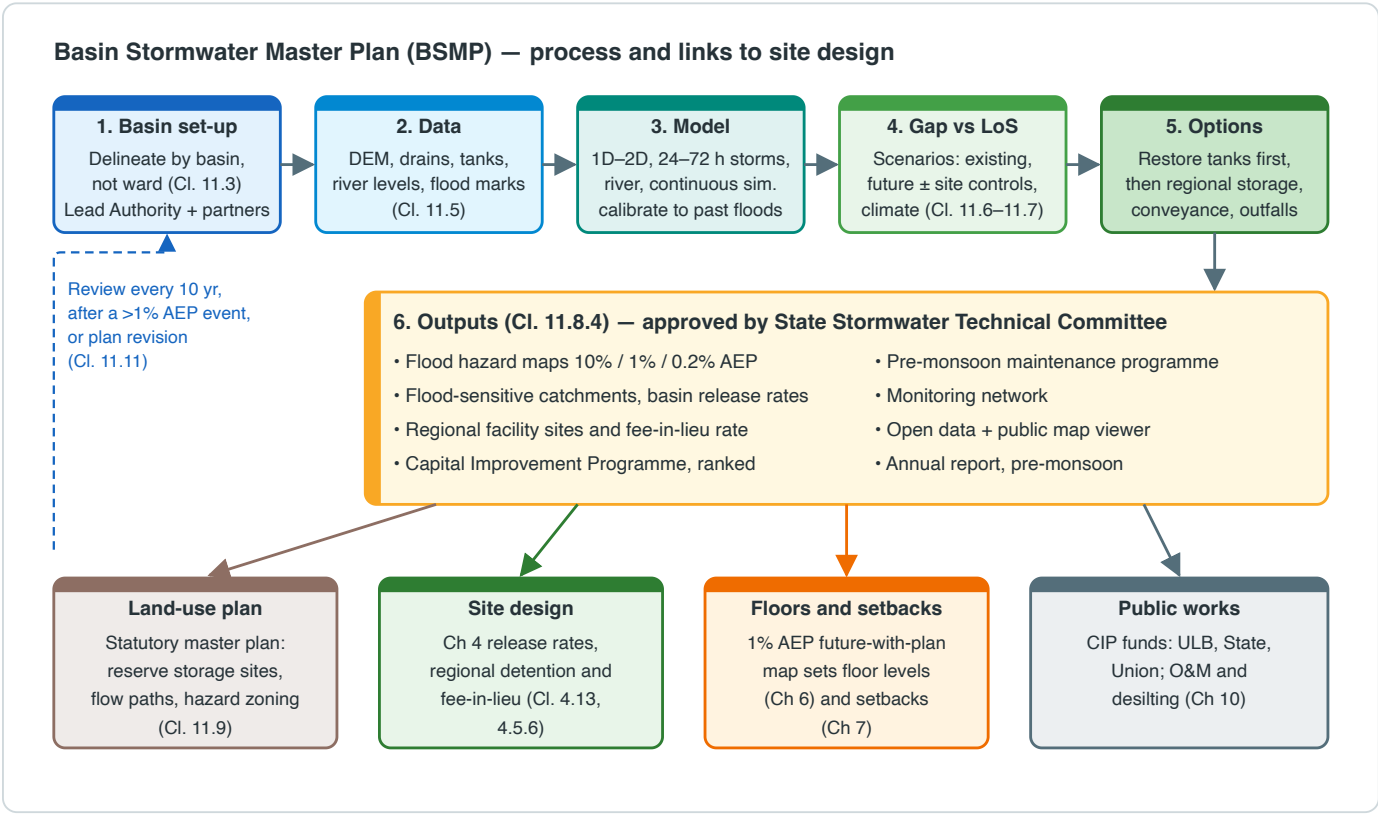

Figure 11.1 — Basin Stormwater Master Plan process and its links to site design. Original drawing for this Manual. The phase structure is adapted from Defra, Surface Water Management Plan Technical Guidance (2010), and Mile High Flood District master planning practice.

> **Commentary.** Water does not follow ward boundaries. A ward-by-ward drain plan can pass the problem to the next ward, and to the next local body. In Jammu and Kashmir a single nallah passes through many hands on its way to a river. In Srinagar the Telbal Nallah carries the runoff of Dachigam and the untreated sewage of Telbal into Dal (JKPCC, 2024); the lake is managed by LCMA, and its outlets drain through the Dal Gate to the Tsunth Kol and the Jhelum and through Nallah Amir Khan to Nigeen, Khushalsar and Anchar; the city's drains are planned and built by UEED and run by the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir; the banks of the Jhelum, its embankments, the flood spill channel and the city channels are I&FC's (Water Resources Act 2010, s.81); and Hokersar, Shallabugh and Hygam, which take the overflow, are wetland conservation reserves of the Wildlife Department. In Jammu the roadside drains carry runoff and raw effluent to the Tawi (Jammu Master Plan 2032, §5.1.3), the khads are recorded by the Revenue Department as Gair Mumkin Khad, whose "true Khad" is to be fixed with I&FC (§12.2.3), and the Sewerage and Drainage Division (West) of UEED works only within JMC's limits. No rule divides the khads and natural nallahs from the municipal drains (as this Manual reads the record); the nearest is the Act's vesting in I&FC of the bed and banks of every water source. This clause makes the basin the planning unit, so that one model carries each nallah and khad from its head in the hills to the river, whoever owns each reach, and so that the sewage it carries is separated before it reaches a lake (Chapter 8, Clause 8.9.5).

11.4 Who prepares, and when

11.4.1 **Lead Authority.**

- For the basins of Srinagar: **SMC**, jointly with **UEED**, which plans, designs and builds the city's drainage schemes and dewatering stations, and with **SDA** in the Srinagar Local Planning Area, into whose master plan the BSMP is taken (Clause 11.9); for the basins of Jammu: **JMC**, jointly with the Sewerage and Drainage Division (West) of **UEED** and with **JDA** in the Jammu Local Planning Area; either Municipal Corporation may prepare the plan as H&UDD directs, with the Town Planning Organisation of Kashmir or Jammu. Where a basin extends beyond the Corporation or the local planning area, the other local bodies, the Halqa Panchayats and the planning authorities in the basin are partners, and one BSMP covers the whole basin (Clause 11.3.1).
- No order dividing the khads and natural nallahs from the municipal drains, or the drains of the local bodies from the rivers, lakes and channels, was found; until one is made, this Manual assigns the reaches within each BSMP as in Table 1.5, each body being Lead Authority for the reaches and works it owns or runs and for the parts of the CIP on them: **I&FC** for the Jhelum, the Tawi, the Chenab, the Ravi, the Ujh, the Basantar, the Devak and the other rivers, for the beds and banks of the nallahs and khads, for the embankments, the flood spill channel and any supplementary channel, for the city channels such as the Tsunth Kol and the Padshahi Canal, and for the canals and zamindari khuls; **UEED** with the **Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir** for Srinagar's drainage schemes, drains and dewatering stations, **JMC** with UEED within JMC's limits in Jammu, and the **Municipal Councils** and **Municipal Committees** for the drains within their limits; **PW (R&B)** for the side drains, catch-water drains and culverts of its roads, including the hill roads, and **NHAI** for the national highways; **LCMA** for Dal and Nigeen and the drains it holds in their catchment, **WUCMA** for Wular and its feeder channels, and the **Wildlife Department** for the wetland conservation reserves, with the **J&K Wetland Authority** under the Wetlands Rules 2017; **SDA**, **JDA**, the J&K Housing Board, the **Smart City companies** of Srinagar and Jammu and colony developers for the drains of their works and schemes, until handed over in writing; **NHPC** for Salal and Dul Hasti, **JKSPDC** for Baglihar and the operator of Ranjit Sagar for their reservoir levels and releases;

UEED for the sewers and treatment plants whose effluent reaches the drains (Clause 8.9); the **Revenue Department** for the records of Gair Mumkin Khad, nambal, rakh and kahcharai land; and **J&K SDMA** for the mapping of the landslide, cloudburst, debris-flow and glacial-lake hazards that a BSMP must show.

- In Tier B bodies: the Lead Authority is named by H&UDD. Basins draining to a common river reach or lake may be grouped into one district-level plan.

J&K SDMA and the Deputy Commissioner shall be consulted on every BSMP, and the Geological Survey of India wherever a basin includes a mapped subsidence or sliding zone, such as Pernote, Duksar or Thathri; LCMA, WUCMA or the Wildlife Department on every BSMP whose basin drains to Dal, Nigeen, Wular, a Ramsar site or a wetland conservation reserve; JKPCC on every BSMP that proposes works on a drain or nallah that carries sewage, among them the drains to Dal and the stretches that CPCB lists as polluted (the Chunt Kol, the Jhelum below the Vishav, the Tawi, the Basantar and the Devak); NHPC, JKSPDC or the dam operator on every BSMP whose basin drains to a reservoir or to a river below a dam; and, for a basin whose outfall lies on the Ravi, shared with Punjab, that State's water resources department, through I&FC. For a basin whose outfall lies on a river that crosses into Pakistan, the BSMP states that the level beyond the border is not monitored.

The Irrigation and Flood Control (I&FC) wing of the Jal Shakti Department shall be a partner in every BSMP that includes a river, canal or tank under its control.

11.4.2 **When a BSMP is required.**

- (a) Every Tier A body shall approve BSMPs covering its whole area within **3 years** of this Manual taking effect.
- (b) A BSMP is required before:
  - any regional detention or fee-in-lieu is accepted under Clause 4.13;
  - a fee held under Clause 4.5.6.3 is spent; and
  - a basin-specific release rate is applied under Clause 11.8.3.
- (c) A Tier B body shall prepare a BSMP where its Lead Authority, or the State Stormwater Technical Committee, finds recurrent flooding of buildings or arterial roads.

11.4.3 **Preparation.** BSMPs shall be prepared by, or under the direction of, an engineer empanelled as a Stormwater Design Professional (Chapter 10) with experience in basin-scale modelling.

11.5 Data and surveys

11.5.1 Each BSMP shall assemble and publish (Clause 11.10) the data in Table 11.1:

Table 11.1 — Minimum data and surveys for a BSMP

Data	Minimum requirement
Terrain	Digital elevation model from LiDAR or photogrammetry, with vertical accuracy of 0.15 m RMSE or better in urban areas, tied to the Survey of India datum
Drain network	Inventory of all public drains, culverts and outfalls with invert levels, sizes, condition and silt depth; private drains above 600 mm
Waterbodies	Survey of every tank, talab, pond and marsh under Chapter 7: FTL, MWL, bund level, stage–storage, sluices, surplus weirs, supply channels, encroachment
Rivers and canals	Cross-sections at no more than 200 m spacing and at every structure

Data	Minimum requirement
Outfalls, rivers, khads, lakes and reservoirs	The datum of every level named; outfall invert levels against the levels of the receiving river at the nearest CWC site and its recorded peaks (on the Jhelum the danger and high flood levels at Sangam, 1,590.88 m and 1,595.7 m or 1,595 m, at Ram Munshi Bagh, 1,585.48 m and 1,589.65 m or 1,588.99 m (the lists of 2018 and 2022 differ, and the higher governs until CWC confirms one), and at Safapora, 1,579.66 m and 1,582.1 m, with 1,595.43 m at Khanabal in 2025; on the Tawi at Sidhra the high flood level of 321.1 m of 2025, and on the Chenab at Akhnoor 324.29 m of 1992; CWC levels as transcribed by SANDRP, as reported), with the I&FC readings in feet at Sangam, Ram Munshi Bagh, Asham, Akhnoor and on the Tawi kept as a separate series and never converted until I&FC publishes its gauge zeros; the stage at which each gravity outfall closes, and the duty points, sump levels, start levels and standby power of every pumping station (lists of UEED and SMC [TBC]); for the ungauged khads and nallahs and every river reach outside the CWC sites, surveyed flood marks, the debris lines of 2014 and 2025 and the 1% AEP flood level with its sediment and debris; for outfalls to lakes and nambals, the outlet levels and gate rules of Dal (the Dal Gate and Nallah Amir Khan), Nigeen, Anchar, Wular (danger level 1,578 m, as reported) and the other lakes, from LCMA, WUCMA or I&FC, on a named datum [TBC]; for outfalls to reservoirs and barrage ponds, the maximum water level, full reservoir level and spillway and gate data from JKSPDC, NHPC or the operator (Baglihar 840 m; Salal 487.68 m; Ranjit Sagar 527.91 m or 527.13 m, a conflict; the Tawi barrage [TBC]), with their release records; the capacity of the Jhelum and the flood spill channel by reach (the channel was designed for 17,000 cusecs and carried 4,000 in 2014, CAG); the debris-flow fans, landslide and subsidence zones and glacial lakes above the basin, from J&K SDMA and the Geological Survey of India where mapped; and the flap gates, penstocks, debris racks, sediment traps and pumping stations on the outfalls, with their capacities and operating rules
Rainfall and levels	All available rain gauges (IMD, including its observatories and stations at Srinagar, Jammu and Jammu Airport, Udhampur IAF, Katra, Qazigund, Banihal, Batote, Bhaderwah, Kokernag, Pahalgam, Gulmarg and Kupwara, the automatic weather stations reported by the Meteorological Centre Srinagar, among them Kawa (Udhampur), Rambagh and Srinagar, and its gauges at Kathua, Samba, Rajouri, Poonch, Anantnag, Baramulla, Doda and Kishtwar; the self-recording gauges at Srinagar and Gulmarg used for the CWC Flood Estimation Report for zone 7; the river gauges of CWC and the staff gauges of I&FC; the rain and reservoir records of JKSPDC at Baglihar and of NHPC at Salal and Dul Hasti; and any gauges kept by SMC, JMC, the Smart City companies, J&K SDMA and the Jal Shakti Department) and water-level records, including those for the 3–10 September 2014 (599.8 mm at Qazigund in the four days to 6 September and 698.6 mm at Katra in 72 hours, Ray et al., 2015; the Jhelum at Ram Munshi Bagh at its high flood level on 8 September, 1,588.99 m or 1,589.65 m in CWC's lists of 2022 and 2018, as transcribed by SANDRP; 262 km², 34% of the Srinagar planning area, flooded), 26–27 August 2025 (380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30 IST on 27 August, IMD, with the Tawi at Sidhra at a new high flood level of 321.1 m, as reported), 1 August 2019 (Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar waterlogged after 26.4 mm, as reported), 7–10 September 1992 (the Chenab at Akhnoor at its high flood level of 324.29 m on 10 September, CWC as transcribed by SANDRP, and 61 ft on the I&FC gauge, as reported) and 25 September 1988 (316.2 mm at Batote, 292.4 mm at Katra and 270.4 mm at Jammu, IMD) events
Flood evidence	Surveyed flood marks and mapped flood extents from past events, including public reports
Land use	Existing land use and imperviousness; future land use from the statutory master plan
Soils and groundwater	HSG map (Annex 3A); seasonal high groundwater; aquifer and recharge zones
Sewer interaction	Known sewage cross-connections, dry-weather flow in drains, and solid-waste hotspots

Commentary. The 0.15 m accuracy has no direct precedent; this Manual sets it because on the Kashmir valley floor, where Srinagar and the other embanked towns lie on flat ground below the Jhelum in flood, and where water stood up to 16 ft deep for up to 25 days in places in 2014 (as reported), on the Sirowal of the Jammu plains, where slopes are gentle and the water table is near the surface, and on the Kandi fans and khad terraces of Jammu, Samba and Kathua, where a raised road, a fill or a low wall can turn the overflow of a khad from one side of a fan to the other, a small error in ground level moves the flood edge a long way, and the 1% extent from the BSMP sets floor levels (Chapter 6) and setbacks (Chapter 7). Past flood marks matter as much as models. The 3–10 September 2014 (599.8 mm at Qazigund in the four days to 6 September and 698.6 mm at Katra in 72 hours, Ray et al., 2015; the Jhelum at Ram Munshi Bagh at its high flood level on 8 September, 1,588.99 m or 1,589.65 m in CWC's lists of 2022 and 2018, as transcribed by SANDRP; 262 km², 34% of the Srinagar planning area, flooded), 26–27 August 2025 (380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30

IST on 27 August, IMD, with the Tawi at Sidhra at a new high flood level of 321.1 m, as reported), 1 August 2019 (Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar waterlogged after 26.4 mm, as reported), 7–10 September 1992 (the Chenab at Akhnoor at its high flood level of 324.29 m on 10 September, CWC as transcribed by SANDRP, and 61 ft on the I&FC gauge, as reported) and 25 September 1988 (316.2 mm at Batote, 292.4 mm at Katra and 270.4 mm at Jammu, IMD) events are the best calibration data Jammu and Kashmir has, and much of the evidence is held in photographs, news reports and residents' records that should be collected before it is lost.

11.6 Levels of service

11.6.1 Each BSMP shall adopt the following minimum levels of service. A BSMP may adopt stricter levels.

Table 11.2 — Minimum levels of service

Element	Minimum level of service
Minor system	The design AEP of Chapter 6 (Table 6.1)
Habitable buildings	No flooding above floor level in the 1% AEP (100-yr) event
Critical facilities (hospitals, emergency services, substations, water and sewage plants)	No flooding of the facility in the 0.2% AEP (500-yr) event; access road passable in the 1% AEP event
Evacuation routes and arterial roads	Passable (hazard class H2 or better, Chapter 6) in the 1% AEP event
Ponding drain time	Surface water cleared from roads within **6 hours** after rain ends in the 10% AEP (10-yr) event
Tank and talab storage	No net loss of flood storage below the MWL in the basin, measured against the earliest available survey
Outfalls	Functioning under the joint and outfall-closed cases of Chapter 5

Commentary. The building and road levels repeat Chapter 6, so that the basin plan and the site designs aim at the same outcome. The 0.2% AEP for critical facilities, the 6-hour ponding drain time and the no-net-loss rule for tank storage have no direct precedent and are set by this Manual. The drain time reflects what residents notice most after a storm. The no-net-loss rule reflects a loss of storage that has been reported but rarely measured. Jammu and Kashmir's storage is in its lakes and nambals more than in tanks. Wular (18,900 ha, designated in 1990), Hokera or Hokersar (1,375 ha, 2005), Surinsar–Mansar (350 ha, 2005), Hygam (802 ha, 2022) and Shallabugh (1,675 ha, 2022) are its Ramsar sites (MoEFCC, 31 January 2024; WUCMA gives Wular's area as 13,000 ha and the Wildlife Department Hygam's as 7.62 km², conflicts); Dal covers 20.37 km² in a catchment of about 314 km² (2024); and the wetlands of the Kashmir valley were put at about 42,661 ha in 755 water bodies (as quoted by the National Green Tribunal). Seven wetlands, Hokersar, Shallabugh, Hygam, Freshkoori, Kranchoo, Chatlam and Manibugh, have been game reserves since Order No. 710-C of 17 July 1945 and are now wildlife conservation reserves; the J&K Wetland Authority was constituted on 25 November 2020, but no wetland had been notified under Rule 4 of the Wetlands Rules 2017 by September 2024, and the brief document for Wular approved for notification in 2022 has not been found notified. In the Jammu plains the storage is in the 365 ponds of the Kandi, 249 in Jammu and 116 in Kathua district, of which 165 are perennial (CGWB), and in the talabs (तालाब; تالاب; Kashmiri *talāv*, pond or tank) that the Jammu Master Plan 2032 would revive for recharge, while its old town talabs are lost. The losses are visible on the ground and in the records: on 13 November 2026 the National Green

> Tribunal found the wetland areas taken from revenue records "insufficient" and asked for the area that exists on the ground (as reported), and a rakh near Baramulla was reported "not existing on the spot" (as reported). No survey of the flood-storage volume of any lake, nambal or talab, or of any floodplain inside a ULB, was found.

11.7 Modelling and scenarios

11.7.1 **Model.** Each BSMP shall use a coupled 1D–2D hydraulic model of:

- the minor system;
- the major (overland) system;
- rivers, canals and tanks; and
- the outfalls.

Methods shall follow Chapter 3. Tidal and river boundaries shall follow Chapter 5.

11.7.2 **Design storms.** The model shall be run for the design storms of Chapter 2, including the 24-, 48- and 72-hour storms, for at least the 50%, 10%, 1% and 0.2% AEPs. Areal reduction shall be applied under Clause 2.7.3.

11.7.3 **Continuous simulation.** Basins with tank cascades shall also be run by continuous simulation (Clause 3.13), using the full IMD gridded daily record where available and at least 30 years, disaggregated by the temporal patterns of Annex 2D. This shows how full the tanks are when the design storms arrive, and how often heavy rain coincides with a closed outfall. The two-step approach of Clause 3.13.5 may be used: a simplified storage model is run for the whole record, and the coupled 1D–2D model of Clause 11.7.1 is run only for the design storms, starting from the tank levels the continuous run gives. A continuous run of the full 1D–2D model is not required.

11.7.4 **Scenarios.** Each BSMP shall model at least:

- (a) **Existing:** existing land use, network, tanks and outfalls;
- (b) **Future, uncontrolled:** future land use under the statutory master plan, with no site controls;
- (c) **Future, controlled:** future land use with the site controls of Chapter 4;
- (d) **Future, with plan:** scenario (c) plus the works of the CIP; and
- (e) **Climate:** scenarios (a) and (d), with the climate factors of Clause 2.8, used unchanged: no projection of heavy rainfall for Jammu and Kashmir has been adopted with a design factor; the State Action Plan on Climate Change (2012) projects rainfall intensity rising by 1–2 mm/day and annual rainfall by 5% to 13%, and by up to 50% in parts, by the 2030s, without a design factor, and a revised plan is reported in draft (2026, as reported); observed trends are mixed, with annual and spring rainfall falling at several valley stations (Zaz et al., 2019) and a slight rise in Srinagar's extreme indices (Dar et al., 2021); and in the Jammu division the storms already on record, 380 mm at Jammu on 27 August 2025 among them, exceed the zone-7 design depths before any factor is applied, so that the larger correction there is to the base value (Clause 2.3.6(h)), which is a reason to keep the factors, not to reduce them; in snow-fed basins of sub-area JK-D the climate scenario adds no rainfall factor, and the glacial-lake, debris-flow and landslide-dam hazards of Clause 11.3.3 are mapped instead.

11.7.5 **Calibration.** The model shall be calibrated and validated under Clause 3.15, using at least two of the 3–10 September 2014 (599.8 mm at Qazigund in the four days to 6 September and 698.6 mm at Katra in 72 hours, Ray et al., 2015; the Jhelum at Ram Munshi Bagh at its high flood level on 8 September, 1,588.99 m or 1,589.65 m in CWC's lists of 2022 and 2018, as transcribed by SANDRP; 262 km², 34% of the Srinagar planning area, flooded), 26–27 August 2025 (380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30 IST on 27 August, IMD, with the Tawi at Sidhra at a new high flood level of 321.1 m, as reported), 1 August 2019 (Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar waterlogged after 26.4 mm, as reported), 7–10 September 1992 (the Chenab at Akhnoor at its high flood level of 324.29 m on 10 September, CWC as transcribed by SANDRP, and 61 ft on the I&FC gauge, as reported) and 25 September 1988 (316.2 mm at Batote, 292.4 mm at Katra and 270.4 mm at Jammu, IMD) events where data exist.

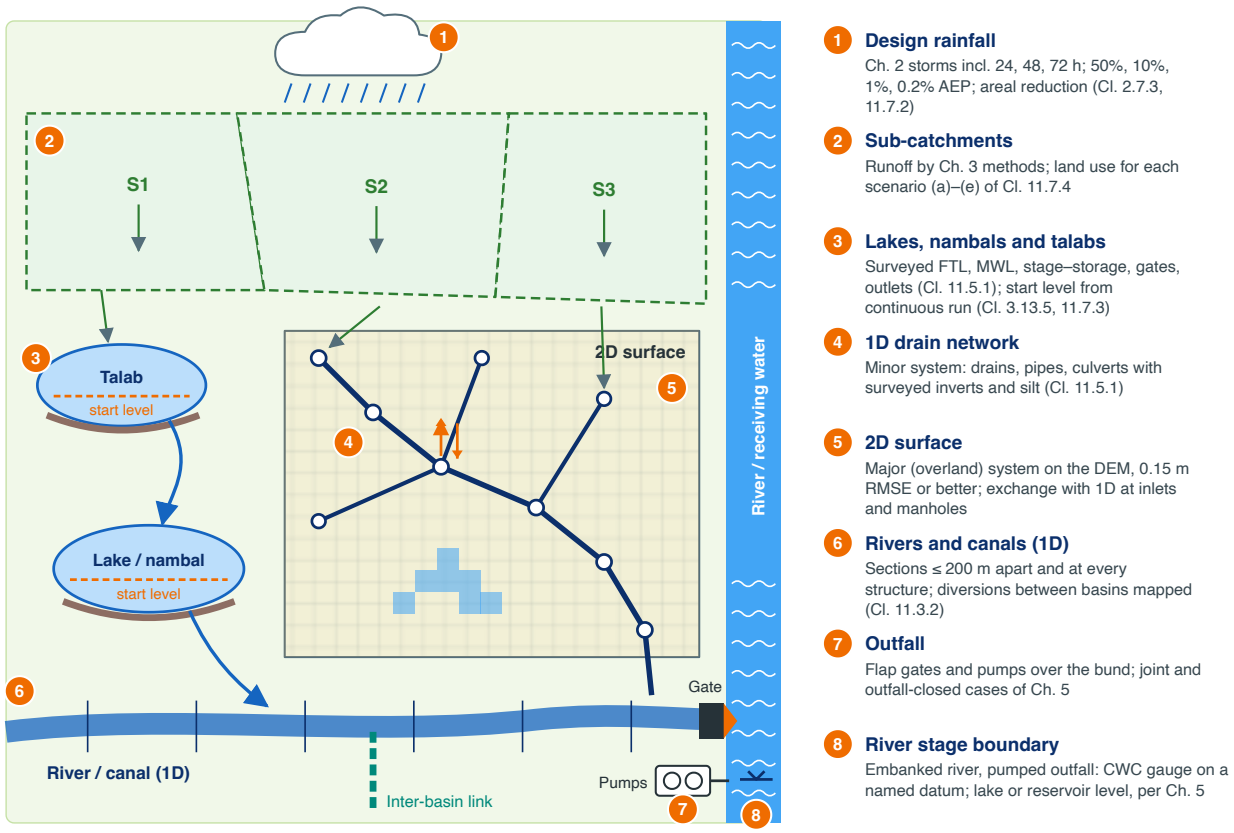

Figure 11.2 — Elements of the BSMP model required by Clause 11.7: sub-catchments, the 1D drain and channel network, the 2D surface, tanks and talabs with starting levels from continuous simulation, and the tidal or river boundary at the outfall (schematic, not to scale). Original drawing for this Manual, adapted from common coupled 1D–2D urban flood modelling practice.

> **Commentary.** Scenario (b) against scenario (c) shows what the site rules achieve on their own. Scenario (d) shows what the public works add. This comparison is also the evidence base for notifying flood-sensitive catchments (Clause 4.5.4) and for setting a stricter basin release rate (Clause 11.8.3).

11.8 Options, outputs and the Capital Improvement Programme

11.8.1 **Options hierarchy.** Options shall be considered in the following order, the basin-scale form of the hierarchy in Clause 1.2:

1. **Protect and restore storage:** talabs, tanks, marshes and floodplains, including desilting to the original bed and recovering encroached area (Chapter 7);
2. **Regional retention and detention**, sited by modelling so that releases do not coincide with the main-stem peak (Clause 4.13);
3. **Conveyance** upgrades to drains, canals and culverts;
4. **Outfall works:** flap gates, penstocks and pumping stations on the outfalls of Srinagar and the other embanked towns of the Kashmir valley floor to the Jhelum, the flood spill channel and the lakes, with their duty points, standby power and storage sized together for the outfall-closed case, and with every dewatering station, permanent or mobile, entered on the drain register; gates, with storage or pumping behind them, on the outfalls

of Jammu to the Tawi, of Akhnoor to the Chenab, of Kathua to the Ujh and of Samba to the Basantar where a river in flood can close them; debris racks, sediment traps and debris basins where the khads of the Kandi and the nallahs of the hill towns enter the built-up area, with ramps for the machines that empty them, and the removal of muck dumped in the khads and nallahs; drop structures, chutes, energy dissipators and protected outfalls where steep drains reach a khad or river, never an unprotected slope; sediment traps, screens and the interception of dry-weather flow before every outfall to Dal, Nigeen, Anchar, Wular and the flood-absorption marshes, and the separation of sewage before the outfalls to the Jhelum, the Chunt Kol and the Tawi; and the operating rules of the Dal Gate and of the regulating gates planned at Hokersar (as reported), and the release rules of Baglihar, Salal and the Tawi barrage, agreed with I&FC, LCMA, JKSPDC and NHPC;
5. **Property-level protection** where works cannot reach the level of service; and
6. **Non-structural measures:** flood warning (for example IMD district rainfall warnings and nowcasts issued by the Meteorological Centre Srinagar, the CWC flood forecasts for the Jhelum at Khanabal, Sangam, Ram Munshi Bagh and Safapora and its level monitoring on the Tawi at Jammu and the Chenab at Akhnoor, the flood-declaration and danger stages that I&FC announces on its gauges, notice of releases from Baglihar, Salal, Dul Hasti and the Tawi barrage to the towns downstream, and the emergency operation centres of J&K SDMA and the districts), flood-hazard zoning, emergency planning and public information.

11.8.2 **Option assessment.** Each option shall be assessed for:

- reduction in flood risk (buildings and people flooded; expected annual damage);
- capital and 30-year maintenance cost;
- land required;
- effect on groundwater recharge on the Kandi fans of Jammu, Samba and Kathua, the preferred recharge zone, from whose groundwater Jammu is supplied (the three districts were Safe in every assessment from 2017 to 2024, CGWB), the waterlogging of the Sirowal and of the Kashmir valley floor, where the water table stands 0–2 m below the ground and wells flow on both sides of the Jhelum, so that recharge there adds to flooding (in Srinagar "there is no scope for artificial recharge", CGWB), the stability of hill slopes, where water put into the ground raises the pore pressure, as at Pernote in 2024 and Thathri in 2023, the springs that feed the lakes and towns and the ponds of the Kandi, the zamindari khuls that carry hill runoff, and the quality of the groundwater, in which nitrate exceeded 45 mg/L in 9.2% of the samples of 2024 (CGWB), and of the lakes, nambals and rivers that the runoff reaches (Chapter 8);
- effect on downstream basins and the receiving river, khad, nallah, lake, nambal, flood spill channel or canal; and
- who benefits.

11.8.3 **Basin release rates.** Where scenario (c) does not meet the level of service, the BSMP may set a basin-specific **permissible site discharge** (m³/s/ha) stricter than Chapter 4, by AEP and sub-catchment. The rate takes effect under the notification procedure of Clause 4.5.4.

11.8.4 **Outputs.** Each BSMP shall produce:

- (a) flood hazard maps (extent, depth, velocity, hazard class) for the 10%, 1% and 0.2% AEPs, existing and future-with-plan. The **1% AEP future-with-plan map** becomes the reference map for floor levels (Chapter 6) and setbacks (Chapter 7);
- (b) recommended flood-sensitive catchments and any basin release rates (Clauses 4.5.4 and 11.8.3);
- (c) regional facility sites, with storage volumes, land needs and the sites they serve;
- (d) the fee-in-lieu unit rate for the basin (Clause 4.13.3);
- (e) the **Capital Improvement Programme**: works ranked by risk reduction per rupee, with cost, phasing and agency;
- (f) a pre-monsoon **maintenance programme**: desilting, gate and pump testing, and tank operating rules (Chapter 10); and
- (g) monitoring needs: new rain gauges, level sensors and flood-mark survey points.

Commentary. Restoring storage comes first because the outfalls of the Kashmir valley floor are closed in the wettest weeks, and because the storage that once took the Jhelum's floods is in lakes and marshes that the towns have filled. The Srinagar Master Plan 2035 records that its predecessor of 1971–91 "triggered growth … mostly in low lying areas, wetlands and flood absorption basins adjacent to Flood Spill Channel", and that the wetlands to the south, west and north-west "have been acting as flood retention basins"; Hokersar has shrunk from 18.75 km² to about 13 km² and is said to have lost nearly half of its flood storage, Wular from 157.74 km² in 1911 to 86.71 km² in 2007, and 37% of Narkara has been built over (all as reported); and the flood spill channel had silted from 17,000 to 4,000 cusecs by 2014 (CAG). In 2014 34% of the Srinagar planning area was flooded. Pumps alone cannot replace that storage: the 104 permanent dewatering stations reported in 2026 lift about 65 m³/s from about 767 km², some 0.3 mm of runoff an hour (this Manual's reading). In Jammu the khads are the storage and the flow paths, and they "hold greater importance in safeguarding the city from flash floods" (Jammu Master Plan 2032, §2.4), while most of the city's old talabs, Rani Talab, Talab Khatikan and Talab Tillo among them, survive only as names. On the valley floor storage means surface storage that drains to the pumps, never a pond that soaks into ground already saturated, on a hill slope a lined tank or a terrace (Clause 8.8.1), and the rainwater-harvesting proposal that UBBL-2021 requires on every plot of 100 m² or more is the first of it. The storms are large for drains with no stated design basis: 380 mm fell at Jammu in the 24 hours to 27 August 2025 (IMD). Conveyance upgrades on their own move water faster to an outfall that the Jhelum in flood closes, as in September 2014, to a lake or nambal whose outlet the river can shut, to a khad whose bed and banks shift with the boulders and muck it carries, or to an outfall limited by the capacity of its gate or pumping station, which across Srinagar is about 2,300 cusecs, some 65 m³/s, for a drainage area of about 767 km² (as reported; about 0.3 mm of runoff an hour, this Manual's reading). Groundwater in Jammu and Kashmir calls for recharge on the Kandi fans and for restraint everywhere else. All 149 assessment units of the Union Territory were Safe in 2024, at a stage of extraction of 22.28%; Srinagar Urban had been Semi-critical at 73.85% in 2022; and Jammu, Samba and Kathua, whose towns draw on groundwater, have been Safe in every assessment from 2017 to 2024 (CGWB). The boulder gravels of the Kandi, with water 7–30 m below the ground, are "a very good medium for the recharge", while the finer Sirowal below the spring line has water at 2–5 m, waterlogging and flowing wells (CGWB). On the Kashmir valley floor the water stood 0–2 m below the ground over the central and south-western valley, artesian wells flow on both sides of the Jhelum, and in Srinagar "there is no scope for artificial recharge to ground water" (CGWB), so recharge there only adds to flooding. On the hill slopes water put into the ground can bring them down: at Pernote the Geological Survey of India found that runoff entering cracks "may have developed the pore pressure" (2024). Springs (nāg) feed the lakes and towns of the valley, and the Kandi holds 365 ponds, 165 of them perennial (CGWB). Nitrate exceeded 45 mg/L in 9.2% of the samples of 2024, in Baramulla, Jammu, Kathua, Kupwara, Rajouri and Samba (CGWB). The Water Resources Act 2010 lets the Government notify areas where extraction is controlled (ss.111–112), and none has been found notified, and its rainwater-harvesting power is advisory (s.122). This is why recharge, slope stability, springs, waterlogging and groundwater quality are all assessment criteria. This Manual ranks projects by risk reduction per rupee so that limited budgets go first where most people are protected.

11.9 Integration with land-use planning

11.9.1 An approved BSMP shall be incorporated into the statutory land-use plan: the master plans of the local planning areas notified under the Jammu and Kashmir Development Act 1970, among them the Srinagar Master Plan 2035 and the Jammu Master Plan 2032 and its revision, with their zonal development plans and regulations and UBBL-2021; the conservation plans of LCMA for Dal and Nigeen and of WUCMA for Wular; and the layouts and buildings permitted under them. In particular:

- (a) regional facility sites, restored tank flood storage, and major flow paths shall be **reserved** in the plan;
- (b) the 1% AEP hazard map shall be shown, and Chapter 7 setbacks applied to it;
- (c) land in hazard classes H5–H6 in the 1% AEP event shall not be zoned for new habitable development; and

- (d) the open space of layouts within a basin should be located, where possible, to form part of the major flow paths or regional storage shown in the BSMP.

11.9.2 Where a land-use plan is revised before a BSMP is approved, the planning authority shall use the best available flood mapping and record the BSMP as pending.

> Commentary. Jammu and Kashmir draws its watercourse lines from three reference lines, and no drainage-flood line. UBBL-2021 bars development within 50 m of the edge of the bank of the Chenab, the Jhelum, the Tawi, the Ravi, the Ujh "or any other river/khad", 30 m of the listed lakes, among them Mansar, Surinsar, Wular, Nigeen and Manasbal, and 20 m of unlisted rivulets and canals, "or as per building regulation whichever is more" (cl. 7.12(b)), and keeps a green buffer of at least 30 m "from the highest water level" along nallahs and rivers (cl. 5.2.5); the Srinagar Master Plan 2035 sets lake, nallah and wetland buffers from the edge, from 20 m to 200 m (Tables 8-2 and 8-3; 100 m for unlisted wetland reserves, §8.2.3), and records 125 km² of its planning area as undevelopable and 136.50 km² as vulnerable on the flood zonation of I&FC (§4.2); the Jammu Master Plan 2032 sets its buffers from the Full Tank Level, 50 m (30 m in built-up areas) on the Tawi, the Devak and the Basantar, 15 m on the Balol, Thather and Bhalwal khads and 5 m elsewhere (§7.3.3), lines that UBBL's 50 m overrides where the bye-laws apply; and the High Court holds 200 m around Dal (2002, as quoted) and Wular (2020, as reported). Building in flood-prone areas is left to I&FC "or the flood zonation maps notified by the department from time to time" (UBBL-2021, cl. 7.12(a)), none of which has been found. The Flood Plain Zones Act 2005 has not been found brought into force, and no flood basin has been found declared under Part VI of the Water Resources Act 2010. The Jammu Master Plan proposes to release land recorded as Gair Mumkin Khad, more than 30% of JDA's land, outside the "true Khad" to be fixed with I&FC (§12.2.3); this Manual requires any release to follow a hydraulic study of the functional khad at the 1% AEP flow with its sediment bulking (set by this Manual). These are watercourse lines, not drainage-flood lines: where a flood basin is notified under Part VI of the Act its restrictions govern; until then the mapped design flood line of Chapter 7 applies (set by this Manual), the widest of the statutory lines governs, and the hydraulic corridor and setback zones of Chapter 7, with a Zone 1 of at least 15 m, apply only where nothing wider binds, as this Manual's proposal. A BSMP gives the master plans the 1% AEP drainage-flood map, including the khads and nallahs that no plan yet covers, and the buffer widths of Chapter 7, that they need. Using open space land as storage or flow path has no direct precedent; this Manual adopts it because UBBL-2021 already requires public open spaces of more than 500 m² to capture and use their storm water (cl. 10.4), recharge in parks, parking areas, plazas and playgrounds (cl. 10.5) and permeable paving for the open parking of group housing (Table 10-1), and the Srinagar Master Plan 2035 asks for detention and retention as source controls under its stormwater performance standard (§13.3), but no rule sets a detention volume or a peak-runoff limit; storage placed in a layout's open space builds on these duties, and because that land still serves as open space, the storage must stay usable as one; on the Kashmir valley floor it is shallow surface storage that drains to the outfall or the pumps, never an infiltration basin, and on a hill slope it is a lined tank or a shallow terrace (Clause 8.8.1). Placing it on the flow path costs the developer nothing extra and gives the basin storage it would otherwise have to buy.

11.10 Consultation and publication

11.10.1 A draft BSMP shall be published for public comment for at least **60 days**, with public meetings in each affected local body.

11.10.2 After approval, the following shall be published as open data:

- the model files;
- the flood hazard maps;
- the data of Clause 11.5.1, except security-sensitive asset details; and
- the CIP.

They shall also be shown on a public map viewer.

> Commentary. Publishing the maps lets buyers, lenders, insurers and residents see flood hazard before they build or buy. Publishing the model lets designers use the same boundary conditions as the Authority, so site designs and the basin plan stay consistent. This matches the publication approach of Chapter 10.

11.11 Approval, review and reporting

11.11.1 **Approval.** BSMPs shall be approved by the State Stormwater Technical Committee (Chapter 1), after review of the model and of the public comments.

11.11.2 **Review.** Each BSMP shall be reviewed:

- every **10 years**;
- within **2 years** of an event exceeding the 1% AEP design depth in the basin (Clause 2.14); and
- when the statutory land-use plan is revised.

11.11.3 **Annual report.** The Lead Authority shall publish an annual implementation report before each SW monsoon (by 31 May). The report shall show:

- CIP progress;
- the fee-in-lieu ledger (Clause 4.13.4);
- maintenance completed; and
- any flooding against the levels of service.

11.12 Interim arrangements

11.12.1 Until a BSMP is approved for a basin:

- (a) all site criteria of Chapters 4 to 8 apply in full;
- (b) regional detention and fee-in-lieu under Clause 4.13 are not available, except the holding of fees under Clause 4.5.6.3;
- (c) floor levels and setbacks use the best available mapping, and the methods of Chapters 6 and 7 where no mapping exists; and
- (d) public drain projects shall include a basin-level check that their outfall and downstream reaches can take the design flow under the Chapter 5 tailwater cases.

References (chapter)

- Central Ground Water Board. *Dynamic Ground Water Resources*, Jammu and Kashmir, 2022 and 2024 (stage of extraction; assessment units); *Ground Water Year Book, Jammu and Kashmir, 2021–22* (depth to water); aquifer mapping (NAQUIM) reports for the Kashmir valley and the Jammu plains (Kandi and Sirowal; Kandi ponds); and the district booklet for Srinagar ("no scope for artificial recharge").
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- National Green Tribunal. O.A. No. 239 of 2024 (wetlands of Kashmir), report of the Forest, Ecology and Environment Department of 9 September 2024 (Wetland Authority; Wular; wildlife conservation reserves) and order of 13 November 2026 (as reported). https://www.greentribunal.gov.in/
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Annexes and forms

Annex / Form	Content
11A	BSMP terms of reference template
11B	Basin lists and boundaries for Tier A bodies
11C	Depth–damage curves for Jammu and Kashmir building types

Annex / Form	Content
11D	BSMP data and model publication standard
Form 11-1	Annual implementation report

ANNEXES TO CHAPTER 1

Policy, Applicability and Adoption

These annexes support Chapter 1. They hold the lists and maps that define where the Manual applies, the model text of the Policy Supplement and of the legal instruments that would give the Manual effect, and the two forms an Applicant files under Chapter 1. The Manual is a draft; it is not adopted by any government or agency: model legal text is offered for consideration by a competent authority and is not in force, and the forms are draft forms. An annex marked "To be prepared" states the data it needs and the rule to use until it is published (Clause 1.11.5).

Annex 1A — List of Tier A authorities, with the boundaries of the Municipal Corporations and of the local planning areas of Srinagar and Jammu notified under the Jammu and Kashmir Development Act, 1970

Supports Clauses 1.6.1 to 1.6.5 of Chapter 1.

1A.1 Clause 1.6.1 defines Tier A by class of authority. Table 1A.1 sets out the classes, and the authorities named in the clause, as Chapter 1 defines them. Every authority not in Table 1A.1 is Tier B (Clause 1.6.2).

Table 1A.1 — Tier A authorities as defined in Clause 1.6.1

Item	Tier A authority	Clause
(a)	Srinagar Municipal Corporation (SMC) and the Jammu Municipal Corporation (JMC)	1.6.1(a)
(b)	Every Approving Authority within the Srinagar Local Planning Area (SRO-429 of 21 October 2014), including SDA, SMC and the Municipal Councils and Committees in that area	1.6.1(b)
(c)	Every Approving Authority within the Jammu Local Planning Area, including JDA, JMC and the Municipal Councils and Committees in that area	1.6.1(c)
—	A Tier B authority that opts into Tier A by council resolution, or that the Government notifies as Tier A	1.6.4

1A.2 Whatever the tier, the design-aid route and the alternatives of Clause 1.7 are not available in a flood-sensitive catchment (Clause 1.6.5; Annex 1B).

To be prepared. This annex will contain the full list, by name, of every Approving Authority within the Srinagar and Jammu Local Planning Areas, with the date from which each is Tier A, and the boundaries of those areas and of the two Municipal Corporations as a map and as a GIS layer. It needs the notified local planning areas and their master plans: the Srinagar local area of SRO-429 of 21 October 2014 (SMC, the Budgam, Ganderbal, Pampore and Khrew local bodies and 160 villages in six districts) and the Srinagar Master Plan 2035, and the Jammu local area and the Jammu Master Plan 2032 with its amendments and the revision reported pending (H&UDD, the Town Planning Organisations, SDA and JDA); the current list and boundaries of the Municipal Corporations, Councils and Committees (H&UDD); the areas in which LCMA and WUCMA give no-objection certificates; and the district and tehsil boundaries (Revenue Department, Survey of India). Until it is published, the tier is decided by the classes in Clause 1.6.1 and recorded on Form 1-1, and the Authority confirms it at the pre-application stage (Clause 1.5.9).

Table 1A.2 — Register of Tier A authorities (layout)

No.	Authority	Class (Municipal Corporation / Municipal Council / Municipal Committee / SDA / JDA / other Development Authority / other)	District	Basis (Clause 1.6.1(a), (b), (c) or 1.6.4)	Tier A from (date)	Notification or resolution reference
1						
2						
3						

1A.3 The Municipal Corporation and local-planning-area boundary map shall be published as open data in a machine-readable format (Clause 10.17.4), with the date of the notification it shows.

Annex 1B — Maps of flood-sensitive catchments

Supports Clauses 1.4, 1.6.5 and 1.10.3(d) of Chapter 1, and Clauses 4.5.3 and 4.5.4 of Chapter 4.

1B.1 The flood-sensitive catchments are listed in Clause 4.5.3.2. Table 1B.1 repeats that list. The maps of this annex and the boundaries of Annex 4A are the same data set and shall be issued together.

Table 1B.1 — Flood-sensitive catchments listed in Clause 4.5.3.2

Item	Catchment	Extent as described in Chapter 4
(a)	Srinagar behind the Jhelum embankments	The land of the SMC and SDA area that drains to the Jhelum, the flood spill channel and the city channels through gated outfalls and pumping stations, 89 counted in 2019 (Srinagar Master Plan 2035) and 104 permanent dewatering stations reported in 2026 (as reported); the Dal–Nigeen catchment, which drains through the Dal Gate and the Nallah Amir Khan to Gilsar, Khushalsar and Anchar; and the low land of the west-bank flood basins, from Lelhar and Lasjan to Rakh-e-Arth, Narkara and Hokersar. Almost 34% of the planning area, 262 km², was flooded in 2014 (Srinagar Master Plan 2035, §4.2), when the Jhelum reached 1,588.99 m at Ram Munshi Bagh (CWC data as transcribed by SANDRP); the water table is 0–2 m below ground (CGWB), and 26.4 mm of rain waterlogged the city centre on 1 August 2019 (as reported)
(b)	Anantnag–Bijbehara–Pampore on the upper Jhelum	The land of Anantnag, Bijbehara, Pampore and the other towns of the upper Jhelum that drains to the Jhelum between Sangam and Srinagar and to the nallahs that join it there; the CWC sites at Khanabal and Sangam set new highest levels in 2014 and 2025 (1,595 m at Sangam on 4 September 2014; 1,595.43 m at Khanabal on 3 September 2025; CWC data as transcribed by SANDRP), Anantnag received 180 mm on 4 September 2014 (Ray et al., 2015), and wells below 25 m in Anantnag district flow (CGWB)

Item	Catchment	Extent as described in Chapter 4
(c)	Sopore–Baramulla–Sumbal–Bandipora on the lower Jhelum and Wular	The land of Sopore, Baramulla, Sumbal and Bandipora that drains to the Jhelum below Srinagar, to Wular, the valley's flood basin, or to the flood spill channel; the outlet of Wular at Ningli carried about 20,000 cusecs before 2014 (as reported), the Jhelum at Safapora reached 1,582.1 m in 2014 (CWC data as transcribed by SANDRP), and 81.8% of the observation wells of Baramulla district stood within 2 m of the surface in 2021–22 (CGWB)
(d)	Jammu's khads and the Tawi	The land of the JMC and JDA areas that drains to the Tawi and to the khads that cross the Kandi, among them the Balol, Thather and Bhalwal khads and the Devak, including the land recorded as "Gair Mumkin Khad" (Jammu Master Plan 2032, §12.2.3) and the localities flooded in 2025 and 2026, among them Gangyal, Trikuta Nagar, Nanak Nagar, Rajinder Nagar, Muthi and Bantalab (as reported); Jammu recorded 380 mm on 27 August 2025 (IMD) and the Tawi at Sidhra rose to 321.1 m (CWC data as transcribed by SANDRP)
(e)	Kathua–Hiranagar on the Ujh and the Ravi, and Samba on the Basantar	The land of Kathua and Hiranagar that drains to the Ujh, the Ravi and their khads, and of Samba that drains to the Basantar and its khads; the Ujh at Panjtirthi carried 59,750 cusecs in late August 2025 against an alert of 48,000 cusecs (as reported), more than half the wells of Kathua flow (CGWB), and the Basantar below Samba is a polluted stretch of Priority V (CPCB, 2025)
(f)	R.S. Pura–Bishnah–Arnia in the Sirowal	The land of R.S. Pura, Bishnah, Arnia and the other towns of the Sirowal below the spring line, which drains across flat land towards the international border, where the water table is 2–5 m below ground, with waterlogging in the south-west and flowing wells (CGWB), and whose drains run to streams that cross into Pakistan within about 10–30 km, beyond which the tailwater is not monitored (NEER reading)
(g)	Akhnoor on the Chenab	The land of Akhnoor that drains to the Chenab below the Salal reservoir; the Chenab at Akhnoor reached 61 ft on the gauge of I&FC in September 1992 and 43 ft on 3 September 2025, against a danger level of 35 ft, and its CWC highest level is 324.29 m (10 September 1992) (CWC data as transcribed by SANDRP; as reported)
(h)	Udhampur on the Tawi and the Devak, and Katra	The land of Udhampur that drains to the Tawi and the Devak, and of Katra that drains to the khads below it; Udhampur IAF recorded 63 cm on 27 August 2025 (IMD), Katra recorded 488.6 mm in 48 hours and 698.6 mm in 72 hours in September 2014 (Ray et al., 2015), and a landslide on the Vaishno Devi route killed 30 to 35 people on 26 August 2025 (as reported)
(i)	Hill towns of the Chenab valley: Ramban–Batote–Banihal and Doda–Thathri–Kishtwar	The land of Ramban, Batote, Banihal, Doda, Thathri and Kishtwar that drains to the Chenab and its tributaries, on the Murree and Siwalik clay–sandstone slopes, or lies on the slopes of the subsidence and sliding zones of Pernote (2024), Duksar and Thathri Nai Basti (2023) (GSI; JKPCC; as reported; Commentary to Clause 4.11); Batote holds the Union Territory's highest 24-hour fall in the IMD tables to 2012, 316.2 mm (25 September 1988), and the Chenab rose above its highest levels at Prem Nagar, Neeru and Kalnai in 2025 (CWC data as transcribed by SANDRP)
(j)	Notified catchments	Any catchment notified under Clause 4.5.4

To be prepared. This annex will contain a map of each catchment in Table 1B.1 at a scale fit for deciding whether a plot lies inside it, and the same boundaries as a GIS layer. It needs catchment boundaries drawn from a digital elevation model and the drain network (SMC, JMC, UEED, the Town Drainage wings, SDA, JDA, the Municipal Councils and Committees of the towns listed, Survey of India); the drains, pumping stations, gated outfalls and sewage interceptions, with their sump levels and the river stage at which each gate shuts, on a stated datum (UEED, SMC, JMC); the gauge zeros of I&FC's feet gauges at Sangam, Ram Munshi Bagh, Asham, Akhnoor and on the Tawi, and the CWC levels at Khanabal, Sangam, Ram Munshi Bagh, Safapora, Akhnoor and Sidhra with their datums (I&FC, CWC); I&FC's flood zonation of the Srinagar planning area and the 25-year floodplain from Lelhar to Lasjan (Srinagar Master Plan 2035); the flood marks of 2014 and 2025 along the Jhelum, the Tawi, the Chenab, the Ujh and the Basantar, and the embankment breaches of 2014 (I&FC, J&K SDMA, the Deputy Commissioners); the "Gair Mumkin Khad" land and the "true Khad" of the Jammu Master Plan 2032 (Revenue Department, JDA, I&FC); the levels and gate rules of the Dal Gate, Wular, Salal, Baglihar, Ranjit Sagar and the Tawi barrage (LCMA, WUCMA, the operators); and the subsidence, landslide and debris-flow maps of the hill towns (GSI, J&K SDMA [TBC]). Anantnag's side valleys, Kupwara, Handwara, Ganderbal, Rajouri, Poonch, Reasi and the high towns of sub-area JK-D are candidates for notification under Clause 4.5.4 once their catchment boundaries and flood record are documented [TBC]. The buffers of the UBBL-2021, of the master plans and of the High Court's orders round the rivers, khads, lakes and wetlands are governed by Chapter 7 and by the instruments that bind there rather than by this list. Until it is published, the Authority decides at the pre-application stage whether a site lies in a listed catchment, from the best boundary available, and the decision and its basis are recorded on Form 1-1 and in the drainage report (Clauses 1.5.9 and 1.11.5).

Table 1B.2 — Attributes of the flood-sensitive catchment layer (layout)

Field	Content	Unit or format
catchment_id	Unique identifier	text
name	Catchment name	text
basis	Clause 4.5.3.2 item (a) to (i), or the notification under Clause 4.5.4	text
notification_ref	Gazette notification number, where notified	text
notified_on	Date of notification	date
applies_from	Date from which the rule applies to applications (Clause 4.5.4.2, step 5)	date
boundary_source	Source and date of the boundary	text
area_km2	Catchment area	km²

Annex 1C — Policy Supplement: text of alternatives S-1 to S-5 and model council resolution

Supports Clauses 1.6.3, 1.6.5 and 1.7.1 to 1.7.3 of Chapter 1.

Model text for consideration by a competent authority. Not in force. The text below shows how the Policy Supplement of Clause 1.7 could be written. It has no effect unless and until it is issued by the Government and adopted by an Approving Authority under Clause 1.7.3.

Part 1 — General provisions

P1.1 **Scope.** This Supplement sets out alternatives S-1 to S-5 to the requirements of the Jammu and Kashmir Stormwater Design Manual (the Manual) named in each alternative. An alternative applies within the area of an Approving Authority (the Authority) only from the date on which the Authority adopts it under P1.3.

P1.2 **No lower criterion.** No alternative lowers any criterion of the Manual. S-1 and S-2 are simplified methods for meeting the same criterion (Clause 1.7.3(a)).

P1.3 **Adoption.**

- (a) A Tier B authority adopts an alternative by council resolution in the form of Part 3, and sends a copy to the State Stormwater Technical Committee (the Committee) within 30 days of the resolution.
- (b) A Tier A authority adopts an alternative only after the Committee has concurred in writing.
- (c) The Authority publishes the alternatives it has adopted on its website and in the register of Clause 10.17.

P1.4 **Retention.** No alternative replaces the retention requirement (Annex 2E depth), except where fee-in-lieu under S-5 funds equivalent retention in the same basin (Clause 1.7.3(d)).

P1.5 **Tables.** The tables used by S-1, S-2 and S-3 are those issued by the Committee, and are reviewed with Chapter 2 of the Manual (Clauses 1.7.3(e) and 2.14). An alternative that depends on a table cannot be used until that table is issued.

P1.6 **Record.** An Applicant who uses an alternative states it on Form 1-1 and in the drainage report, with the resolution or concurrence under which it was adopted.

Part 2 — The alternatives

S-1 — Design-aid route for storage

S-1.1 *Replaces:* storage sized by a hydrograph method under Chapter 3.

S-1.2 *Alternative:* retention and detention volumes may be taken from the unit-storage tables issued for Annex 4B (m³ per ha, by rainfall zone, hydrologic soil group and impervious fraction) and the compliance calculator, by the method of Clause 4.14.2.

S-1.3 *Eligibility:* sites of 2 ha or less outside flood-sensitive catchments, and of 0.5 ha or less within them (Table 1.2; Clause 4.14.1).

S-1.4 *Conditions:* the post-development imperviousness used shall be that shown on the approved plans; the outlet, spillway, RWH accounting and safety provisions of Clause 4.14.2 apply; the compliance calculator may be the sole calculation (Table 1.1).

S-2 — Permissible site discharge (PSD)

S-2.1 *Replaces:* the release rate $Q_{post}(T) \le 0.9 \times Q_{pre}(T)$ computed for the site (Clause 2.11.2).

S-2.2 *Alternative:* the release rate for each AEP may be taken as the tabulated unit-area release rate for the site's zone and AEP, multiplied by the site area. The tabulated rates are derived from the $0.9 \times Q_{pre}$ rule (Table 1.2).

S-2.3 *Eligibility:* any site outside a flood-sensitive catchment.

S-2.4 *Conditions:* storage is then sized to hold every duration of Clause 2.5.2 at the PSD; drawdown, minimum orifice and spillway rules of Chapter 4 apply unchanged.

S-3 — Fixed-width waterbody setback

S-3.1 *Replaces:* the waterbody setback extended to the mapped 1% AEP flood extent plus margin (Chapter 7).

S-3.2 *Alternative:* where no 1% AEP extent is mapped, the setback shall be the fixed width for the class of waterbody in the table of Clause 7.4.6 (and Annex 7B), measured as in Clause 7.4.3.

S-3.3 *Eligibility:* waterbodies with no mapped 1% AEP extent.

S-3.4 *Conditions:* no setback under this alternative is less than the Zone 1 minimum of Clause 7.4.7 (Clause 1.10.3(c)); the no-fill zone of Chapter 7 applies; where a 1% AEP extent is later mapped and adopted, the mapped setback applies to new applications.

S-4 — Downstream screening checklist

S-4.1 *Replaces:* downstream analysis by hydraulic model under Chapter 5.

S-4.2 *Alternative:* the Applicant completes a screening checklist of downstream capacity and known flooding, covering at least the conditions of Clause 5.3.4: that the receiving public drain has documented capacity for its minor-system design flow (Chapter 6), and that no flood-prone location is recorded within 500 m downstream. A hydraulic model under Chapter 5 is required only where the screen fails.

S-4.3 *Eligibility:* sites of less than 1 ha, outside flood-sensitive catchments, not discharging to a tidal outfall.

S-4.4 *Conditions:* the checklist is signed by the registered professional who signs the drainage report (Clause 10.6); flood-prone locations are those recorded by the local body, the Deputy Commissioner and the District Disaster Management Authority, J&K SDMA, I&FC, UEED or the Town Drainage wings (Clause 5.3.3(d)).

S-5 — Fee-in-lieu toward regional storage

S-5.1 *Replaces:* on-site detention under Chapter 4.

S-5.2 *Alternative:* all or part of the detention requirement may be met by a fee-in-lieu toward a regional detention facility or restored talab or tank storage identified in the basin plan (Clause 4.13.1).

S-5.3 *Eligibility:* sites in a basin for which a basin plan has been notified (Table 1.2).

S-5.4 *Conditions:*

- (a) the conditions of Clause 4.13.2 apply, including interim on-site detention until the regional facility or restored tank is operational, and retention and WQv treatment on site;
- (b) the fee is computed under Clause 4.13.3 and held in the ring-fenced basin account;
- (c) the volume credited and the fee are entered in the public ledger of Clause 4.13.4; and
- (d) in a flood-sensitive catchment, fee-in-lieu is available only as allowed by Clause 1.10.3(d).

Part 3 — Model council resolution

> **Model text for consideration by a competent authority. Not in force.**

Resolution No. _____ of _____ (name of Municipal Corporation / Municipal Council / Municipal Committee), dated _____

Subject: Adoption of alternatives under the Policy Supplement to the Jammu and Kashmir Stormwater Design Manual.

The Council, having considered the report of the Commissioner / Executive Officer dated _____, and noting that:

- (i) the Jammu and Kashmir Stormwater Design Manual and its Policy Supplement have been given effect by _____ (instrument and date);
- (ii) this local body is a Tier B / Tier A authority under Clause 1.6 of the Manual; and

- (iii) for a Tier A authority, the State Stormwater Technical Committee concurred on _____ (reference _____),

resolves:

1. to adopt the following alternatives of the Policy Supplement within its area, under the conditions of Clause 1.7.3 of the Manual:

Table 1C.1 — Alternatives adopted by this resolution

Alternative	Adopted (Yes / No)	Area to which it applies (whole area, or wards / zones)	Applies from (date)
S-1 Design-aid route			
S-2 Permissible site discharge			
S-3 Fixed-width setback			
S-4 Downstream screening checklist			
S-5 Fee-in-lieu			

2. that no adopted alternative shall apply within a flood-sensitive catchment except as the Manual allows (Clause 1.6.5);
3. that a copy of this resolution be sent to the State Stormwater Technical Committee within 30 days;
4. that the adopted alternatives be published on the local body's website and entered in the register of Clause 10.17; and
5. that this resolution be reviewed when the tables of Clause 1.7.3(e) are revised.

Mayor / President: _____ Commissioner / Executive Officer: _____ Date: _____

Annex 1D — Model UBBL-2021 amendment and model ULB bye-law

Supports Clauses 1.3.1, 1.3.4, 1.11 and 1.12 of Chapter 1.

> **Model text for consideration by a competent authority. Not in force.** The text shows one way the instruments of Clause 1.3.1 could be drafted. Rule and section numbers are left blank.

> **Drafting note D1D.1.** The rule numbers of the Jammu and Kashmir Unified Building Bye-Laws 2021 at which the new rule and the conditions would be inserted, and the enabling sections of the Jammu and Kashmir Development Act, 1970 and the municipal and panchayat Acts, are to be confirmed by the Government's legal advisers. None is stated here.

Part A — Model amendment to the Jammu and Kashmir Unified Building Bye-Laws 2021

A.1 **Short title and commencement.**

- (1) These rules may be called the Jammu and Kashmir Unified Building Bye-Laws (Stormwater Management) (Amendment) Bye-Laws, _____.
- (2) They shall come into force on the date six months after their publication in the Jammu and Kashmir Official Gazette (Clause 1.11.1).

A.2 **Insertion of a new rule.** After rule [_____] of the building bye-laws notified under the Jammu and Kashmir Municipal Corporation Act, 2000 and the Jammu and Kashmir Municipal Act, 2000, the following rule shall be inserted:

> **Rule [_____]. Stormwater management.**
>
> (1) *Definitions.* In this rule, "the Manual" means the Jammu and Kashmir Stormwater Design Manual as notified by the Government, with its annexes and amendments; other words have the meanings given in Clause 1.4 of the Manual.
>
> (2) *Application.* This rule applies to every development for which planning permission, building permit or layout approval is required under these rules.
>
> (3) *Runoff control.* Where a development, over its common plan of development, involves land disturbance of 0.1 ha or more, or new or replaced impervious area of 500 m² or more, the development shall comply with Chapters 4 and 5 of the Manual (retention, detention, downstream and tailwater analysis).
>
> (4) *Provisions for every development.* Every development, whatever its size, shall comply with Clause 1.5.4 of the Manual: no sewage connection to a storm drain; floor levels; waterbody setbacks and the no-fill zone; and no obstruction of a drainage path.
>
> (5) *Exemptions.* A single dwelling on its own plot below the thresholds of sub-rule (3), and linear road resurfacing that adds no impervious area, are exempt from sub-rule (3) but not from sub-rule (4) or the rainwater harvesting provisions of these rules.
>
> (6) *Conditions of approval.* The competent authority shall not grant:
>
> - (a) planning permission or layout approval, unless a preliminary drainage report under the Manual has been accepted;
> - (b) a building permit, or permission to commence, unless the final drainage design has been accepted; or
> - (c) a completion certificate, unless the as-built certificate has been accepted and the maintenance declaration has been registered, or the public assets have been handed over,
>
> for a development to which sub-rule (3) applies (Manual, Clause 10.3).
>
> (7) *Certification.* Drainage reports and designs shall be signed by a registered professional, and, where Clause 10.6.1 of the Manual so requires, by an empanelled Stormwater Design Professional.
>
> (8) *Rainwater harvesting.* Nothing in this rule alters the rainwater harvesting provisions of these rules.
>
> (9) *Variances and waivers.* The competent authority may grant a variance or waiver only on the grounds and by the procedure of Clause 1.10 of the Manual, and shall publish each decision.
>
> (10) *Transition.* Applications filed complete before the commencement of this rule, and Tier B authorities, are governed by Clause 1.11 of the Manual.

Part B — Model ULB bye-law

B.1 **Title and commencement.** These bye-laws may be called the _____ (name of local body) Stormwater Management Bye-laws, _____. They come into force on _____.

B.2 **Adoption of the Manual.** The Jammu and Kashmir Stormwater Design Manual, as notified by the Government, applies to:

- (a) every development approved by the local body; and

- (b) every drainage, road, culvert, waterbody and flood-mitigation work executed by the local body, including its own drains and roads (Clause 1.3.1(b)).

B.3 **Public works.** Every detailed project report and contract for a work under B.2(b) shall require compliance with the Manual, from the dates in Clause 1.11 (Clause 1.3.4).

B.4 **Tier and alternatives.** The local body is a Tier _____ authority under Clause 1.6 of the Manual. The alternatives of the Policy Supplement adopted by the local body are listed in the Schedule, with the resolution under which each was adopted.

B.5 **Submittals and review.** Submittals shall be made in the stages of Clause 10.3 of the Manual and reviewed within the periods of Clause 10.7.

B.6 **Maintenance, inspection and enforcement.** Maintenance declarations, inspections, handover of public assets and enforcement shall follow Clauses 10.10 to 10.15 of the Manual.

B.7 **Publication.** The local body shall publish the registers and reports of Clause 10.17 of the Manual.

B.8 **Review.** These bye-laws shall be reviewed whenever the Manual is amended under Clause 1.12.

Table 1D.1 — Schedule: alternatives adopted (layout)

Alternative	Resolution number and date	Committee concurrence (Tier A only)	Applies from	Area

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Form 1-1 — Applicability Determination

Supports Clauses 1.5.1 to 1.5.9 and 1.6 of Chapter 1, and Clause 10.3 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Lodged at the pre-application meeting (Stage 0) or with the preliminary drainage report (Stage 1), as Clause 10.3.2 requires.

Table 1F.1 — Form 1-1: Applicability Determination

No.	Item (clause)	Entry
	A. Applicant and site	
A1	Applicant (owner, developer or department)	_____
A2	Site address and survey numbers	_____
A3	Site coordinates (latitude, longitude)	_____
A4	Approving Authority (Clause 1.4)	_____
A5	Tier of the Authority: A / B (Clause 1.6; Annex 1A)	_____
A6	Approval sought: planning permission / building permit / layout approval / public work (DPR)	_____
A7	Type of development: building / layout / sub-division / road / paving / land-use change / other (Clause 1.4)	_____
A8	Stage at which this form is lodged: Stage 0 / Stage 1 (Clause 10.3)	_____
	B. Coverage (Clause 1.5.1)	
B1	Development requiring approval under the Jammu and Kashmir Unified Building Bye-Laws 2021 — 1.5.1(a): Yes / No	_____
B2	Public work by a ULB, State department, board or State undertaking — 1.5.1(b): Yes / No	_____
B3	Work by a Central agency needing the Authority's approval or no-objection — 1.5.1(c): Yes / No	_____
	C. Areas over the common plan of development (Clauses 1.4, 1.5.5)	
C1	Phases, plots and sub-divisions included (one layout approval or one ownership)	_____
C2	Total site area (ha)	_____
C3	Land disturbance (ha)	_____
C4	Existing impervious area (m²)	_____
C5	New impervious area (m²)	_____
C6	Replaced impervious area, removed to subgrade and rebuilt (m²)	_____
C7	New plus replaced impervious area, C5 + C6 (m²)	_____
C8	Plot area for the RWH mandate (m²) (Clause 1.5.3)	_____
	D. Thresholds and exemptions	
D1	Land disturbance 0.1 ha or more — 1.5.2(a): Yes / No	_____
D2	New or replaced impervious area 500 m² or more — 1.5.2(b): Yes / No	_____
D3	Redevelopment (existing impervious cover on the site) — 1.5.6: Yes / No	_____
D4	Constrained redevelopment route of Clause 4.5.6 proposed: Yes / No	_____

No.	Item (clause)	Entry
D5	Linear public work: added impervious area per drainage catchment crossed given in Table 1F.2 — 1.5.7: Yes / No / not applicable	_____
D6	Exemption claimed — 1.5.8(a) single dwelling below the thresholds / 1.5.8(b) resurfacing with no added impervious area / none	_____
D7	RWH mandate applies (UBBL-2021, cl. 10.1: every building on a plot of 100 m² or more) — 1.5.3: Yes / No	_____
	E. Site conditions	
E1	Site in a flood-sensitive catchment (Annex 1B; Clause 4.5.3): No / Yes — name	_____
E2	Source of the catchment boundary used	_____
E3	1% AEP level mapped or determinable for the site (Clause 1.5.4(b)): Yes / No; source	_____
E4	Waterbody on or adjoining the site (Clause 1.5.4(c); Chapter 7): No / Yes — name	_____
E5	Natural drainage path or major-system flow path crossing the site (Clause 1.5.4(d)): No / Yes	_____
E6	Site drains to a tidal outfall (Clause 10.3.2(d)): Yes / No	_____
E7	Variance, waiver, regional facility or fee-in-lieu proposed (Clause 10.3.2(c)): No / Yes — Form 1-2 attached	_____
	F. Determination	
F1	Result: (i) Chapters 4 and 5 apply, with Clause 1.5.4 and the RWH mandate; (ii) Clause 1.5.4 and the RWH mandate only (below thresholds); (iii) exempt under 1.5.8, Clause 1.5.4 and the RWH mandate still apply	_____
F2	Stage 0 mandatory under Clause 10.3.2: Yes (state item (a) to (d)) / No	_____
F3	Storage method: hydrograph method (Chapter 3) / design-aid route S-1 (Clause 1.7, where adopted and eligible)	_____
F4	Other Policy Supplement alternatives relied on (S-2 to S-5), with the adopting resolution	_____
F5	Tier B phased start applies (Clause 1.11.3): Yes / No	_____
	G. Declaration	
G1	I declare that the information above is correct and covers the whole common plan of development. Applicant: name, signature, date	_____
G2	Prepared by (registered professional, Clause 1.4): name, registration number, signature, date	_____
	H. For the Authority (Clause 1.5.9)	
H1	Determination confirmed / corrected	_____
H2	Corrections and reasons	_____
H3	Officer: name, designation, signature, date	_____

Table 1F.2 — Form 1-1: added impervious area by drainage catchment, linear works (Clause 1.5.7)

Drainage catchment crossed	Chainage from – to	Added impervious area (m²)	500 m² or more (Yes / No)	Storage location: right of way / regional facility

Form 1-2 — Variance / Waiver Request

Supports Clause 1.10 of Chapter 1.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Lodged with the preliminary drainage report (Clause 1.10.4(a)), with one form for each requirement concerned.

Table 1F.3 — Form 1-2: Variance / Waiver Request

No.	Item (clause)	Entry
	A. Applicant and site	
A1	Applicant	_____
A2	Site address and coordinates	_____
A3	Form 1-1 reference and date	_____
A4	Tier of the Authority: A / B	_____
A5	Site area (ha)	_____
A6	Site in a flood-sensitive catchment: Yes / No	_____
	B. Request	
B1	Type: variance from a numeric requirement (1.10.1) / waiver of Chapter 4 detention (1.10.2)	_____
B2	Clause of the Manual concerned	_____
B3	Value required by the Manual	_____
B4	Value or arrangement proposed	_____
	C. Matters that cannot be varied or waived (Clause 1.10.3) — confirm that the request does not concern any of them	
C1	(a) a sewage connection to a storm drain	Not concerned: _____
C2	(b) the lowest habitable floor level of Chapter 6	Not concerned: _____
C3	(c) a waterbody setback below the Zone 1 minimum of Clause 7.4.7, or fill or construction in the no-fill zone of Chapter 7	Not concerned: _____
C4	(d) retention in a flood-sensitive catchment, except by fee-in-lieu under Clause 1.7	Not concerned: _____
	D. Variance: grounds (Clause 1.10.1(a))	
D1	Site condition: high groundwater table / contaminated soil / rock / site too small for the required facility / other	_____
D2	Evidence (tests, surveys, plans), with references	_____
D3	Options assessed and why each is impracticable	_____
	E. Variance: equal performance or make-up (Clause 1.10.1(b))	
E1	Downstream point used (Chapter 5)	_____
E2	Performance at that point with full compliance and with the variance (peak flows, water levels)	_____

No.	Item (clause)	Entry
E3	Or: shortfall made up by fee-in-lieu or off-site works in the same catchment — volume (m³), works or fee	_____
	F. Waiver of detention: grounds (Clause 1.10.2)	
F1	Site discharges directly to the sea / to a tidal reach with no flood-prone property downstream	_____
F2	Analysis showing that undetained flow does not worsen the outfall-closed condition of Chapter 5 — reference	_____
F3	Retention still provided in full: Yes	_____
	G. Attachments (Clause 1.10.4(a))	
G1	Report certified under Clause 10.6	_____
G2	Preliminary drainage report	_____
	H. Certification and declaration	
H1	Certified by (registered professional; empanelled professional where Clause 10.6.1 applies): name, registration or empanelment number, signature, date	_____
H2	Applicant: name, signature, date	_____
	I. For the Authority (Clause 1.10.4)	
I1	Referred to the State Stormwater Technical Committee (Tier B, site 1 ha or more): Yes / No; date	_____
I2	Decision: granted / granted with conditions / refused	_____
I3	Reasons and conditions	_____
I4	Entry number in the public register (Clause 10.17)	_____
I5	Note: a variance runs with the approval and lapses if the approval lapses (Clause 1.10.4(d))	—
I6	Officer: name, designation, signature, date	_____

ANNEXES TO CHAPTER 2

Design Rainfall and Design Storms

These annexes support Chapter 2. Annexes 2A to 2E will hold the statewide rainfall tables that Chapter 2 refers to: the benchmark checks and zone map, sub-daily ratios, grid-to-point factors, temporal patterns and retention depths. Each needs analysis of NIH-DHAARA and IMD records that has not yet been done for this Manual, so each is marked "To be prepared" and gives its intended layout and the rule to use until it is published (Clause 1.11.5). Form 2-1 is a draft form for the Design Rainfall Sheet that every hydrologic submittal must include (Clause 2.13). The Manual is a draft; it is not adopted by any government or agency.

Annex 2A — NIH-DHAARA vs IMD station and IMD gridded checks at benchmark points; zone map

Supports Clauses 2.3.1 to 2.3.5 of Chapter 2.

To be prepared. This annex will compare, at benchmark points across the State, the NIH-DHAARA design depths with frequency analyses of long IMD daily station records and of IMD gridded daily data (converted to point values with Annex 2C), for 24 hours and longer and for the AEPs of Table 2.1. It will also contain the map of rainfall zones used by Annexes 2B, 2C and 2E and by the Tier B tables of Chapter 4. It needs NIH-DHAARA values at the benchmark coordinates (NIH), IMD daily and recording-gauge station records and IMD gridded rainfall (IMD), State rain-gauge records (the district rain gauges whose readings IMD tabulates for the Union Territory, the gauges of I&FC, and the gauges of JKSPDC and NHPC at their dams [TBC]), and district and basin boundaries (Survey of India, I&FC). Until it is published, design depths are taken from NIH-DHAARA under Clause 2.3.1, the cross-checks of Clause 2.3.3 are reported on Form 2-1, and the zone of a site is the one agreed with the Authority and recorded on Form 2-1.

Table 2A.1 — Benchmark comparison of design depths (layout)

Benchmark point	IMD station ID	Latitude, longitude	Years of record	Duration (h)	AEP	NIH-DHAARA (mm)	IMD station analysis (mm)	IMD gridded, point value (mm)	NIH-DHAARA / IMD station	Remarks
				24						
				48						
				72						

2A.1 The zone names below are the working names used in the Tier B table template of Chapter 4 (Clause 4.14.2). Their boundaries, and whether further zones are needed, are to be set by the analysis of this annex.

Table 2A.2 — Rainfall zones (layout)

Zone (working name)	Extent (districts, basins)	Representative stations	Notes
JK-Z1 Jammu plains	The plains of the Jammu division south of the Siwalik front, from Akhnoor to Lakhanpur, with the Kandi fans below the hills and the Sirowal below the spring line, in CWC zone 7, Western Himalayas, which covers the whole Union Territory with no part in subzone 1(e) (Clause 2.3.6(b)); south-monsoon regime; catchments that cross a zone line take the higher zone value	Jammu (42056; daily record from 1910) and Jammu Airport; Katra (from 1980) for the front; the district rain gauges of Kathua and Samba; no recording gauge of the zone-7 report	Annual normal 1,401.9 mm at Jammu, 77% in June–September (IMD, normals 1991–2020). FER zone 7 50-yr 24-h about 240–280 mm at Jammu and Akhnoor and about 240 mm at R.S. Pura, Bishnah and Samba; Kathua and Hiranagar not resolved (240–320 mm). NIH-DHAARA 50-yr 24-h 327–411 mm (cross-check only). Records: Jammu 380 mm (27 Aug 2025), 299.2 mm (31 Jul 1961) and 270.4 mm (25 Sep 1988) (IMD)
JK-Z1 Jammu plains: JK-A Jammu plains, Kandi and Sirowal (Jammu–R.S. Pura–Akhnoor–Samba–Kathua)	Jammu, Gangyal, Bari Brahmana, Nagrota, R.S. Pura, Bishnah, Arnia, Akhnoor, Khour, Samba, Vijaypur, Kathua, Hiranagar and Lakhanpur; boundaries [TBC]	Jammu (42056) and Jammu Airport; Kathua and Samba (district gauges); Akhnoor (FER Annex 4.3)	FER zone 7 50-yr 24-h about 240–280 mm at Jammu and Akhnoor, 100-yr about 240–280 mm; zone-7 ratios, which give about 102–119 mm in 1 hour at 50 years at Jammu, a depth never measured there (no recording gauge of Jammu was used by the zone-7 report). Record check (Clause 2.3.6(h)): Jammu's 380 mm of 27 Aug 2025 counts and sets the 1% AEP 24-h depth at 380 mm, and the 2% AEP at not less than 340 mm, within 25 km of the Jammu gauge, which takes in Jammu city, Nagrota, Gangyal, Bari Brahmana, R.S. Pura, Bishnah and Akhnoor (NEER reading of distances); Akhnoor 249 mm (25 Sep 1917, FER) excluded until its gauge's record is confirmed [TBC]. NIH-DHAARA 50-yr 24-h 334 mm at Jammu, 343 mm at Akhnoor, 327 mm at R.S. Pura, 351 mm at Samba and 411 mm at Kathua (cross-check only; Clause 2.3.6(m)). Kandi: boulder-gravel fans, water 7–30 m below ground (to 84 m), transmissivity 21–1,197 m²/day at Jammu and 692–2,613 m²/day at Kathua, the preferred recharge zone; Sirowal: finer, water 2–5 m below ground, waterlogging and flowing wells (Hiranagar, Rajpura, Jangi Chak, Airwan, Nagri) (CGWB). Jammu, Samba and Kathua "Safe" in every assessment of 2017–2024 (CGWB). Receiving waters: the Tawi (Sidhra, highest level 321.1 m, 26 Aug 2025; the Tawi barrage, pool level [TBC]); the Chenab at Akhnoor (highest level 324.29 m, 10 Sep 1992); the Ujh, the Basantar, the Devak and the khads of the Kandi; the Ravi and Ranjit Sagar for Kathua; the Tawi, the Basantar, the Ujh and the Chenab cross into Pakistan within about 10–30 km of the towns

Zone (working name)	Extent (districts, basins)	Representative stations	Notes
JK-Z2 Pir Panjal–Chenab hills	The Siwalik, Murree and Lesser Himalayan hills of the Jammu division, from Poonch and Rajouri across Reasi and Udhampur to Ramban, Banihal and the Chenab valley at Doda and Kishtwar, in CWC zone 7 (Clause 2.3.6(b)); monsoon regime on the outer hills, with western-disturbance maxima in February on the Pir Panjal; catchments that cross a zone line take the higher zone value	Batote (from 1977), Banihal (42045; from 1961), Katra (from 1980), Bhaderwah (from 1977); Udhampur IAF (period of record [TBC]); Kawa automatic weather station (Udhampur); the district gauges of Rajouri, Poonch, Reasi, Ramban, Doda and Kishtwar	Gauge normals 2,151.1 mm at Katra, 1,529.0 mm at Batote, 1,364.8 mm at Banihal and 1,227.9 mm at Bhaderwah (IMD, normals 1991–2020). FER zone 7 50-yr 24-h from about 160–200 mm at Poonch and Kishtwar to 240–280 mm at Udhampur, Katra and Banihal and 280–320 mm at Reasi, with a closed cell of more than 320 mm at Mahore–Gulabgarh. Records exceed or reach the plates on the outer front: Batote 316.2 mm and Katra 292.4 mm (25 Sep 1988) (IMD); Udhampur IAF 63 cm (27 Aug 2025, IMD), excluded under Clause 2.3.6(h) [TBC]. Murree and Siwalik "alternating layers of permeable sandstone and weak impermeable clay" (GSI, 2024); subsidence at Pernote, Thathri and Duksar
JK-Z2 Pir Panjal–Chenab hills: JK-B Outer and middle hills (Udhampur–Katra–Reasi–Rajouri–Poonch–Ramban–Banihal)	Udhampur, Ramnagar, Chenani, Katra, Reasi, Mahore–Gulabgarh, Rajouri, Sunderbani, Nowshera, Poonch, Surankote, Mendhar, Ramban, Batote, Banihal, Billawar, Basohli and Bani; boundaries [TBC]	Katra; Batote; Banihal (42045); Udhampur IAF and the Kawa automatic weather station; Rajouri and Poonch (district gauges)	FER zone 7 50-yr 24-h about 240–280 mm at Udhampur, Katra, Rajouri, Ramban, Batote and Banihal, 280–320 mm at Reasi (a closed cell of more than 320 mm at Mahore–Gulabgarh, taken under Clause 2.3.6(c) as the contour plus one interval) and about 160–200 mm at Poonch; 100-yr about 280–320 mm on the front; zone-7 ratios. Record check (Clause 2.3.6(h)): Batote 316.2 mm and Katra 292.4 mm (25 Sep 1988) count and raise the 1% AEP 24-h depth within 25 km of their gauges wherever the plate reading at the site is lower, for example at Udhampur, about 20 km from Katra, where the 100-yr plate reads about 280 mm (NEER reading of distance); Banihal 205.6 mm (28 Aug 1997) lies below its plate. Excluded [TBC]: Udhampur IAF 63 cm (27 Aug 2025), the gauge's period of record not being in any IMD table read, reported on Form 2-1 beside the design depth as the stress case of the sub-area, about 2.3 times the 100-yr plate; Gulabgarh 371 mm (14 Sep 1906, FER), two places of that name; Poonch 268 mm (31 Aug 1928, FER), gauge period not confirmed. 48- and 72-hour records: Katra 488.6 mm and 698.6 mm (September 2014) (Clause 2.3.6(e)). Recording-gauge hours: Kawa 35 mm in 1 hour and 101 mm in 3 hours (6 Sep 2014). Basohli, Bani and the Sewa lie on the edge of the closed cell over the Ravi hills; the Sewa HE project (383 km², Kathua district) is the one catchment of the zone-7 unit hydrograph in Jammu and Kashmir. Receiving waters: the Tawi at Udhampur (gauge of I&FC: alert 15 ft, danger 20 ft, also given as 17 ft, as reported) and Kishanpur Manwal (442.65 m, 2025); the Chenab and the reaches of Salal (full reservoir level 487.68 m) and Baglihar (840 m), whose gate and flushing operations may since 2025 come without notice downstream (as reported); the khads of the Trikuta, Rajouri and Poonch hills

Zone (working name)	Extent (districts, basins)	Representative stations	Notes
JK-Z2 Pir Panjal–Chenab hills: JK-B1 Inner Chenab hills (Doda–Kishtwar–Bhaderwah)	Doda, Thathri, Bhaderwah, Kishtwar and the lower Paddar valley; boundaries [TBC]	Bhaderwah (from 1977); Doda and Kishtwar (district gauges); the CWC sites at Prem Nagar (Doda) and Gulabgarh (Paddar)	FER zone 7 50-yr 24-h about 200–240 mm at Doda and Bhaderwah and about 160–200 mm at Kishtwar; zone-7 ratios. Records: Bhaderwah 164.4 mm (26 Sep 1988) in one IMD table and 170.2 mm (5 Sep 1995) in another, both below the plate. Cloudbursts at Dachhan (28 Jul 2021) and Chasoti (14 Aug 2025), both unmeasured (as reported). Subsidence at Thathri Nai Basti (2023), where a committee before the NGT found no planned drainage (as reported). Receiving waters: the Chenab (Prem Nagar, 902.56 m in 2025), the Neeru Nallah (1,075.33 m) and the Kalnai (932.7 m), all above their highest levels in 2025 (CWC data as transcribed by SANDRP); Dul Hasti, Ratle and Pakal Dul. Debris-flow and subsidence mapping govern siting (Chapters 6 and 7)
JK-Z3 Kashmir valley	The floor of the Kashmir valley, with its Karewa tablelands, from Qazigund and Anantnag to Baramulla, Sopore, Bandipora and Kupwara, in CWC zone 7 (Clause 2.3.6(b)); western-disturbance and snowmelt regime, with September storms; an embanked Jhelum; catchments that cross a zone line take the higher zone value	Srinagar (42027; daily record from 1901), with the recording gauge used by the zone-7 report; Qazigund (42044; from 1962); Kokernag (from 1978); Kupwara (from 1977); the Srinagar and Rambagh automatic weather stations	Annual normal 697.5 mm at Srinagar, 30% in June–September, wettest month March (IMD, normals 1991–2020). FER zone 7 plates: a closed low over Srinagar (25-yr less than 100 mm, 50-yr less than 120 mm, 100-yr less than 160 mm), about 120–160 mm at Baramulla and Sopore and about 160–200 mm at Kupwara and Anantnag at 50 years. Records: Srinagar 147.8 mm (31 Jan 1930); Qazigund 206.0 mm (5 Sep 2014) (IMD)

Zone (working name)	Extent (districts, basins)	Representative stations	Notes
JK-Z3 Kashmir valley: JK-C Kashmir valley floor and Karewas (Srinagar–Anantnag–Pampore–Sopore–Baramulla–Kupwara)	Srinagar (the SMC and SDA area), Ganderbal, Budgam, Pampore, Pulwama, Awantipora, Anantnag, Bijbehara, Kulgam, Shopian, Qazigund, Sopore, Baramulla, Bandipora, Sumbal, Kupwara and Handwara; Uri and the Jhelum gorge below Baramulla, which the research for this Manual did not place, take the rainfall of JK-C with the hill rules of JK-B (Clauses 4.11 and 6.3.6) [TBC]; boundaries [TBC]	Srinagar (42027) and its recording gauge; Qazigund (42044); Kokernag; Kupwara; the automatic weather stations at Srinagar, Rambagh and Anantnag	FER zone 7 24-h at Srinagar read under Clause 2.3.6(c) as the enclosing contour of the closed low: 100 mm at 25 years, 120 mm at 50 years and 160 mm at 100 years; about 120–160 mm at 50 years at Baramulla, Sopore and Uri, about 160 mm at Anantnag, 160–200 mm at Kupwara and 200–240 mm at Qazigund. Zone-7 ratios, which give less than 51 mm in 1 hour at 50 years at Srinagar against its recorded 32 mm (recording gauge, 28 Aug 1975) and about 40 mm (1970–2005, as quoted). Records: Srinagar 147.8 mm (31 Jan 1930), below the 100-yr reading of 160 mm; Qazigund 206.0 mm (5 Sep 2014), below its 100-yr reading of about 240–280 mm; Anantnag 180 mm and Kokernag 149.5 mm (4–5 Sep 2014) (IMD; Ray et al., 2015); Srinagar's own fall of 3–6 Sep 2014 was only about 140–152 mm. Two design cases and the river-stage rule of Clause 2.3.6(g). Alluvium, Gurti clay and Nambal peat on the valley floor, with the water table 0–2 m below ground over the central and south-western valley and flowing wells on both sides of the Jhelum; Upper Karewa of low permeability with perched water, Lower Karewa moderately permeable; CGWB: in Srinagar "there is no scope for artificial recharge to ground water". Receiving waters: the Jhelum behind its embankments (CWC: Ram Munshi Bagh danger level 1,585.48 m, highest level 1,588.99 m, 8 Sep 2014; Sangam danger level 1,590.88 m, highest 1,595 m, 4 Sep 2014; Khanabal 1,595.43 m, 3 Sep 2025; Safapora danger level 1,579.66 m, highest 1,582.1 m; CWC data as transcribed by SANDRP); the gauges of I&FC in feet (Ram Munshi Bagh flood declaration 18 ft, danger 21 ft, as reported; zeros not published); the flood spill channel and the city channels; the Dal (Dal Gate; Nallah Amir Khan), Nigeen, Anchar and Wular (danger 1,578 m, as reported); the marshes of Hokersar, Narkara and Shallabugh. Srinagar drains through pumping stations, 89 in 2019 and 104 permanent dewatering stations in 2026 (as reported)
JK-Z4 High mountains	The high Pir Panjal and Great Himalaya above the valley and the Chenab hills, with snow-fed and glacier catchments that the zone-7 report excludes (Clause 2.3.6(i)); western-disturbance snow and rain on snow; hazard-first, with mandatory GLOF, landslide-lake, debris-flow and avalanche screening; catchments that cross a zone line take the higher zone value	Gulmarg (42026; from 1901), with the recording gauge used by the zone-7 report; Pahalgam (from 1978); Sonemarg (FER Annex 4.3); the automatic weather station below the Amarnath cave; the CWC site at Ganeshpura on the Lidder	Gauge normals 1,449.2 mm at Gulmarg (26% in June–September) and 1,273.5 mm at Pahalgam, wettest month March (IMD, normals 1991–2020). FER zone 7 50-yr 24-h about 120–160 mm at Gulmarg and Pahalgam and about 200–240 mm at Sonamarg and Gurez, inside a closed high over Sonamarg. Winter records: Gulmarg 293.4 mm (20 Feb 1967) and 270.3 mm (27 Jan 1957) (IMD); Sonemarg 300 mm (27 Feb 1936, CWC, zone 7, Annex 4.3), all excluded under Clause 2.3.6(h) until IMD states whether they are rain or snow measured as water [TBC]

Zone (working name)	Extent (districts, basins)	Representative stations	Notes
JK-Z4 High mountains: JK-D High mountains and snow-fed catchments (Gulmarg–Pahalgam–Sonamarg–Gurez–Paddar; hazard-first)	Gulmarg, Tangmarg, Pahalgam, Aru, Sonamarg, Gurez, Tulail, Machil, Keran, Karnah, the Warwan valley, Paddar, upper Kishtwar (Marwah), Kokernag–Daksum, Bani–Sarthal and the Amarnath yatra route, and every catchment elsewhere with permanent snow or a glacier; all in UTM zone 43N; boundaries [TBC]	Gulmarg (42026) and its recording gauge; Pahalgam; the Amarnath cave automatic weather station	Zone-7 relations not used for snow-fed catchments; site-specific hydrology and a GLOF, landslide-lake, debris-flow and avalanche screening (Clause 2.3.6(i)); for local catchments below the snow, Clause 2.3.6(c) to (h) apply, with the 1-hour floor of 62 mm of Clause 2.3.6(g)(i). Recording-gauge maxima at Gulmarg: 62 mm in 1 hour and 99 mm in 24 hours (9–10 Sep 1980) (CWC, zone 7, Annex 4.4); Amarnath cave 25 mm in 1 hour (8 Jul 2022), not a cloudburst (MoES). Thin soils over rock and moraine, frozen in winter. Events not driven by rain at the gauges: the flood at the Amarnath cave (8 Jul 2022) and the Chasoti cloudburst (14 Aug 2025) (as reported). Receiving waters: the Sind, the Lidder (Ganeshpura), the Kishanganga at Gurez, the Warwan and the Marusudar, and the Chenab headwaters from Lahaul through Paddar

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Annex 2B — Sub-daily ratios P(t)/P(24h) by zone: NIH-DHAARA (hourly-based) vs the one-third rule

Supports Clauses 2.6.1 to 2.6.4 of Chapter 2.

To be prepared. This annex will tabulate, for each zone of Annex 2A, the ratios of the t-hour to the 24-hour design depth from NIH-DHAARA, which are derived from hourly records, against the ratios implied by IMD Das et al. (2022) and by the one-third rule. It needs NIH-DHAARA depths for each duration at representative points in each zone (NIH), IMD recording-gauge data and the IDF values of Das et al. (2022) (IMD). Until it is published, sub-daily depths are read directly from NIH-DHAARA or an approved station IDF (Clause 2.6.1). Where only daily depths are available, the ratios used are those agreed with the Authority, which in Jammu and Kashmir are those of Clause 2.3.6: the CWC Flood Estimation Report ratios for zone 7 in Table 2B.1, in every sub-area, with the 1-hour floor of 62 mm of Clause 2.3.6(g)(i) in sub-area JK-D, applied to the 24-hour depth before the record check of Clause 2.3.6(h) (Clause 2.6.2), and are recorded on Form 2-1. The one-third rule is not used (Clause 2.6.4).

2B.1 The first row of Table 2B.1 gives the ratios of the one-third rule P(t) = P(24)·(t/24)^(1/3), for comparison only. The 1, 3, 6 and 12 h values are those stated in the commentary to Clause 2.6; the 2 h value is computed from the same formula. The rule shall not be used for design unless this annex confirms it for the zone concerned (Clause 2.6.4).

Table 2B.1 — Ratios P(t)/P(24h) by zone (layout)

Zone	Source	1 h	2 h	3 h	6 h	12 h	24 h
All (reference only, not for design)	One-third rule	0.35	0.44	0.50	0.63	0.79	1.00
JK-Z1 (JK-A Jammu plains, Kandi and Sirowal), JK-Z2 (JK-B Outer and middle hills; JK-B1 Inner Chenab hills), JK-Z3 (JK-C Kashmir valley floor and Karewas) and JK-Z4 (the local catchments of JK-D below the snow)	CWC FER zone 7, 10-yr basis, nine recording gauges (interim design ratios, Clause 2.3.6(f); 2-h value interpolated on logarithmic axes; no exception in any sub-area)	0.425		0.600	0.725	0.845	1.00

Zone	Source	1 h	2 h	3 h	6 h	12 h	24 h
JK-Z4 (JK-D), 10% AEP and rarer	1-hour floor of Clause 2.3.6(g)(i), set by this Manual: not less than 62 mm, the largest hour of the Gulmarg recording gauge (9 Sep 1980), not a ratio						
JK-Z3 (JK-C): Srinagar	CWC FER zone 7, Annex 4.4: recording-gauge maxima as ratios to the 24-h maximum of the same record (separate storms: 1 to 12 h on 28 Aug 1975, 24 h on 16–17 May 1975; comparison only)	0.48		0.81	0.96	0.99	1.00
JK-Z4 (JK-D): Gulmarg	CWC FER zone 7, Annex 4.4: recording-gauge maxima of 9–10 Sep 1980 (comparison only)	0.63		0.64	0.66	0.85	1.00
JK-Z2 (JK-B): Kawa (Udhampur)	Automatic weather station, storm of 5–6 Sep 2014: 35 mm in 1 hour and 101 mm in 3 hours against 260 mm in the 24 hours to 08:30 on 6 Sep (Ray et al., 2015; a long storm; comparison only)	0.13		0.39			1.00
All sub-areas (22 town cells)	NIH-DHAARA (IMDAA), 50-yr 1-h / 24-h, queried 13 Nov 2026: 0.10–0.18 in the hill cells (Ramban 0.10; Udhampur and Katra 0.18), 0.20–0.21 on the valley floor and 0.21–0.27 in the Jammu plains, Rajouri and Poonch (not used, Clause 2.3.6(m))	0.10–0.27					1.00

2B.2 Depths from fixed observation windows are converted to true-interval depths with the factors of Clause 2.6.3, repeated in Table 2B.2. They are the standard WMO (Hershfield) values and are not provisional.

Table 2B.2 — Fixed-interval adjustment factors (Clause 2.6.3)

Number of fixed observation intervals in the duration	Factor
1	1.13
2	1.04
3–4	1.02

Annex 2C — Grid-to-point factors

Supports Clauses 2.7.1 and 2.7.4 of Chapter 2.

To be prepared. This annex will give the factors that convert grid-average design depths (for example from 0.25° cells) to point depths, by zone, duration and AEP. It needs paired frequency analyses of IMD gridded rainfall and of the IMD and State gauges inside each cell (IMD, I&FC, and the district rain gauges of the Union Territory whose records IMD tabulates [TBC]), the benchmark points of Annex 2A, and a stated method for deriving the factors. Until it is published, design depths are taken as point values from NIH-DHAARA or an approved station IDF (Clauses 2.3.1 and 2.3.2). Grid-average values are not used as design depths unless a conversion agreed with the Authority is recorded on Form 2-1 (Clause 1.11.5).

2C.1 The commentary to Clause 2.7 shows why the factors matter. In Jammu and Kashmir NIH-DHAARA, whose values come from a reanalysis grid of about 12 km, was queried at 22 town cells for this Manual (13 November 2026): its 24-hour depths are close to the plates at Srinagar (140 mm at 50 years) and above them across the Jammu division (334 mm at Jammu, 388 mm at Udhampur and 411 mm at Kathua at 50 years, against about 240–280 mm on the plates), while its 1-hour depths are only 0.10–0.16 of the 24-hour depths in the hill cells and 0.21–0.27 in the plains (NIH-DHAARA; NEER reading). The district totals that IMD publishes after a storm show the size of the gap between an area value and a point: in 4–10 September 2014 the Srinagar district total was 148.0 mm, while the gauge at Qazigund, about 60 km away, recorded 599.8 mm in four days (Ray et al., 2015). Across the Pir Panjal the gauge normals change two- to three-fold within a few tens of kilometres, from 697.5 mm a year at Srinagar to 1,364.8 mm at Banihal and 2,151.1 mm at Katra (IMD, normals 1991–2020). Values of this kind are grid- or area-average values and need these factors before any use as point depths; under Clause 2.3.6 they are not used as design depths in Jammu and Kashmir until this annex and Annex 2A are published, NIH-DHAARA's 24-hour depths are used only as a cross-check in sub-area JK-A, and its 1-hour depths are not used at all (Clause 2.3.6(m)).

Table 2C.1 — Grid-to-point factors (layout)

Zone	Grid product and cell size	Duration (h)	AEP	Factor (point / grid)	Stations used	Years of record
		24				
		48				
		72				

Annex 2D — Jammu and Kashmir temporal patterns (Huff curves)

Supports Clauses 2.9.3 and 2.9.4 of Chapter 2, and Clause 11.7.3 of Chapter 11.

To be prepared. This annex will give dimensionless time-distribution (mass) curves of Jammu and Kashmir storms, in the form introduced by Huff (1967), by zone, storm-duration class and quartile, at stated probability levels. It needs storm hyetographs from recording gauges and automatic weather stations (IMD, its automatic weather stations and automatic rain gauges in the Union Territory, under the Meteorological Centre Srinagar, among them those at Srinagar, Rambagh, Jammu Aero, Udhampur IAF, Kawa, Pahalgam, Govindpur and the Amarnath cave, and any recording gauges of I&FC, J&K SDMA and the Smart City companies of Srinagar and Jammu [TBC]), separated into independent storms by a stated rule, and the storms recorded by the recording gauges of the CWC zone-7 report at Srinagar (16–17 May and 28 August 1975) and Gulmarg (9–10 September 1980), the storm of 3–7 September 2014 as recorded at the automatic weather stations at Kawa, Anantnag, Govindpur, Pahalgam, Srinagar and Rambagh, the Srinagar storm of 1 August 2019, the Amarnath storm of 8 July 2022 and the Jammu and Udhampur storm of 26–27 August 2025 among them. Until it is published, design storms use the alternating-block pattern of Clause 2.9.1 and the 48- and 72-hour pattern of Clause 2.9.2; for catchments of 25–5,000 km², the CWC Flood Estimation Report curves may be used with a sensitivity run under Clause 2.9.1 (Clause 2.9.4). SCS Type distributions are not used (Clause 2.9.3). For the disaggregation of daily records in continuous simulation (Clause 11.7.3), the method is agreed with the Authority and recorded (Clause 1.11.5).

Table 2D.1 — Cumulative fraction of storm depth against cumulative fraction of storm time (layout, one table per zone, duration class and quartile)

Fraction of storm time	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
10% probability curve	0										1.0
50% probability curve	0										1.0
90% probability curve	0										1.0

2D.1 Each table shall state the zone, the duration class, the quartile (the quarter of the storm in which most rain fell), the number of storms analysed and the period of record.

Reference: Huff, F.A. (1967). Time distribution of rainfall in heavy storms. *Water Resources Research* 3(4), 1007–1019.

Annex 2E — Retention percentile depths by zone

Supports Clauses 2.8.3 and 2.10.1 to 2.10.2 of Chapter 2, Clause 4.4 of Chapter 4 and Chapter 8.

To be prepared. This annex will give, for each zone of Annex 2A, the retention design depth P_R: the 24-hour rainfall depth not exceeded on 90% of days with rain (≥ 2.5 mm) in the long-term record (Clause 2.10.1). It needs long daily records at stations in each zone (IMD, I&FC, and the district rain gauges of the Union Territory whose records IMD tabulates [TBC]) and IMD gridded data with the factors of Annex 2C where stations are sparse. Until it is published, P_R is computed by the definition of Clause 2.10.1 from the long-term daily record of a station agreed with the Authority, by the steps in 2E.1, and recorded on Form 2-1 (Clause 1.11.5).

2E.1 **Computing P_R from a daily record.**

1. Take the daily (24-hour) rainfall series of the station for its full record.
2. Keep only the days with rain of 2.5 mm or more (wet days).
3. Rank the wet-day depths and take the depth not exceeded on 90% of them (the 90th percentile).
4. Do not apply the climate factor (Clause 2.8.3) or the fixed-interval factor; P_R is a statistic of everyday rainfall, not an AEP design depth.
5. Record the station, the period of record, the number of wet days and P_R on Form 2-1.

Table 2E.1 — Retention depth P_R by zone (layout)

Zone	Stations or grid cells used	Period of record	Number of wet days (≥ 2.5 mm)	P_R, 90th percentile (mm)	Issued on
JK-Z1 Jammu plains					
JK-Z2 Pir Panjal–Chenab hills					
JK-Z3 Kashmir valley					
JK-Z4 High mountains					

Form 2-1 — Design Rainfall Sheet

Supports Clauses 2.3 to 2.13 of Chapter 2, and Clause 10.4.1(d) of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One sheet for each hydrologic submittal. The steps follow Figure 2.3 of Chapter 2.

Table 2F.1 — Form 2-1: site, source and storms

No.	Item (clause)	Entry
	A. Site (Clause 2.13, item 1)	
A1	Project and site	_____
A2	Site coordinates (latitude, longitude, decimal degrees)	_____
A3	Rainfall zone (Annex 2A, or as agreed with the Authority)	_____
A4	Contributing catchment area (km²) (Clause 2.7)	_____
A5	Design life: more than 25 years / temporary works, 5 years or less (Clause 2.8.2)	_____
A6	Outfall under tidal or river backwater influence: Yes / No (Clauses 2.5.3, 2.12)	_____
	B. Source (Clauses 2.3, 2.3.5; item 2)	
B1	NIH-DHAARA: version or access date	_____
B2	Coordinates queried	_____
B3	Screenshot or export of the values extracted attached: reference	_____
B4	Station IDF used (Clause 2.3.2): No / Yes — station, ID, distance from site (km)	_____
B5	Station IDF: years of recording-gauge data (30 or more); published or approved by	_____
B6	Station IDF: change of terrain or coastal exposure between gauge and site: None / describe	_____
	C. AEPs and durations (Clauses 2.4, 2.5)	
C1	Elements designed and their AEPs (Table 2.1)	_____
C2	Conveyance: Tc and design duration (not less than 10 min) (Clause 2.5.1)	_____
C3	Storage: durations checked from {1, 2, 3, 6, 12, 24, 48, 72 h}; 24, 48 and 72 h included (Clause 2.5.2)	_____
C4	Critical duration found for each storage element	_____
	D. Conversions	
D1	Sub-daily depths: read directly / from Annex 2B ratios / from ratios agreed with the Authority (Clauses 2.6.1, 2.6.2)	_____
D2	Fixed-interval factor applied: none (true-interval source) / 1.13 / 1.04 / 1.02 (Clause 2.6.3)	_____
D3	Grid-to-point factor: not needed (point source) / Annex 2C / agreed value (Clause 2.7.1)	_____
D4	ARF: 1.0 (10 km² or less; single-site storage) / CWC curve / interpolated (Clauses 2.7.2–2.7.4)	_____
D5	Climate factor: 1.20 (≤ 6 h) and 1.10 (> 6–72 h) / 1.0 temporary works / projected depths under Clause 2.8.4	_____
	E. Cross-checks (Clause 2.3.3; item 4)	
E1	IMD Das et al. (2022) values for 1–24 h: reported in Table 2F.2	_____

No.	Item (clause)	Entry
E2	CWC zone 7 24-hour point value, catchments of 25–5,000 km²: subzone used	_____
E3	CWC floor governs for any AEP: No / Yes — AEPs	_____
	F. Retention depth (Clause 2.10)	
F1	P_R (mm) and source: Annex 2E zone value / computed under Annex 2E, 2E.1 — station and period	_____
F2	No climate factor applied to P_R (Clause 2.8.3): confirmed	_____
	G. Design storms (Clauses 2.9, 2.11, 2.12; items 5 and 6)	
G1	Storms up to 24 h: alternating block, peak at 50%; time step (≤ Tc/3 and ≤ 15 min)	_____
G2	48 and 72 h storms: built under Clause 2.9.2 (Table 2F.3)	_____
G3	Other pattern used: none / Annex 2D / CWC FER with sensitivity run (Clauses 2.9.3, 2.9.4)	_____
G4	Hyetographs attached as a table and a plot for each design storm: reference	_____
G5	AMC: III for every design storm of 1 March–31 May on the Kashmir valley floor (JK-C), and there at any time while the Jhelum is at or above flood-declaration level at Sangam or Ram Munshi Bagh; III for every design storm of 1 July–30 September on the Sirowal and valley-floor alluvium of JK-A and in JK-B and JK-B1; III at any time in JK-D and in catchments draining to a reservoir, barrage pond or backwater or to Dal, Anchar or Wular; at any other site or time (including the Kandi and the Karewas), III for a storm that follows or contains a 5-day total of more than 53 mm; II otherwise (Clause 2.11.4)	_____
G6	Pre-development condition: greenfield, open land in good condition for the mapped HSG (Clause 2.11.5)	_____
G7	Release criterion: standard, Q_post ≤ 0.9 × Q_pre (Clause 2.11.2) / flood-sensitive, mixed-frequency rule (Clause 2.11.3)	_____
G8	Tailwater joint cases run (Clause 2.12): case (a) MHWS + sea-level allowance; case (b) 10% AEP 48 h storm with 1% AEP still-water level + sea-level allowance; governing case	_____
	H. Prepared by	
H1	I confirm that the values above are those extracted and used in the submittal. Name, registration number, signature, date	_____

Design depth = source depth × fixed-interval factor × grid-to-point factor × ARF × climate factor. Where the design depth is lower than the CWC floor for the same AEP, the floor is adopted (Clause 2.3.3).

Table 2F.2 — Form 2-1: depth table (Clause 2.13, item 3)

AEP (T-yr)	Duration	Source depth (mm)	Fixed-interval factor	Grid-to-point factor	ARF	Climate factor	Design depth (mm)	IMD Das et al. (2022) (mm)	CWC floor (mm)	Adopted depth (mm)

Table 2F.3 — Form 2-1: 48- and 72-hour storm construction (Clause 2.9.2)

AEP (T-yr)	Duration (h)	Total design depth (mm)	24 h design depth, final 24 h (mm)	Remainder (mm)	Hours before the final 24 h	Uniform intensity before the final 24 h (mm/h)
	48				24	
	72				48	

ANNEXES TO CHAPTER 3

Hydrologic Methods

These annexes support Chapter 3. Annex 3C sets out benchmark test problems for software acceptance, and Forms 3-1 and 3-2 are the submittal forms required by Clause 3.17. Annexes 3A, 3B, 3D and 3E need survey, gauging or published report data that this draft does not yet contain; each gives the intended layout and the interim rule of Chapter 3 that applies until it is published. The forms are draft forms and have no statutory status.

Annex 3A — Jammu and Kashmir soil series to HSG lookup; seasonal high water table map

Supports Clauses 3.7 and 3.10 of Chapter 3.

To be prepared. This annex will contain (a) a lookup from each soil series mapped in Jammu and Kashmir to its hydrologic soil group (HSG), in both the drained and the undrained state, and (b) a map of the depth to the seasonal high groundwater table in the south-west monsoon (June–September). It needs NBSS&LUP and Agriculture Production Department, Jammu and Kashmir (soil survey) [TBC] series maps with their scales, measured saturated hydraulic conductivity and depth to an impermeable layer for each series, and observation-well records from the Central Ground Water Board and the Jal Shakti Department, supplemented by piezometers in the floor of the Kashmir valley in and around Srinagar, Anantnag–Bijbehara, Pampore, Sopore, Baramulla, Sumbal and Bandipora, where water stands 0–2 m below ground over the central and south-western valley and wells flow on both sides of the Jhelum, the Sirowal of the Jammu plains round R.S. Pura, Bishnah, Arnia and Hiranagar, where water stands mostly 2–5 m below ground and wells flow, the floodplains and low terraces of the Tawi, the Chenab, the Ujh, the Basantar, the Ravi and the khads, the margins of Dal, Nigeen, Anchar, Wular, Manasbal, Hokersar and the other lakes and nambals, of Mansar and Surinsar and of the Kandi ponds and talabs, the margins of the Salal and Baglihar reservoirs and of the Tawi barrage pond at Jammu, and hill towns with perched water on unstable slopes, such as Thathri Nai Basti in Doda and Pernote and Duksar in Ramban. Until it is published, use the interim rules of Chapter 3: assign HSG from measured saturated hydraulic conductivity and depth to an impermeable layer or water table by the criteria of NEH Part 630, Ch. 7 (Clause 3.7.2); verify it by site infiltration tests wherever retention relies on infiltration (Clause 3.7.3); take the seasonal high water table from site piezometers, trial pits or the nearest observation well (Clause 3.10.2); and assign HSG D wherever that level is within 0.6 m of the ground surface (Clause 3.10.1).

Table 3A.1 — Soil series to HSG lookup (layout)

Soil series	District(s)	Taxonomic class	Surface texture	Saturated hydraulic conductivity (mm/h)	Depth to impermeable layer (m)	HSG, drained	HSG, undrained	Source map and scale

Table 3A.2 — Seasonal high water table, by mapping unit (layout)

Mapping unit or grid cell	Observation wells used	Years of June–September record	Highest June–September level below ground (m)	Within 0.6 m of ground (Clause 3.10.1)?	Data source

Annex 3B — Jammu and Kashmir CN calibration and supplementary land covers (valley-floor paddy, Karewa orchards, Kandi scrub, conifer and chir pine forest, slide scars, debris fans and muck dumps, bare rock and scree, alpine meadow and snow, boulder-bed khads, nambal reed beds, lake, talab and reservoir beds)

Supports Clauses 3.8 and 3.15 of Chapter 3.

To be prepared. This annex will contain (a) curve numbers calibrated against observed rainfall and runoff in Jammu and Kashmir catchments, compared with the TR-55 values of Table 3.5, and (b) curve numbers for land covers that Table 3.5 does not list: the paddy of the floor of the Kashmir valley and of the Sirowal of the Jammu plains, ponded behind field bunds and fed by kuhls (the "zamindari khuls" of the Water Resources Act 2010), which hold water on each field until it overtops; the orchards of the Karewa tablelands and the valley sides, often on terraces with weeded or grassed floors; the dry scrub and degraded forest of the Kandi belt and the Siwalik hills; the conifer forest of the middle hills and the valley sides, with deep litter, and the chir pine forest of the outer hills, whose needle litter sheds water; the fresh scars, slide debris and debris fans of landslides and debris flows, and the cut slopes and muck dumps of hill roads and hydro-electric projects on the Chenab and its tributaries; bare rock, scree and the skeletal soils of the steep hills; the alpine meadows and the snow and frozen ground of the high mountains; the wide boulder beds of the Kandi khads, which are dry for most of the year and lose flow to the gravels until the bed is saturated; the reed beds and marsh of the nambals and wetland reserves, such as Hokersar, Hygam and Shallabugh, which are wet at the start of most storms; and the beds of Kandi ponds, talabs, lake margins and reservoirs that are dry or drawn down at the start of a storm, such as the margins of Wular and the drawdown zones of the Salal and Baglihar reservoirs. It needs paired rainfall–runoff records for small gauged catchments of known cover and soil, from I&FC gauging sites, agricultural research stations and tank gauges, analysed by event and by antecedent moisture. Until it is published: the pre-development reference stays open space in good condition for every site (Clause 3.3.2), so these covers do not enter the pre-development run; for off-site existing conditions, use the nearest Table 3.5 or TR-55 cover row, including the cultivated rows (Clause 3.8.3(c)), and state the row chosen and the reason on Form 3-1; land under standing water at the start of the design storm is modelled as water surface with no losses (Table 3.5; Clause 3.10.4(b)). Any departure from these defaults requires calibration under Clause 3.15 (Clause 3.15.1(d)).

Table 3B.1 — Supplementary land covers, AMC II (layout)

Cover type	HSG A	HSG B	HSG C	HSG D	Ia ratio	Basis (catchments, events, years)
Paddy of the Kashmir valley floor and the Sirowal, ponded behind field bunds and fed by kuhls						
Orchard on the Karewas or the valley sides, with the floor recorded (weeded, grassed or mulched; terraced or not)						

Cover type	HSG A	HSG B	HSG C	HSG D	Ia ratio	Basis (catchments, events, years)
Dry scrub and degraded forest of the Kandi belt and the Siwalik hills						
Conifer forest of the middle hills and valley sides, with deep litter; chir pine forest of the outer hills, with needle litter						
Fresh landslide scar, slide debris or debris fan; hill-road cut slope; road or project muck dump						
Bare rock, scree and skeletal soil of steep slopes						
Alpine meadow; snow or frozen ground at the start of the storm						
Boulder bed of a Kandi khad, dry at the start of the storm						
Nambal marsh and reed bed (Hokersar, Hygam, Shallabugh and the like), wet at the start of the storm						
Kandi pond, talab, lake margin or reservoir bed dry or drawn down at the start of the storm (Wular margins; Salal and Baglihar drawdown zones)						
Other (state)						

Table 3B.2 — CN calibration catchments (layout)

Catchment	District	Area (km²)	Dominant HSG and cover	Events used	Table 3.5 CN	Calibrated CN	Calibrated ÷ Table 3.5

Annex 3C — Benchmark test problems for software acceptance

Supports Clauses 3.5, 3.6, 3.8, 3.9, 3.11, 3.12 and 3.16 of Chapter 3.

Purpose. Software not listed in Clause 3.16.1 shall reproduce the results of the five problems below (Clause 3.16.3). Each problem is fully specified and uses only the methods and tables of Chapter 3, so every answer can be checked by hand. The acceptance tolerance is ±5% on each tabulated result, the equivalence threshold of Clause 3.16.2; for closed-form results (Problems 3C-1 to 3C-4), software should agree to the rounding shown. The submittal shall report the software result next to each answer below.

Illustrative — not design values. The inputs (areas, intensities, rainfall depths, slopes and the basin) are chosen for testing only. They are not design data for any site.

Problem 3C-1 — Rational Method peak (Clause 3.5)

Inputs. A 2.0 ha catchment draining to one inlet: 1.2 ha concrete paving and roofs, C = 0.90 (Table 3.2, upper half of 0.80–0.95); 0.8 ha lawns on sandy soil, average slope, C = 0.15 (Table 3.2, upper half of 0.10–0.15). Design AEP 1% (100-yr). Rainfall intensity at Tc, including the climate factor: i = 120 mm/h.

Part (b): a separate 0.5 ha fully paved catchment, C = 0.90, design AEP 1%, i = 150 mm/h.

Table 3C.1 — Problem 3C-1 solution

Step	Calculation	Result
Composite C (Clause 3.5.4)	(1.2 × 0.90 + 0.8 × 0.15) / 2.0	0.60
Frequency factor (Table 3.3)	1% AEP	Cf = 1.25
C · Cf (≤ 1.0)	0.60 × 1.25	0.75
Peak flow (Clause 3.5.1)	0.75 × 120 × 2.0 / 360	**Q = 0.500 m³/s**
Part (b): C · Cf	0.90 × 1.25 = 1.125, capped at 1.0 (Clause 3.5.3)	1.00
Part (b): peak flow	1.00 × 150 × 0.5 / 360	**Q = 0.208 m³/s**

Problem 3C-2 — Time of concentration by the segment method (Clause 3.6)

Inputs. Pre-development flow path: sheet flow over greenfield, n = 0.15 (Clause 3.6.3), L = 30 m, S = 0.01; P2 (50% AEP 24-hour rainfall, no climate factor) = 80 mm. Shallow concentrated flow, unpaved, L = 200 m, S = 0.01. Channel flow, L = 400 m, bank-full velocity V = 1.0 m/s (given).

Table 3C.2 — Problem 3C-2 solution

Segment	Calculation	Travel time
Sheet flow (Clause 3.6.2(a))	0.091 × (0.15 × 30)^0.8 / (80^0.5 × 0.01^0.4) = 0.2138 h	12.83 min
Shallow concentrated (Clause 3.6.2(c))	V = 4.918 × 0.01^0.5 = 0.4918 m/s; 200 / (3,600 × 0.4918) = 0.1130 h	6.78 min
Channel (Clause 3.6.2(d))	400 / (3,600 × 1.0) = 0.1111 h	6.67 min
Tc (Clause 3.6.1; ≥ 10 min)	12.83 + 6.78 + 6.67	**26.27 min**
Lag (Clause 3.6.5)	0.6 × 26.27	15.76 min

Problem 3C-3 — SCS-CN runoff depth, AMC and Ia sensitivity (Clause 3.8)

Inputs. Pre-development reference on HSG C: CN = 74 at AMC II (Table 3.5), all pervious. Cumulative rainfall P = 100 mm; second case P = 25 mm.

Table 3C.3 — Problem 3C-3 solution

Case	S (mm)	Ia (mm)	Runoff Q (mm), P = 100 mm	Runoff Q (mm), P = 25 mm
(a) AMC II, Ia = 0.2S: S = 25,400 / 74 − 254	89.24	17.85	**39.38**	**0.53**
(b) AMC III, Ia = 0.2S: CN(III) = 23 × 74 / (10 + 0.13 × 74) = 86.75	38.80	7.76	**64.93**	—
(c) AMC II, Ia = 0.05S: S0.05 = 25.4 × 1.33 × (89.24 / 25.4)^1.15	143.31	7.17	**36.49**	**1.97**

Runoff is Q = (P − Ia)² / (P − Ia + S). Case (c) gives less runoff than case (a) at 100 mm but more at 25 mm, as Clause 3.8.5 and Figure 3.3 describe.

Problem 3C-4 — Separate vs composite impervious representation, and SCS unit hydrograph peak (Clauses 3.9 and 3.11.2)

Inputs, part (a). A site that is 50% directly connected impervious (CN 98) and 50% open space on HSG B (CNp = 61), AMC II, Ia = 0.2S, P = 25 mm.

Inputs, part (b). A sub-area of A = 2.5 km² with Tc = 1.0 h and computation interval Δt = 0.1 h.

Table 3C.4 — Problem 3C-4 solution

Step	Calculation	Result
(a) Impervious half (Clause 3.9.2)	S = 5.18 mm, Ia = 1.04 mm; Q = 23.96² / (23.96 + 5.18)	19.70 mm
(a) Pervious half	S = 162.39 mm, Ia = 32.48 mm > P	0 mm
(a) Area-weighted runoff, separate sub-areas	0.5 × 19.70 + 0.5 × 0	**9.85 mm**
(a) Composite CN (Clause 3.9.4)	61 + 0.50 × (98 − 61)	79.5
(a) Runoff with composite CN	S = 65.50 mm, Ia = 13.10 mm; Q = 11.90² / (11.90 + 65.50)	**1.83 mm**
(b) Interval check (Clause 3.11.3(a))	0.133 × 1.0 = 0.133 h ≥ Δt = 0.1 h	satisfied
(b) Lag and time to peak (Clause 3.11.2)	tL = 0.6 × 1.0 = 0.60 h; tp = 0.1 / 2 + 0.60	tp = 0.65 h
(b) Unit hydrograph peak, Q = 1 mm	0.208 × 2.5 × 1 / 0.65	**qp = 0.800 m³/s per mm**

Part (a) reproduces the comparison in the commentary to Clause 3.9 (about 9.9 mm vs 1.8 mm).

Problem 3C-5 — Level-pool (modified Puls) storage routing (Clause 3.12.1)

Inputs. A detention basin with vertical sides and plan area 500 m², with the stage–storage–discharge relationship of Table 3C.5. Triangular inflow hydrograph: 0 at t = 0, rising linearly to 0.50 m³/s at t = 30 min, falling linearly to 0 at t = 90 min. Basin empty at t = 0. Routing interval Δt = 10 min (600 s). No tailwater.

Table 3C.5 — Problem 3C-5 stage–storage–discharge relationship

Stage (m)	Storage S (m³)	Outflow O (m³/s)
0.0	0	0.00
0.5	250	0.05
1.0	500	0.10
1.5	750	0.15
2.0	1,000	0.20
2.5	1,250	0.25

Method. The storage-indication equation is (I1 + I2) + (2S1/Δt − O1) = (2S2/Δt + O2). The table gives O = S / 5,000 (S in m³, O in m³/s), so 2S/Δt + O = 17.667 O and 2S/Δt − O = 15.667 O, and each step is O2 = [(I1 + I2) + 15.667 O1] / 17.667. Software interpolating linearly in Table 3C.5 shall give the same result.

Table 3C.6 — Problem 3C-5 routed outflow

Time (min)	Inflow I (m³/s)	Outflow O (m³/s)	Storage (m³)	Stage (m)
0	0.0000	0.0000	0.0	0.000
10	0.1667	0.0094	47.2	0.094
20	0.3333	0.0367	183.3	0.367
30	0.5000	0.0797	398.4	0.797
40	0.4167	0.1226	612.8	1.226
50	0.3333	0.1511	755.7	1.511
60	0.2500	0.1670	835.2	1.670
70	0.1667	**0.1717**	**858.6**	**1.717**
80	0.0833	0.1664	832.1	1.664
90	0.0000	0.1523	761.5	1.523
120	0.0000	0.1062	531.1	1.062
180	0.0000	0.0517	258.3	0.517

Results. Peak outflow 0.172 m³/s at 70 min; peak storage 859 m³; peak stage 1.72 m. The inflow peak of 0.50 m³/s is reduced to 34% of its value.

Table 3C.7 — Benchmark results to be reported by the applicant

Problem	Result	Benchmark	Software result	Difference (%)	Within ±5%?
3C-1	Q, main case (m³/s)	0.500			
3C-1	Q, part (b) (m³/s)	0.208			
3C-2	Tc (min)	26.27			
3C-3	Q, case (a), P = 100 mm (mm)	39.38			
3C-3	Q, case (b), P = 100 mm (mm)	64.93			
3C-3	Q, case (c), P = 100 mm (mm)	36.49			
3C-3	Q, case (c), P = 25 mm (mm)	1.97			
3C-4	Runoff, separate sub-areas (mm)	9.85			
3C-4	Runoff, composite CN (mm)	1.83			
3C-4	qp (m³/s per mm)	0.800			
3C-5	Peak outflow (m³/s)	0.172			
3C-5	Peak storage (m³)	859			

Annex 3D — Peak rate factor study for flat coastal land

Supports Clauses 3.11.5 and 3.15 of Chapter 3.

Not required in Jammu and Kashmir. Jammu and Kashmir is landlocked and mountainous, so no land in the Union Territory meets Clause 3.11.5(a), and the standard factor 484 (PRF' = 0.208) applies to all land (Clause 3.11.5). The floor of the Kashmir valley and the Sirowal of the Jammu plains are flat, but they are not coastal plain; their slow response is represented by storage, pumping and backwater (Clauses 3.10.4, 3.12.4 and 3.13), not by a lower peak rate factor, while the hills, the Kandi and the khads respond fast. The annex and the layout of Table 3D.1 are kept only so that the annex numbering is unchanged.

Table 3D.1 — Calibrated peak rate factors (layout)

Catchment	Area (km²)	Mean slope (m/m)	Drainage condition	Events used	Calibrated PRF (US customary)	PRF' (SI)	Range of applicability

Annex 3E — CWC SUH parameters for zone 7, with worked example

Supports Clauses 3.4.3 and 3.11.4 of Chapter 3.

To be prepared. This annex will tabulate, for CWC zone 7 (Western Himalayas), the regression relationships for the synthetic unit hydrograph parameters, the design storm duration, loss rate, base flow, areal reduction and time distribution, each with its reference to the Flood Estimation Report, and a worked example for one catchment. It needs the one CWC Flood Estimation Report that covers Jammu and Kashmir, the Western Himalayas zone 7 report (No. WH/22/1994, November 1994), which covers the whole Union Territory, from Jammu, R.S. Pura, Samba, Kathua and Lakhanpur on the plains, all inside its isopluvial field, to Udhampur, Katra, Rajouri, Poonch, Ramban, Doda and Kishtwar in the hills and Srinagar, Anantnag, Sopore and Baramulla in the Kashmir valley, but whose unit-hydrograph relationships are not to be used in its snow-fed catchments, such as the Sind above Sonamarg, the Lidder above Pahalgam, the Kishanganga at Gurez and the Warwan, Marwah and Paddar valleys, on the floor of the Kashmir valley or for the Jhelum main stem (see the References of Chapter 3 and Annex 3E); with the zone 7 areal reduction factors for areas above 300 km² and for 24 hours, the legends and inner labels of Plates 8, 9 and 10, which are not legible on the copy read (Plate 10 is also misregistered on it), the plate readings at Kathua, Hiranagar, Rajouri and Basohli and in the closed cells over Srinagar, Sonamarg and Mahore–Gulabgarh, and the ordinates of the 1-hour representative unit graph of the Sewa hydro-electric project, which the report uses but does not print, still to be confirmed on a cleaner copy of the report or from CWC [TBC], transcribed and checked against the published reports, and a catchment with physiographic parameters measured from survey or a DEM. Until it is published, take all SUH inputs directly from the applicable Flood Estimation Report (Clause 3.11.4(a)), apply the 24-hour design rainfall of Clauses 2.3.3(b) and 2.7.3 with the climate factor of Clause 2.8 (Clause 3.11.4(b)), report the SUH result alongside the HEC-HMS or SWMM result for the existing natural condition (Clause 3.11.4(c)), and, where the hydrograph model gives a lower 1% AEP peak, either justify it by calibration under Clause 3.15 or adopt the SUH peak (Clause 3.11.4(d)).

Table 3E.1 — SUH relationships by subzone (layout)

Parameter	Symbol	Unit	Zone 7 (Western Himalayas) relationship
Time from centre of unit rainfall to peak	tp	h	tp = 2.498 (L·Lc/S)^0.156 (printed with S, not √S; see the note)
Peak discharge per unit area	qp	m³/s per km²	qp = 1.048 tp^−0.178
Width of UH at 50% of peak	W50	h	W50 = 1.954 (L·Lc/S)^0.099
Width of UH at 75% of peak	W75	h	W75 = 0.972 (L·Lc/S)^0.124
Width of rising limb at 50% of peak	WR50	h	WR50 = 0.189 W50^1.769
Width of rising limb at 75% of peak	WR75	h	WR75 = 0.419 W75^1.246
Base width of UH	TB	h	TB = 7.845 tp^0.453
Unit duration	tr	h	1
Design storm duration	TD	h	TD = 1.1 tp (it gave the highest peak on all the gauged catchments)
Design loss rate	—	mm/h	5 (printed "0.5 cm/hr"; the observed modal value of 0.6 cm/h was judged "on higher side", and "Designers can modify this value as per local conditions"); the worked example uses 0.20 cm/h "as recommended in para 3.5", which conflicts with para 3.5 [TBC]; not for snow-fed areas; in Jammu and Kashmir, for rural SUH runs in the Jammu division only
Design base flow	—	m³/s per km²	0.05 (27 of 45 events in the range 0.00–0.10)
Ratio of t-hour to 24-hour rainfall	—	—	10-yr, from 9 self-recording gauges: 1 h 0.425; 3 h 0.600; 6 h 0.725; 9 h 0.790; 12 h 0.845; 15 h 0.895; 18 h 0.935; 24 h 1.000
Time distribution of rainfall	—	cumulative fraction by hour	3-h storm 0.73, 0.92, 1.00; 6-h storm 0.52, 0.69, 0.82, 0.91, 0.97, 1.00; 12-h storm 0.34, 0.49, 0.60, 0.67, 0.74, 0.81, 0.86, 0.90, 0.94, 0.96, 0.98, 1.00; 24-h storm 0.17, 0.27, 0.36, 0.43, 0.48, 0.53, 0.58, 0.63, 0.67, 0.70, 0.73, 0.76, 0.79, 0.82, 0.84, 0.86, 0.88, 0.90, 0.92, 0.94, 0.96, 0.98, 0.99, 1.00
Conversion of 1-day to 24-hour rainfall	—	factor	1.15
Areal reduction factor	ARF	% of point rainfall	Annex 4.2: 50 km², 94.00 at 1 h, 96.40 at 3 h, 97.70 at 6 h, 98.25 at 12 h; 100 km², 89.00, 92.90, 95.40, 96.50; 200 km², 80.75, 86.20, 89.80, 93.50; 300 km², 74.25, 80.00, 86.20, 90.50; the worked example uses 0.926 for 3 hours at 103.6 km²; the 24-hour column and the rows above 300 km² (to 2,000 km²) not read [TBC]. The storms analysed were centred on self-recording gauges outside Jammu and Kashmir; no Jammu and Kashmir storm was used

Parameter	Symbol	Unit	Zone 7 (Western Himalayas) relationship
50-yr 24-hour point rainfall at Jammu and Kashmir towns (100-yr in brackets)	—	mm	Plate 9 (Plate 10), read by eye within about one contour: Srinagar inside a closed low below 120 (below 160), read as 120 (160) under Clause 2.3.6(c); Gulmarg about 120–160 (about 160); Baramulla and Sopore about 120–160 (below 160); Uri about 120–160 (160–200); Kupwara about 160–200 (160–200); Anantnag about 160 (about 200); Pahalgam about 120–160 (160–200); Qazigund and Kokernag about 200–240 (240–280); Banihal, Ramban and Batote about 240–280 (280–320); Reasi about 280–320 (about 320), next to a closed cell above 320 over Mahore–Gulabgarh; Katra about 240–280 (280–320); Udhampur about 240–280 (about 280); Jammu and Akhnoor about 240–280 (240–280); R.S. Pura, Bishnah and Samba about 240, on the line (220–240); Kathua and Hiranagar not resolved, 240–320 (about 240–280) [TBC]; Rajouri about 240–280 (240–320, not resolved); Poonch about 160–200 (200–240); Doda about 200–240 (200–240); Bhaderwah about 200–240 (about 240); Kishtwar about 160–200 (160–200); Sonamarg and Gurez about 200–240, in and beside a closed high cell (240–280), snow-fed
Gauged catchment in Jammu and Kashmir	—	—	1 of the 6 used: the Sewa at the Sewa hydro-electric project, 75°49'20"E, 32°41'10"N, Kathua district (383.00 km²; L 40.22 km, Lc 16.00 km, S 20.59 m/km); its 1-hour representative unit graph was "developed for Sewa Hydro-Electrical project" and taken into the regression, but its ordinates are not printed in Annex 3.3 [TBC]
Catchment area for which the relationships apply	A	km²	25–1,000; not in snow-fed catchments; in Jammu and Kashmir, not on the floor of the Kashmir valley or for the Jhelum main stem
Report reference	—	—	§§3.3–3.6, Annexes 3.1 to 3.4, §4.4.2, Annexes 4.1 to 4.4, §6.2, worked example (pp. 24–26), Plates 8–10

Note: relationships as printed in the CWC zone 7 report (References of Chapter 3), read from a scanned copy and checked against the page images except where marked. L is the length of the main stream in km, Lc the length to the point nearest the catchment centroid in km, S the equivalent slope in m/km and A the catchment area in km². Zone 7 relates tp to L·Lc/S, printed without the square root that most subzone reports use, and the printed equations reproduce the report's own unit hydrographs only in that form. **Coverage.** The report was written for the four States then in the zone, Jammu and Kashmir among them, over a zone of 322,170 km² that takes in the hill basins of the Indus and Ganga systems, and its rainfall analysis drew on 40 districts, "10 in Jammu & Kashmir". All of Jammu and Kashmir is in zone 7. The contours of Plate 8 end at about 32.0–32.2°N in Gurdaspur district of Punjab, south of Kathua and Hiranagar; on Plate 9 a dashed 200 mm contour runs to the international border south-west of R.S. Pura, with Jammu about 0.2° inside it; the plates of the subzone 1(e) report do not reach the Union Territory; and Annex 4.3 lists the Jammu and Kathua districts without the mark it gives to districts partly or fully outside the zone (NEER's reading of the plates and annex). Lakhanpur, at about 32.28°N the southern tip of the Union Territory, lies inside zone 7, so no town of Jammu and Kashmir needs a cross-check against subzone 1(e). The plates cover the whole Kashmir valley, with a closed low over Srinagar. **Basis.** The unit hydrograph rests on only six catchments of 44–658 km² (five railway bridges and the Sewa hydro-electric project), with 2–5 years of record each in 1962–67 and 45 flood events, all near the southern edge of the zone: in the report's words they are "clustered near the border of the zone with subzone 1(e) and represent only about 1%" of it. No catchment of the Jhelum valley, the Tawi, the Ujh or the Chenab was used. **The Sewa.** The Sewa is the one catchment of the six in Jammu and Kashmir. Its representative unit graph is printed only as parameters (Annex 3.4): tp 4.5 h, qp 0.89 m³/s per km², a peak of 340.00 m³/s, TB 15 h, W50 2.4 h, W75 1.1 h, WR50 1.0 h and WR75 0.5 h; Annex 3.3 prints the ordinates of the five railway-bridge catchments only. For the Sewa the printed relationships give L·Lc/S = 31.25, tp ≈ 4.27 h, qp ≈ 0.81 m³/s per km², a peak of about 310 m³/s, TB ≈ 15.1 h, W50 ≈ 2.7 h, W75 ≈ 1.5 h and TD ≈ 4.7 h (NEER's computation). The regression thus reproduces the Sewa's time to peak within about 5% and its base width closely, but gives a peak about 9% below the Sewa's own unit graph and a broader hydrograph: in the one Jammu and Kashmir catchment of the report the relationships under-state the peak. Until CWC's ordinates for the Sewa are obtained [TBC], a designer using the SUH on a catchment of the Ravi side of Kathua district, of the Ujh or of the Basantar shall report the peak from the relationships increased by 10% beside the unadjusted value, and adopt the higher where the result governs (set by this Manual). The report itself warns that a design flood computed from these relations is not to be used "without verifying the results on the basis of alternate methods", and that the relations are

"not to be utilised for computation of design flood in the snow fed area of the zone". **Worked example.** The report's example, the Banu Khad at railway bridge 629, outside the Union Territory (103.60 km², L 21.32 km, Lc 11.58 km, S 69.21 m/km), was checked for this Manual against its own equations. It prints tp = 2.5 h, which is the value of that catchment's own representative unit graph in Annex 3.4, while the equations give L·Lc/S = 3.57 and tp ≈ 3.05 h; the printed qp (0.86 m³/s per km²), TB (13.0 h) and unit-hydrograph peak (89.02 m³/s) follow 3.05 h, not 2.5 h, so the example mixes the two. With the 50-yr 24-hour point rainfall of 32.00 cm read from Plate 9, the 3-hour ratio of 0.600 and an ARF of 0.926, the areal rainfall is 17.78 cm. The example then applies a loss of 0.20 cm/h, "as recommended in para 3.5", where para 3.5 recommends 0.5 cm/h; the printed 50-yr peak of 1,365.22 m³/s follows from the 0.20 cm/h loss, and with 0.5 cm/h the same unit hydrograph gives about 1,311 m³/s, about 4% lower (NEER's recomputation). This Manual uses 0.5 cm/h and reads tp from the equations [TBC]. **Use in the Union Territory.** The gauged catchments have slopes of 9.9–84 m/km; the urban hill catchments of Udhampur, Katra, Ramban, Doda and Rajouri are far steeper and far smaller than 25 km², and are designed by the methods of Clause 3.4 with the rules for steep ground of the Commentary to Clause 3.7. The SUH applies to the rural khads and nallahs of 25–1,000 km² that enter the towns of the Jammu division and leave the hills of the Kashmir valley, such as the tributaries of the Tawi and the khads of the Kandi above Jammu, the Devak above Udhampur, the Basantar above Samba, the tributaries of the Ujh and the Ravi above Kathua and Hiranagar, the streams entering Akhnoor, Rajouri and Poonch, and, down to the break of slope only, the Doodhganga, the Sukhnag, the Romshi, the Vishow and the Rambiara where they leave the Pir Panjal for the Karewas; the Tawi at Jammu, the Ujh and the Basantar shall be checked against the report's range of 25–1,000 km² before it is used. It does not apply on the floor of the Kashmir valley, whose flat land drains to an embanked river and whose flows are stored by Wular, Hokersar and the flood basins, nor to the Jhelum main stem; there the catchment is modelled with storage, pumps and river stage under Clauses 3.12 and 3.13. In sub-area JK-D (High mountains and snow-fed catchments) the zone 7 SUH does not apply: catchments with snow or glacier cover, such as the Sind above Sonamarg, the Lidder above Pahalgam, the Kishanganga at Gurez, the Warwan, the Marwah and the Paddar valley, require a site-specific hydrological study, and no design there is complete without the glacial-lake-outburst, landslide-lake and debris-flow screening of Clause 2.3.6(i). Where a city catchment lies within the range, the SUH is computed only as the benchmark of its natural condition (Clause 3.11.4), and the catchment itself is designed by the methods of Clause 3.4 with the design rainfall of Chapter 2. The Jhelum, the Chenab and the Ravi are far larger than the catchments of the report and are outside Clause 3.11.4 (Clause 3.4.5); below Salal, Baglihar, Dul Hasti and Ranjit Sagar the flood is set by releases (Chapter 5). The design loss rate of 5 mm/h is a φ-index fitted to the monsoon floods of whole rural catchments of the outer hills; it is used only in rural SUH runs in the Jammu division, is not a soil infiltration capacity and is not used to assign HSG (Clause 3.7), in urban SCS-CN or SWMM models, or to size infiltration practices (Chapter 4). The ratios are not to be used to derive intensities for durations shorter than the TD of the SUH (Chapter 2): with the zone 7 ratio of 0.425 the 50-yr 1-hour depth is below about 51 mm at Srinagar, about 51–68 mm at Gulmarg and about 102–119 mm at Jammu, against largest recorded 1-hour falls of 32 mm at Srinagar (28 August 1975) and 62 mm at Gulmarg (9 September 1980) (Annex 4.4 of the report); no 1-hour record at Jammu has been found, and Clause 2.3.6 deals with the difference. At 24 hours the plates are exceeded on the outer-hill front of the Jammu division, where Jammu recorded 380 mm in the 24 hours to 08:30 IST on 27 August 2025 (IMD) and 299.2 mm on 31 July 1961, Batote 316.2 mm and Katra 292.4 mm on 25 September 1988 (IMD, *Extremes … up to 2012*), and Udhampur IAF 630 mm on 27 August 2025 (IMD; gauge record to be confirmed [TBC]); at high stations in winter, such as Gulmarg (293.4 mm on 20 February 1967); and they are matched or not reached in the Kashmir valley, as at Srinagar (147.8 mm on 31 January 1930) and Qazigund (206 mm in September 2014). The plate values are therefore a floor under Clause 2.3.3, not a ceiling, and Clause 2.3.6(h) decides which records count.

Table 3E.2 — Worked example outline (layout)

Step	Content	Clause
1	Catchment area, main stream length, length to centroid and equivalent slope, from survey or DEM	3.11.4(a)
2	SUH parameters from Table 3E.1 and the plotted unit hydrograph	3.11.4(a)
3	Design storm duration, point and areal 24-hour rainfall with climate factor, time distribution	3.11.4(a), (b)
4	Effective rainfall after the design loss rate; convolution with the SUH; base flow added	3.11.4(a)

Step	Content	Clause
5	1% AEP peak compared with the HEC-HMS or SWMM peak for the existing natural condition	3.11.4(c), (d)

Form 3-1 — Hydrologic Calculation Summary

Supports Clauses 3.4, 3.6, 3.7, 3.8, 3.10–3.13, 3.15–3.17 of Chapter 3.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One form per submittal. Attach the documents listed in Section H.

A. Project

Table 3F.1 — Form 3-1: project

Field	Entry
A1. Project name and applicant	
A2. Location (village or ward, survey numbers, district)	
A3. Site area (ha) and number of points of comparison (POCs)	
A4. Catchment class: standard (Clause 2.11.2) or flood-sensitive (Clause 2.11.3)	
A5. Design Rainfall Sheet reference (Form 2-1)	

B. Method and software (Clauses 3.4, 3.11, 3.12, 3.16)

Table 3F.2 — Form 3-1: method and software

Field	Entry
B1. Purpose of each calculation (conveyance, storage, comparison, catchment study)	
B2. Contributing area for each purpose (ha or km²)	
B3. Method used and the row of Table 3.1 that permits it	
B4. Reason for the choice of method	
B5. Software and version; engine and version for packages built on SWMM or HEC (Clause 3.16.1, 3.16.2)	
B6. For other software: benchmark results of Annex 3C attached (Table 3C.7) and the 5% comparison of Clause 3.16.2	
B7. Runoff transform (Clause 3.11.1)	
B8. Computation interval Δt (h), with 0.133 Tc of the smallest sub-area and the hyetograph time step (Clause 3.11.3(a))	
B9. Storage routing and channel routing methods (Clauses 3.12.1, 3.12.2)	
B10. Dynamic-wave routing required? If yes, which condition of Clause 3.12.4	
B11. CWC SUH benchmark required (25–5,000 km², Clause 3.11.4)? Result reference	
B12. Continuous simulation required (Clause 3.13.1)? Record used and starting tank levels (Clause 3.13.5)	
B13. Calibration required (Clause 3.15.1)? Calibration report reference	

C. Soils and groundwater (Clauses 3.3.3(b), 3.7, 3.10)

Table 3F.3 — Form 3-1: soils and groundwater

Field	Entry
C1. HSG source map, scale and lookup used (Clause 3.7.1, Annex 3A) or NEH Part 630, Ch. 7 assignment (Clause 3.7.2)	
C2. Infiltration tests: number, locations, depths, results (Clause 3.7.3)	
C3. Seasonal high water table: depth below ground and source (Clause 3.10.2)	
C4. Areas within 0.6 m assigned HSG D (Clause 3.10.1)	
C5. Disturbed pervious areas and HSG downgrade applied (Clause 3.3.3(b))	

D. Parameters by sub-area and condition (Clauses 3.3, 3.5, 3.8, 3.9; Clause 3.17 item 4)

Table 3F.4 — Form 3-1: parameters by sub-area and condition

Sub-area	Condition (pre / post)	Area (ha)	Impervious: roofs / paved / roads (ha)	DCIA (ha)	Disconnected (ha)	HSG	CN, AMC II	CN, AMC III (pervious part)	C and Cf (if Rational)	Tc (min)

E. Time of concentration worksheet (Clause 3.6)

One worksheet per sub-area and condition.

Table 3F.5 — Form 3-1: time of concentration worksheet

Segment	Flow type	Surface and n (Table 3.4)	L (m)	S (m/m)	P2 (mm)	V (m/s)	Tt (min)
1	Sheet					—	
2	Shallow concentrated				—		
3	Channel or pipe				—		
	Tc (not less than 10 min)						

E1. Is the post-development Tc shorter than the pre-development Tc? If not, explain (Clause 3.6.6): _____

F. Rainfall and losses (Clauses 3.8.4, 3.8.5, 3.11.5, 3.12, 3.3.5)

Table 3F.6 — Form 3-1: rainfall, losses and starting levels

Field	Entry
F1. AEPs and durations run; climate factor applied (Chapter 2)	
F2. AMC used for each duration (Clause 3.8.4)	
F3. Ia ratio for design runs; Ia = 0.05S sensitivity run made (Clause 3.8.5)	
F4. Peak rate factor used; if lower than 484, the Annex 3D value and the land it applies to (Clause 3.11.5)	
F5. Starting water level of each tank or waterbody, and its basis (Clauses 3.12.5, 3.13.5)	

Field	Entry
F6. Off-site run-on: land use assumed for conveyance and for the comparison (Clause 3.3.5)	
F7. Incidental storage counted? If yes, the authority's acceptance (Clause 3.12.3)	

G. Departures

Table 3F.7 — Form 3-1: departures from Chapter 3

No.	Clause departed from	Value used in place of the Chapter 3 value	Justification
1			
2			

H. Attachments (Clause 3.17)

Table 3F.8 — Form 3-1: attachments

Item	Attached (yes / no / not applicable)	Reference
H1. Catchment maps, pre- and post-development, with sub-areas, Tc flow paths, POCs and off-site run-on		
H2. HSG map, water-table data and infiltration test results		
H3. Parameter tables (Section D) and Tc worksheets (Section E)		
H4. Design Rainfall Sheet (Form 2-1) and hyetographs		
H5. Hydrograph tables and plots; stage–storage and stage–discharge tables; routed outflows; peak water levels		
H6. Form 3-2 for each POC		
H7. Calibration report (Clause 3.15)		
H8. Native model input and output files (Clause 3.16.4)		

I. Statement by the responsible engineer (Clause 3.17 item 10)

I state that the methods and parameters of Chapter 3 of the Jammu and Kashmir Stormwater Design Manual (Draft v1.0) have been used in this submittal, and that every departure is listed and justified in Section G.

Table 3F.9 — Form 3-1: statement by the responsible engineer

Field	Entry
Name	
Qualification and registration number	
Organisation	
Signature	
Date	

Form 3-2 — Pre- vs Post-Development Comparison

Supports Clauses 3.8.5, 3.11.5 and 3.14 of Chapter 3.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One form for each point of comparison (POC). Flows in m³/s, volumes in m³.

A. Point of comparison (Clause 3.14.2)

Table 3F.10 — Form 3-2: point of comparison

Field	Entry
A1. POC identifier and location	
A2. Area draining to the POC: site (ha) and off-site run-on (ha)	
A3. Off-site run-on passes through site storage? (Clause 3.14.2(c))	
A4. Catchment class: standard (Clause 2.11.2) or flood-sensitive (Clause 2.11.3)	
A5. Tailwater applied, including joint cases of Clause 2.12 (Clause 3.14.9(c))	
A6. Flood-sensitive only: largest 10% AEP pre-development peak over all durations, the cap of Clause 2.11.3 (Clause 3.14.7)	
A7. Flood-sensitive only: 50% AEP pre-development peak at the pre-development critical duration (Clause 2.11.3)	

B. Peak flows (Clauses 3.14.7–3.14.10)

Limit: standard catchments 0.9 × Q_pre for the same AEP and duration (Clause 3.14.10(a)); flood-sensitive catchments the caps A6 (for 1% AEP) and A7 (for 50% AEP) (Clause 3.14.10(b)).

Table 3F.11 — Form 3-2: peak flows by AEP and duration

AEP	Duration (h)	AMC	Q_pre	Q_post, uncontrolled	Q_post, routed	Limit	Met?
50% (2-yr)	1	II					
50% (2-yr)	2	II					
50% (2-yr)	3	II					
50% (2-yr)	6	II					
50% (2-yr)	12	III					
50% (2-yr)	24	III					
50% (2-yr)	48	III					
50% (2-yr)	72	III					
10% (10-yr)	1	II					
10% (10-yr)	2	II					
10% (10-yr)	3	II					
10% (10-yr)	6	II					

AEP	Duration (h)	AMC	Q_pre	Q_post, uncontrolled	Q_post, routed	Limit	Met?
10% (10-yr)	12	III					
10% (10-yr)	24	III					
10% (10-yr)	48	III					
10% (10-yr)	72	III					
1% (100-yr)	1	II					
1% (100-yr)	2	II					
1% (100-yr)	3	II					
1% (100-yr)	6	II					
1% (100-yr)	12	III					
1% (100-yr)	24	III					
1% (100-yr)	48	III					
1% (100-yr)	72	III					

C. Volumes and storage (Clauses 3.14.8–3.14.10)

Table 3F.12 — Form 3-2: volumes and storage

AEP	Governing duration (h)	Runoff volume, pre	Runoff volume, post uncontrolled	Retention volume	Detention storage required	Peak water level in storage (m)
50% (2-yr)						
10% (10-yr)						
1% (100-yr)						

C1. Governing duration for storage, and the 24, 48 and 72 h results (Clause 3.14.10): _____

D. Sensitivity runs (Clauses 3.8.5, 3.14.11)

Table 3F.13 — Form 3-2: sensitivity runs

Run	Governing storm (AEP, duration)	Change in Q_post, routed (%)	Change in required storage (%)	Retention volume or WQv governing (Clause 3.8.5(c))
Ia = 0.05S				
Standard peak rate factor (only where a lower factor is used)				—

E. Associated checks (Clause 3.14.12)

Table 3F.14 — Form 3-2: associated checks

Check	Result	Reference in submittal
Drawdown times (Chapter 4)		
Minimum orifice and trash screen (Chapter 4)		
Emergency spillway (Chapter 4)		
Outfall-closed storage check (Chapter 5)		
Downstream analysis (Chapter 5)		

F. Statement by the responsible engineer

I state that this comparison has been made by the procedure of Clause 3.14, with the same design storms in the pre- and post-development runs, and that no runoff has been diverted from one natural catchment to another to meet the criterion (Clause 3.14.2(b)).

Table 3F.15 — Form 3-2: statement by the responsible engineer

Field	Entry
Name	
Qualification and registration number	
Signature	
Date	

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

ANNEXES TO CHAPTER 4

Site Runoff Control: Retention and Detention

These annexes support Chapter 4. Annex 4C is a complete Tier A worked example with routing tables, built on the illustrative example of Clause 4.6.7. Annex 4B sets out the structure of the Tier B tables, the provisional fixed release coefficients and a standard orifice table computed from the Chapter 4 orifice equation; the values that need NIH-DHAARA depths are still to be derived. Annex 4A needs GIS and groundwater data that this draft does not yet contain; it gives the intended layout and the interim rules of Chapter 4. Forms 4-1 to 4-3 are the submittal forms required by Clause 4.17. They are draft forms and have no statutory status.

Annex 4A — Flood-sensitive catchment boundaries (GIS); shallow-groundwater zone map

Supports Clauses 4.5.3, 4.5.4 and 4.12 of Chapter 4.

4A.1 **Flood-sensitive catchment boundaries.** The catchments are those listed in Clause 4.5.3.2, with any catchment notified under Clause 4.5.4. Their maps and GIS layer are the same data set as Annex 1B, which lists the catchments and gives the attribute layout of the layer. The two annexes shall be issued together.

4A.2 **Shallow-groundwater zone map.** This map shows the areas where Clause 4.12 applies: the floor of the Kashmir valley, on its alluvium, Gurti clay and Nambal peat, in and around Srinagar, Anantnag–Bijbehara, Pampore, Sopore, Baramulla, Sumbal and Bandipora, the Sirowal of the Jammu plains round R.S. Pura, Bishnah, Arnia and Hiranagar, the floodplains and low terraces of the Jhelum, the Tawi, the Chenab, the Ujh, the Basantar, the Ravi and the khads, the margins of Dal, Nigeen, Anchar, Wular, Manasbal, Hokersar and the other lakes and nambals, of Mansar and Surinsar and of the Kandi ponds and talabs, the margins and backwaters of the Salal, Baglihar and Dul Hasti reservoirs and of the Tawi barrage pond, and hill sites with perched water, such as Thathri Nai Basti, Pernote and Duksar, and any area where the groundwater table lies within 3 m of the surface at any time of year (Clause 4.12.1).

To be prepared. This annex will contain (a) the boundaries of the flood-sensitive catchments as a GIS layer and as maps at a scale fit for deciding whether a plot lies inside them, and (b) a map of the shallow-groundwater zone of Clause 4.12.1, with the seasonal high groundwater depth during and after the SW monsoon. It needs basin and sub-basin boundaries from a digital elevation model and the drainage network (I&FC, NRSC, Survey of India), the embankments, flood spill channels, city channels and other flood-control works of I&FC on the Jhelum, the Tawi, the Chenab and the khads, with their design levels and the levels of the CWC and I&FC gauges (the first in metres, the second in feet on zeros that are not published; neither is converted into the other), the flood-zonation categories of I&FC used in the Srinagar Master Plan 2035 and the Lelhar–Lasjan 25-year floodplain the plan proposes, the levels of the Salal, Baglihar, Dul Hasti and Ranjit Sagar reservoirs and of the Tawi barrage pond from their operators, the buffers of clauses 5.2.5 and 7.12 of UBBL-2021 and of the Srinagar and Jammu master plans, the Gair Mumkin Khad land of the revenue records with the functional khads identified with I&FC, the Ramsar sites (Wular, Hokersar, Surinsar–Mansar, Hygam and Shallabugh) and the wetland conservation reserves, the areas of LCMA and WUCMA, the zamindari khuls and the Ranbir and other canals, and the land-sinking areas listed by JKPCC, town boundaries (H&UDD and the Town Planning Organisations of Kashmir and Jammu, SMC, JMC and the Municipal Councils and Municipal Committees, and SDA, JDA and the other Development Authorities), flood maps held by J&K SDMA, observation-well records of the CGWB and the Jal Shakti Department (PHE), and the extent of the Kandi fans and khad beds, the Sirowal, the Karewa tablelands, the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, the river terraces, the Siwalik and Murree rocks, debris cover, colluvium, slide debris, moraine and exposed rock of the hills, and the soils of the high mountains, with the slopes of more than 10° to which the hill infiltration rule of Clause 4.11 applies from soil survey maps (NBSS&LUP, the Agriculture Production Department, Jammu and Kashmir (soil survey) [TBC]). Until it is published: (a) the catchments named in Clause 4.5.3.2 apply, and whether a site lies in one is decided and recorded as set out in Annex 1B; and (b) every site to which Clause 4.12.1 may apply establishes its design groundwater level from site piezometer readings over one March–November season or, failing that, from the nearest CGWB or State observation well plus 0.5 m and the design flood level of any adjacent river, khad, nallah, lake, nambal, talab or reservoir (Clause 4.12.1(b)). For the flotation check in the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, the Sirowal belt of the Jammu plains, the river terraces and floodplains, and the lake, nambal and reservoir margins without piezometer readings, the design groundwater level is existing ground level (Clause 4.12.1).

Table 4A.1 — Attributes of the shallow-groundwater zone layer (layout)

Field	Content	Unit or format
zone_id	Unique identifier	text
zone_class	Kashmir valley floor (Srinagar, Anantnag–Bijbehara, Pampore, Sopore–Baramulla or other); Sirowal of the Jammu plains (R.S. Pura, Bishnah, Arnia, Hiranagar or other); river floodplain or low terrace (Jhelum, Tawi, Chenab, Ujh, Basantar, Ravi or a khad); lake, nambal or talab margin (Dal, Nigeen, Anchar, Wular, Manasbal, Hokersar, Mansar, Surinsar, a Kandi pond or other); reservoir or barrage-pond margin or backwater (Salal, Baglihar, Dul Hasti, the Tawi barrage or other); perched water on a hill slope (Thathri, Pernote, Duksar or other); other area with groundwater within 3 m of the surface (Clause 4.12.1)	text
shgw_depth_m	Seasonal high groundwater depth below ground, SW monsoon season	m
shgw_basis	Wells or piezometers used, and period of record	text
tidal_influence	Whether the groundwater level follows an adjacent tidal water body (Clause 4.12.1(b))	yes / no
source	Source agency and date of the data	text
geometry	Zone boundary	polygon

Annex 4B — Tier B tables: PSD and SSR (Table 4.3), retention credit factor C_R, standard outlet sizes; confirmed fixed release coefficients (Table 4.3A)

Supports Clauses 4.4.6.3, 4.14.1, 4.14.2 and 4.14.4 to 4.14.6 of Chapter 4.

4B.1 This annex will hold four tables. Their status in this draft is:

Table 4B.1 — Contents of Annex 4B and their status

Table	Content	Clause	Status in this draft
4B.2	Tier B permissible site discharge (PSD) and site storage requirement (SSR), the values of Table 4.3	4.14.2	To be prepared
4B.3	Retention credit factor C_R	4.4.6.3	To be prepared; C_R = 0 until published
4B.4	Standard outlet sizes	4.14.2 step 4, 4.14.6	Computed in this annex from the orifice equation of Clause 4.6.5.2
4B.5	Fixed release coefficients C_10 and C_2 (Table 4.3A)	4.14.4	Provisional values of Table 4.3A; confirmed values to be prepared

4B.2 PSD and SSR (Table 4.3)

To be prepared. This table will give, for each rainfall zone, hydrologic soil group and post-development imperviousness, the PSD for the 2-yr and 100-yr stages and the SSR, for standard and flood-sensitive catchments, in the layout of Table 4.3. It needs NIH-DHAARA design depths with the climate factor for each zone (Chapter 2, Annex 2A), the sub-daily ratios of Annex 2B, and routing of a set of standard sites by the full method of Clause 4.6 for every AEP and duration of Table 4.1. Each PSD shall be the governing release cap and each SSR the governing storage per hectare, with a margin so that the simplified method is never cheaper than routing. Until it is published, Tier B sites use Clause 4.6, or the fixed-coefficient route of Clause 4.14.3 where the site is 1 ha or less (Clauses 4.14.1 and 4.14.3).

Table 4B.2 — Tier B PSD and SSR (layout of Table 4.3)

Zone (Annex 2A)	HSG	Imperviousness	PSD 2-yr (L/s/ha)	PSD 100-yr (L/s/ha), standard	PSD 100-yr (L/s/ha), flood-sensitive	SSR (m³/ha), standard	SSR (m³/ha), flood-sensitive
JK-Z1 Jammu plains: JK-A Jammu plains, Kandi and Sirowal (Jammu–R.S. Pura–Akhnoor–Samba–Kathua)	A / B / C / D	50% / 70% / 90%	—	—	—	—	—
JK-Z2 Pir Panjal–Chenab hills: JK-B Outer and middle hills (Udhampur–Katra–Reasi–Rajouri–Poonch–Ramban–Banihal)	B / C / D	50% / 70% / 90%	—	—	—	—	—
JK-Z2 Pir Panjal–Chenab hills: JK-B1 Inner Chenab hills (Doda–Kishtwar–Bhaderwah)	B / C / D	50% / 70% / 90%	—	—	—	—	—

Zone (Annex 2A)	HSG	Imperviousness	PSD 2-yr (L/s/ha)	PSD 100-yr (L/s/ha), standard	PSD 100-yr (L/s/ha), flood-sensitive	SSR (m³/ha), standard	SSR (m³/ha), flood-sensitive
JK-Z3 Kashmir valley: JK-C Kashmir valley floor and Karewas (Srinagar–Anantnag–Pampore–Sopore–Baramulla–Kupwara)	B / C / D	50% / 70% / 90%	—	—	—	—	—
JK-Z4 High mountains: JK-D High mountains and snow-fed catchments (Gulmarg–Pahalgam–Sonamarg–Gurez–Paddar; hazard-first)	—	—	Not tabulated: Clause 4.6 applies (Clause 2.3.6(i))	—	—	—	—

4B.3 Retention credit factor C_R

To be prepared. This table will give C_R for each rainfall zone, hydrologic soil group and design infiltration or drawdown rate of the retention practice (Clauses 4.4.3 and 4.4.6.3). It needs routing of the full duration set of Clause 2.5.2 with NIH-DHAARA depths, with the retention practice modelled as in Clause 4.4.6.2, and the credit expressed as the reduction in governing storage per cubic metre of retention provided. Until it is published, **C_R = 0** (Clause 4.4.6.3).

Table 4B.3 — Retention credit factor C_R (layout)

Zone (Annex 2A)	HSG	Design infiltration or drawdown rate (mm/h)	C_R (–)

4B.4 Standard outlet sizes

4B.4.1 Table 4B.4 gives the largest circular orifice, in 5 mm steps, whose discharge does not exceed a stated permissible discharge at a stated head. It is computed from the orifice equation with the discharge coefficient of Clause 4.6.5.2:

$$Q = 0.60 \times (\pi d^2 / 4) \times \sqrt{(2 g H)}$$

where Q is the discharge (m³/s), d the orifice diameter (m), g = 9.81 m/s² and H the head from the water level to the centre of the orifice (m). Sizes are rounded **down**, so that the orifice never passes more than the permissible discharge. Where the computed size is below 50 mm, the 50 mm minimum of Clause 4.8.2 is shown; it is deemed to comply under Clause 4.5.5.1.

4B.4.2 The table assumes free discharge. Where the tailwater can rise above the orifice (Clause 4.6.6), H is the difference between the upstream and downstream water levels and the orifice shall be checked by routing. The State Stormwater Technical Committee may replace this table when it issues Annex 4B.

Table 4B.4 — Largest orifice diameter (mm) for a permissible discharge at a given head (Cd = 0.60, free discharge)

Permissible discharge (L/s)	H = 0.5 m	H = 1.0 m	H = 1.5 m	H = 2.0 m
5	55	50	50	50
10	80	65	60	55
15	100	80	75	70
20	115	95	85	80
30	140	115	105	100
50	180	150	135	130
75	225	185	170	155
100	260	215	195	180
150	315	265	240	225
200	365	305	275	260
300	450	375	340	315

Check: for 50 L/s at H = 1.0 m, the area is 0.050 / (0.60 × √(2 × 9.81 × 1.0)) = 0.0188 m², so d = √(4 × 0.0188 / π) = 0.155 m, rounded down to 150 mm.

4B.5 Fixed release coefficients (Table 4.3A)

4B.5.1 Table 4B.5 repeats the provisional coefficients of Table 4.3A. They may be used now under the fixed-coefficient route (Clause 4.14.4).

Table 4B.5 — Fixed release coefficients C_10 and C_2 (provisional, Table 4.3A)

Hydrologic soil group	C_10	C_2	Clause	Status
A (sandy, well drained)	0.05	0.02	4.14.4	Provisional
B	0.08	0.03	4.14.4	Provisional
C	0.15	0.08	4.14.4	Provisional
D (clay, poorly drained)	0.25	0.15	4.14.4	Provisional

To be prepared. The confirmed coefficients will replace Table 4B.5. They need NIH-DHAARA depths for each zone and the greenfield curve numbers of Clause 3.3, as described in the commentary to Clause 4.14. Until they are published, the provisional values of Table 4.3A apply.

Annex 4C — Worked example (Tier A) with full routing tables

Supports Clauses 4.4 to 4.9, 4.15 and 4.17 of Chapter 4.

Illustrative — not design values. This example continues the illustrative example of Clause 4.6.7. Its inputs are invented to be plausible for a colony draining to a khad in Jammu; they are not NIH-DHAARA values and must not be used for design. Part 1 sets out the inputs, hydrographs and routing step by step, for a trial outlet. Part 2 finds that the trial outlet

fails the drawdown check with the blockage of Clause 4.8.3, and revises it to the outlet reported in Table 4.2. Part 3 completes the spillway, outlet, safety and retention checks. The outfall-closed check of Chapter 5 for the same facility on an outfall to a khad draining to the Tawi in Jammu is in Annex 5C.

Part 1 — Inputs, hydrographs and routing (Clauses 4.6.1 to 4.6.4)

4C.1 **Inputs.**

Table 4C.1 — Inputs (Illustrative — not design values)

Item	Value	Basis
Site area A	2.0 ha (0.02 km²), one outfall	Clause 4.6.7
Catchment class	Flood-sensitive (Clause 4.5.3)	Clause 4.6.7
Land cover and curve numbers, AMC II	Pre-development: all pervious, CN 70. Post-development, as two sub-areas: directly connected impervious 1.57 ha at CN 98, and pervious open space 0.43 ha at CN 70 (same soil as pre-development). Impervious fraction f = (92 − 70) / (98 − 70) = 0.786, so the area-weighted CN is 92	Clauses 3.9.2, 4.6.7
AMC III conversion	Pervious areas only, for storms of 12 h and longer: CN_III = 23·CN / (10 + 0.13·CN) = 84.3. The impervious CN 98 is not converted	Clause 3.8.4
Initial abstraction	Ia = 0.2S; Ia = 0.05S as a sensitivity run	Clause 3.8.5
Time of concentration Tc	45 min pre-development; 15 min post-development, used for both sub-areas, because the open space is small and drains through the same site system	Clause 4.6.7
Unit hydrograph	SCS triangular; tL = 0.6 Tc; tp = Δt/2 + tL; base 2.67 tp	Clauses 3.6.5, 3.11.2
Time step Δt	5 min (= Tc/3 of the post-development site)	Clause 4.6.2, step 8
24-h depths, 2-, 10-, 100-yr	110, 200, 350 mm, taken as including the climate factor	Clause 4.6.7
Shorter durations	P(t) = P24 · (t/24)^0.40 (assumed ratio set, not Annex 2B)	Clause 4.6.7
48-h and 72-h depths	1.25 and 1.40 × P24, with the 24-h depth on the last day	Clauses 4.6.7, 2.9.2
Storage	Open, vertical-walled, 2,500 m² plan area, excavated, no embankment, not publicly accessible	Clause 4.6.7
Trial outlet	Stage 1: 120 mm orifice at the floor. Stage 2: 470 mm orifice, invert 0.533 m above the floor. No Stage 3	Trial for this annex; Part 2 revises it
Outfall	Free outfall to a receiving drain whose level stays below the outlet invert	Illustrative input

The example follows Clauses 3.8.4 and 3.9.2: the runoff of each sub-area is computed separately and the two are added before routing.

4C.2 **Design rainfall.** Table 4C.2 gives the depths. For example, the 100-yr 6-hour depth is 350 × (6/24)^0.40 = 350 × 0.574 = 201.0 mm.

Table 4C.2 — Design rainfall depths, mm (Illustrative — not design values)

Duration (h)	1	2	3	6	12	24	48	72
50% AEP (2-yr)	30.9	40.7	47.9	63.2	83.4	110.0	137.5	154.0

Duration (h)	1	2	3	6	12	24	48	72
10% AEP (10-yr)	56.1	74.0	87.1	114.9	151.6	200.0	250.0	280.0
1% AEP (100-yr)	98.2	129.5	152.3	201.0	265.3	350.0	437.5	490.0

4C.3 **Hyetographs.** Storms up to 24 h use the alternating-block method in 5-minute blocks with the peak block at mid-storm (Clause 2.9.1). The 48- and 72-hour storms spread the depth in excess of the 24-hour depth uniformly over the first 24 or 48 h and place the 24-hour alternating-block storm on the last day (Clause 2.9.2). For the 100-yr 72-hour storm: (490.0 − 350.0) / 576 blocks = 0.243 mm per 5 minutes for the first 48 h; the peak 5-minute block on the last day is 350 × (5/1440)^0.40 = 36.3 mm, at 60:00–60:05 h.

4C.4 **Losses.** Table 4C.3 gives S = 25,400/CN − 254 (mm) and Ia = 0.2S. The runoff depth for a rainfall depth P is Q = (P − Ia)² / (P − Ia + S) for P > Ia, and zero otherwise.

Table 4C.3 — Curve numbers and abstractions (Illustrative — not design values)

Condition	AMC	CN	S (mm)	Ia = 0.2S (mm)
Pre-development	II (durations ≤ 6 h)	70	108.9	21.8
Pre-development	III (durations ≥ 12 h)	84.3	47.3	9.5
Post-development pervious open space (0.43 ha)	II (durations ≤ 6 h)	70	108.9	21.8
Post-development pervious open space (0.43 ha)	III (durations ≥ 12 h)	84.3	47.3	9.5
Post-development directly connected impervious (1.57 ha)	All durations (not converted)	98	5.2	1.0

Check: 100-yr 24 h, post-development. Impervious: Q = (350.0 − 1.0)² / (350.0 − 1.0 + 5.2) = 343.9 mm. Pervious, AMC III: Q = (350.0 − 9.5)² / (350.0 − 9.5 + 47.3) = 299.0 mm. Site: 0.786 × 343.9 + 0.214 × 299.0 = 334.2 mm. The post-development columns of Table 4C.4 are these area-weighted site depths.

Table 4C.4 — Storm runoff depth Q, mm (Illustrative — not design values)

Duration (h)	AMC	2-yr pre	2-yr post	10-yr pre	10-yr post	100-yr post
1	II	0.7	20.1	8.2	41.3	79.2
2	II	2.8	28.2	16.9	57.2	108.5
3	II	5.1	34.2	24.5	69.0	130.2
6	II	11.4	47.5	42.9	94.7	177.1
12	III	45.0	70.5	106.6	137.2	249.9
24	III	68.4	96.4	152.6	185.1	334.2
48	III	93.5	123.3	201.0	234.7	421.5
72	III	108.9	139.6	230.3	264.5	473.9

The runoff volume is 10 × Q × A = 20 × Q m³ for this 2.0 ha site: for example 9,478 m³ for the 100-yr 72-hour storm. The routed hydrographs carry up to 0.5% less, because the 5-minute alternating-block storm places 349.5 mm rather than 350.0 mm on the last day.

4C.5 **Unit hydrographs.** The runoff in each 5-minute block (for the post-development site, the sum of the two sub-areas) is convolved with the triangular unit hydrograph of Table 4C.5. The peak is qp = 0.208 × A × Q / tp, with A in km² and Q = 1 mm (Clause 3.11.2).

Table 4C.5 — Unit hydrograph parameters (Illustrative — not design values)

Condition	Tc (h)	tL = 0.6 Tc (h)	tp = Δt/2 + tL (h)	Base 2.67 tp (h)	qp (L/s per mm of runoff)
Pre-development	0.75	0.45	0.492	1.313	8.5
Post-development	0.25	0.15	0.192	0.512	21.7

4C.6 **Release caps (Clause 4.5.3).** The site is flood-sensitive, so the mixed-frequency rule applies. The 100-yr cap is the largest pre-development 10-yr peak over all durations: **356 L/s** (72 h; Table 4.2). The 2-yr cap is the largest pre-development 2-yr peak: **180 L/s** (72 h). Each cap applies to every post-development duration (Clause 4.5.3.1).

4C.7 **Stage–storage–discharge.** The basin is vertical-walled, so storage S = 2,500 × h (m³), where h is the stage above the floor (m). Outlet discharge follows Clause 4.6.5.2 with Cd = 0.60:

- Stage 1, for h ≥ d: Q1 = 0.60 × A1 × √(2g (h − d/2)). For h < d (orifice part-full), the head is taken as d/2 and the result is multiplied by h/d.
- Stage 2 is counted once the water is above its centre: Q2 = 0.60 × A2 × √(2g (h − z2 − d2/2)), where z2 is its invert. Below its centre its flow is ignored, which slightly over-states storage.

Table 4C.6 — Stage–storage–discharge, trial outlet (Illustrative — not design values)

Stage h (m)	Storage (m³)	Stage 1, 120 mm (L/s)	Stage 2, 470 mm (L/s)	Total (L/s)
0.00	0	0.0	0.0	0.0
0.06	150	3.7	0.0	3.7
0.12	300	7.4	0.0	7.4
0.20	500	11.2	0.0	11.2
0.30	750	14.7	0.0	14.7
0.40	1,000	17.5	0.0	17.5
0.50	1,250	19.9	0.0	19.9
0.60	1,500	22.1	0.0	22.1
0.70	1,750	24.0	0.0	24.0
0.80	2,000	25.9	83.0	108.9
0.90	2,250	27.5	167.8	195.3
1.00	2,500	29.1	222.3	251.4
1.10	2,750	30.7	265.8	296.5
1.20	3,000	32.1	303.2	335.3
1.30	3,250	33.5	336.4	369.9
1.40	3,500	34.8	366.7	401.5

Check at h = 1.00 m: Q1 = 0.60 × 0.01131 × √(19.62 × 0.94) = 0.0291 m³/s; Q2 = 0.60 × 0.1735 × √(19.62 × (1.00 − 0.533 − 0.235)) = 0.2223 m³/s.

4C.8 **Routing.** Each storm is routed by level-pool continuity (Clause 4.6.1): over each 5-minute step, the change in storage equals inflow volume minus outflow volume. The computation used six 50-second sub-steps per 5-minute step. Each row of Table 4C.7 can be checked by hand as ΔS ≈ (I − Ō) × 300 s, where I is the mean inflow over the 5-minute

step ending at the time shown and $\bar{O}$ is the mean of the outflows at the start and end of the step. For example, between 60:15 and 60:20: $\Delta S = 2{,}853.0 - 2{,}613.3 = 239.7$ m³, and $(1.0891 - (0.2655 + 0.3069)/2) \times 300 = 240.9$ m³.

Table 4C.7 — Routing of the 100-yr 72-hour storm through the trial outlet, around the peak (Illustrative — not design values)

Time (h:min)	Rainfall in step (mm)	Inflow I (L/s)	Outflow O (L/s)	Storage S (m³)	Stage h (m)
60:00	8.44	286.3	169.5	2,164.0	0.866
60:05	36.33	354.2	184.1	2,216.9	0.887
60:10	11.61	703.3	218.0	2,367.1	0.947
60:15	6.88	1,066.0	265.5	2,613.3	1.045
60:20	5.23	1,089.1	306.9	2,853.0	1.141
60:25	4.34	897.5	334.8	3,025.0	1.210
60:30	3.77	653.2	349.9	3,117.6	1.247
60:35	3.36	403.6	353.8	**3,132.9**	**1.253**
60:40	3.05	301.5	352.3	3,117.3	1.247
60:45	2.81	254.8	348.6	3,088.7	1.235
60:50	2.61	224.9	343.7	3,052.4	1.221
60:55	2.45	203.3	337.9	3,011.3	1.205

Storage is greatest at the end of the step ending at 60:35. In the next step the mean inflow (302 L/s) is below the outflow (about 352 L/s), so storage falls.

Table 4C.8 — Routing of the 100-yr 72-hour storm through the trial outlet, hourly (Illustrative — not design values)

Time (h)	Cumulative rainfall (mm)	Inflow (L/s)	Outflow (L/s)	Stage (m)	Storage (m³)
12	35.0	14	8	0.130	325
24	70.0	15	12	0.215	536
36	105.0	16	14	0.264	660
48	140.0	16	15	0.294	736
54	181.7	47	19	0.469	1,172
57	213.5	69	23	0.623	1,559
59	248.5	120	91	0.789	1,971
60	293.3	286	170	0.866	2,164
61	378.0	187	332	1.187	2,967
62	399.3	106	237	0.968	2,421
63	414.5	80	142	0.829	2,072
66	446.9	51	52	0.771	1,927
72	489.5	33	33	0.768	1,920
84	489.5	0	18	0.405	1,012

Time (h)	Cumulative rainfall (mm)	Inflow (L/s)	Outflow (L/s)	Stage (m)	Storage (m³)
96	489.5	0	10	0.167	418
108	489.5	0	4	0.058	146

The routed outflow volume equals the inflow volume (about 9,470 m³): detention delays the volume but does not remove it.

4C.9 **Results, trial outlet.** Table 4C.9 gives the peaks, maximum stages and drawdown times for the trial outlet.

Table 4C.9 — Results for the trial outlet (120 mm and 470 mm orifices) (Illustrative — not design values)

Duration (h)	2-yr detained (L/s)	2-yr max stage (m)	10-yr detained (L/s)	10-yr max stage (m)	100-yr detained (L/s)	100-yr max stage (m)	100-yr storage (m³)	10-yr 90% drawdown, clean (h)	10-yr 90% drawdown, 50% blocked (h)
1	9	0.15	15	0.30	22	0.59	1,468	27.2	54.2
2	11	0.20	18	0.42	89	0.79	1,966	28.3	57.0
3	13	0.24	20	0.50	135	0.82	2,058	29.3	59.1
6	15	0.31	23	0.64	190	0.89	2,229	31.1	63.4
12	17	0.40	49	0.77	279	1.06	2,647	36.2	69.2
24	19	0.45	87	0.79	334	1.20	2,991	42.8	75.4
48	20	0.51	144	0.83	353	1.25	3,129	42.5	72.7
72	20	0.52	147	0.84	354	1.25	**3,133**	42.5	71.9

The drawdown time is measured from the time of maximum 10-yr storage until 90% of that storage has been released (Clause 4.7.1).

Part 2 — Checks and revision of the outlet (Clauses 4.5, 4.7 and 4.8)

4C.10 **Release caps.** Every 100-yr detained peak is at or below 356 L/s, and every 2-yr detained peak is far below the 2-yr cap of 180 L/s. Both caps are met. The 2-yr peaks are not compared duration by duration with the pre-development peaks: for a flood-sensitive site the 2-yr cap is the single largest pre-development 2-yr peak (Clause 4.5.3.1).

4C.11 **Drawdown.** Clause 4.8.3 requires the low-flow orifice to be assumed **50% blocked** when drawdown is checked. With the 120 mm orifice at half its area, 90% of the 10-yr storage takes 54 to 75 h to drain (Table 4C.9), against the 48-hour limit of Clause 4.7.1. **The trial outlet fails.** With a clean orifice it would drain in about 42 h.

4C.12 **Revised outlet.** The low-flow orifice was increased in 10 mm steps until the blocked drawdown met 48 h for every duration, and Stage 2 was then re-sized so that the 100-yr cap was still met. The result:

- Stage 1: **170 mm** orifice at the floor;
- Stage 2: **460 mm** orifice, invert 0.53 m above the floor (centre at 0.76 m);
- no Stage 3.

The larger low-flow orifice releases more in frequent storms. That is acceptable here because the 2-yr cap of a flood-sensitive site is the largest pre-development 2-yr peak (Clause 4.5.3.1). The WQv is assumed to be treated in a separate practice upstream (Chapter 8), so Stage 1 is not required to hold the WQv for 24–48 h (Clause 4.6.5.1); where Stage 1 also releases the WQv, Clause 4.7.2 must be checked as well.

Table 4C.10 — Stage–storage–discharge, revised outlet (Illustrative — not design values)

Stage h (m)	Storage (m³)	Stage 1, 170 mm (L/s)	Stage 2, 460 mm (L/s)	Total (L/s)
0.00	0	0.0	0.0	0.0
0.085	213	8.8	0.0	8.8
0.17	425	17.6	0.0	17.6
0.30	750	28.0	0.0	28.0
0.40	1,000	33.9	0.0	33.9
0.50	1,250	38.9	0.0	38.9
0.60	1,500	43.3	0.0	43.3
0.70	1,750	47.3	0.0	47.3
0.76	1,900	49.6	0.0	49.6
0.80	2,000	51.0	88.3	139.3
0.90	2,250	54.5	165.3	219.7
1.00	2,500	57.7	216.4	274.1
1.10	2,750	60.8	257.5	318.3
1.17	2,925	62.8	282.8	345.6
1.20	3,000	63.7	293.0	356.7
1.30	3,250	66.5	324.6	391.1

Table 4C.11 — Results for the revised outlet (170 mm and 460 mm orifices) (Illustrative — not design values)

Duration (h)	2-yr detained (L/s)	2-yr max stage (m)	10-yr detained (L/s)	10-yr max stage (m)	10-yr storage (m³)	100-yr detained (L/s)	100-yr max stage (m)	100-yr storage (m³)	10-yr 90% drawdown, 50% blocked (h)
1	15	0.14	28	0.29	734	42	0.57	1,426	31.3
2	20	0.19	34	0.40	990	79	0.76	1,911	32.1
3	22	0.22	37	0.46	1,147	139	0.80	1,999	32.8
6	25	0.26	41	0.56	1,386	194	0.86	2,154	34.2
12	30	0.33	46	0.68	1,692	276	1.01	2,512	39.0
24	32	0.37	49	0.75	1,870	320	1.11	2,766	45.3
48	34	0.40	82	0.77	1,913	343	1.17	**2,913**	44.8
72	34	0.41	84	0.77	1,915	343	1.16	2,911	44.7

Findings:

- **100-yr cap:** largest detained peak 343 L/s ≤ 356 L/s. Met.
- **2-yr cap:** largest detained peak 34 L/s ≤ 180 L/s. Met.
- **Drawdown:** longest blocked drawdown 45.3 h ≤ 48 h (Clause 4.7.1). Met.

- **Governing storage: 2,913 m³** (100-yr, 48 h), at a maximum stage of **1.17 m**. The larger low-flow orifice releases more water early in the long storms, so the revised outlet needs about 220 m³ less storage than the trial outlet. Table 4.2 in Clause 4.6.7 reports this revised design.
- **Governing storms (Clause 4.6.2, step 12):** storage, the 100-yr 48-hour storm; Stage 1, the 10-yr 24-hour storm (drawdown); Stage 2, the 100-yr 48-hour storm (cap).

Part 3 — Sensitivity, retention, spillway, outlet details and safety

4C.13 **Ia = 0.05S sensitivity (Clause 3.8.5).** With S converted as S0.05 = 25.4 × 1.33 × (S0.20 / 25.4)^1.15, the governing 100-yr 48-hour run gives 2,898 m³ of storage and a 341 L/s peak, slightly below the default run. The pre-development 10-yr peak, and so the 100-yr cap, falls to 344 L/s. The design is based on the default run (Clause 3.8.5(c)); the sensitivity results are reported on Form 3-2.

4C.14 **Retention and retention credit (Clauses 4.4.2 and 4.4.6).** With an illustrative retention depth P_R = 40 mm, Q_R is computed for each sub-area at AMC II, because a composite CN is not used for retention (Clause 3.9.4). Impervious, CN 98: S = 5.2 mm, Ia = 1.0 mm, Q_R = (40 − 1.0)² / (40 − 1.0 + 5.2) = 34.4 mm. Pervious, CN 70: S = 108.9 mm, Ia = 21.8 mm, Q_R = (40 − 21.8)² / (40 − 21.8 + 108.9) = 2.6 mm. RRV = 10 × (34.4 × 1.571 + 2.6 × 0.429) = **552 m³**. The retention is modelled as a store that is empty at the start of the storm and captures all runoff until full, with no infiltration during the storm (Clause 4.4.6.2).

Table 4C.12 — Retention credit by routing, revised outlet (Illustrative — not design values)

100-yr storm	Storage without retention (m³)	Storage with retention (m³)	Reduction (m³)
24 h	2,766	2,628	138
48 h	2,913	2,906	7
72 h	2,911	2,911	0

The governing storage falls from 2,913 to 2,906 m³, so the retention credit is 7 m³, about 1% of the RRV. The retention is still required in full for its own purposes (Clause 4.4.1, Chapter 8).

4C.15 **Emergency spillway (Clause 4.9).** The facility is excavated, with no embankment, so Clause 4.9.7 applies: the overflow route is treated as the spillway and must meet Clause 4.9.1.

- Design flow: the 1% AEP peak inflow, 1,089 L/s, with the outlet blocked and the basin full to the crest.
- Crest: the 1% AEP maximum water level with the outlet working is 1.17 m; with the recommended 0.15 m clearance (Clause 4.9.3) the crest is set at **1.35 m**.
- Crest length: a broad-crested weir with Q = C × L × H^1.5, C = 1.7 (an illustrative coefficient for a broad-crested weir in SI units; Clause 4.6.5.2 requires a coefficient suited to the shape). With L = 4.0 m: H = (1.089 / (1.7 × 4.0))^(2/3) = 0.295 ≈ **0.30 m**.
- Maximum level with the spillway flowing: 1.35 + 0.30 = 1.65 m. With 0.3 m freeboard (Clause 4.9.1), the top of the walls is at least **1.95 m** above the floor.
- The spillway discharges to the 1% AEP overland flow path, away from buildings (Clause 4.9.4).

4C.16 **Outlet details (Clause 4.8).**

Table 4C.13 — Outlet checks, revised outlet (Illustrative — not design values)

Item	Requirement	Value	Result
Minimum orifice	≥ 50 mm (Clause 4.8.2)	170 mm	Met

Item	Requirement	Value	Result
Rack bar spacing	≤ half the smallest opening and ≥ 25 mm (Clause 4.8.3)	≤ 85 mm	Set at 75 mm
Rack open area	≥ 10 × area protected (Clause 4.8.3)	10 × (0.0227 + 0.1662) m² = 1.89 m² for one rack around both orifices	Provide ≥ 1.89 m²
Anti-vortex, Stage 1	Needed if head > 1.5 d (Clause 4.8.4)	Head up to 1.08 m > 0.26 m	Required
Anti-vortex, Stage 2	Needed if head > 1.5 d (Clause 4.8.4)	Head above centre up to 0.41 m < 0.69 m	Not required
Isolation	Facility serving > 1 ha (Clause 4.8.6)	Serves 2.0 ha	Stop-log slot or penstock, normally open
Outlet barrel	≥ 300 mm (Clause 4.8.5)	Sized under Chapter 9 for 343 L/s	To be designed

4C.17 **Safety (Clause 4.15).** The 10-yr depth (0.77 m) exceeds the 0.45 m limit for publicly accessible storage (Clause 4.15.1(a)), so the facility is not open to the public. It has vertical walls higher than 0.6 m and a depth of more than 1.2 m when the spillway flows, so a non-climbable fence at least 1.2 m high with a lockable gate is required (Clause 4.15.3). Signs and a depth marker are provided (Clause 4.15.5).

4C.18 **Summary of the design (Illustrative — not design values).**

Table 4C.14 — Summary of the revised design (Illustrative — not design values)

Item	Value
Storage	2,500 m² plan area; 2,913 m³ at the 1% AEP maximum level of 1.17 m
Stage 1	170 mm orifice at the floor, with trash rack and anti-vortex plate
Stage 2	460 mm orifice, invert 0.53 m
Spillway	Crest 1.35 m, length 4.0 m, maximum level 1.65 m
Top of walls	≥ 1.95 m above the floor
100-yr peak release	343 L/s (cap 356 L/s)
2-yr peak release	34 L/s (cap 180 L/s)
10-yr drawdown, 50% blocked	45.3 h (limit 48 h)
Retention	RRV 552 m³ provided in addition; credit 7 m³
Still to be checked	Outfall-closed check on an outfall to a khad draining to the Tawi in Jammu (Annex 5C); downstream analysis (Chapter 5); groundwater and flotation (Clause 4.12); WQv (Chapter 8)

Form 4-1 — Site Runoff Control Report

Supports Clauses 4.3 to 4.17 of Chapter 4.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One form for each site. Where the site drains to more than one outfall, complete Sections E to J for each outfall (Clause 4.5.1.3). Tier B sites using Clause 4.14.2 attach Form 4-2 in place of Sections F and G; sites using the fixed-coefficient route attach Form 4-3 in place of Sections F and G (Clause 4.17).

A. Site and route

Table 4F.1 — Form 4-1: site and route

Field	Entry
A1. Project name and applicant	
A2. Location (village or ward, survey numbers, district)	
A3. Approving Authority and tier (Tier A / Tier B)	
A4. Site area, land disturbance and new or replaced impervious area (ha, ha, m²) (Clause 4.1.2)	
A5. Number of outfalls (Clause 4.5.1.3)	
A6. Sizing route: full method (Clause 4.6) / Tier B tables (Clause 4.14.2) / fixed-coefficient route (Clause 4.14.3)	
A7. Constrained redevelopment route used (Clause 4.5.6)? If yes, attach the Constraint Statement, the existing-condition model and the shortfall and fee computation	

B. Inputs (Clause 4.17, item 1)

Table 4F.2 — Form 4-1: inputs

Field	Entry
B1. Design Rainfall Sheet reference (Form 2-1)	
B2. Hydrologic Calculation Summary reference (Form 3-1)	
B3. HSG of each sub-area and the tests that confirm it (Clause 4.6.2, step 1)	
B4. Pre-development condition and CN (Clause 4.5.1.2)	
B5. Post-development CN of each sub-area, and Tc pre and post	
B6. Routing method and software, with version; time step (Clauses 4.6.1, 4.6.2)	

C. Order of measures (Clause 4.3.1; Clause 4.17, item 2)

Table 4F.3 — Form 4-1: order of measures

Step	What the design does	Why this step cannot do more
1. Preserve		
2. Retain		

Step	What the design does	Why this step cannot do more
3. Detain		
4. Convey		

D. Retention (Clause 4.4; Clause 4.17, items 3 and 4)

Table 4F.4 — Form 4-1: retention

Field	Entry
D1. Retention depth P_R (mm) and zone (Annex 2E)	
D2. Runoff depth Q_R (mm) by sub-area and RRV (m³) (Clause 4.4.2)	
D3. Retention practices and volume provided (m³)	
D4. Infiltration tests: number, locations and depths, measured rates (mm/h) (Clause 4.4.3(a))	
D5. Design infiltration rate (mm/h), not more than half the measured rate (Clause 4.4.3(b))	
D6. Seasonal high groundwater depth below the base of each practice (m), at least 1.0 m (Clause 4.4.3(c))	
D7. Reuse demand calculation, where retention is by reuse (Clause 4.4.3)	
D8. Retention drawdown time (h), not more than 72 h (Clause 4.4.5)	
D9. Shortfall in RRV (m³), if any, treated as WQv (Clause 4.4.4.2)	
D10. Governing storage without and with retention, and the retention credit (m³) (Clause 4.4.6)	
D11. Preservation credit areas and covenant reference (Clause 4.4.7)	

E. Release criteria (Clause 4.5; Clause 4.17, item 5)

Table 4F.5 — Form 4-1: release criteria

Field	Entry
E1. Catchment class: standard (Clause 4.5.2) or flood-sensitive (Clause 4.5.3), with the Annex 4A map extract	
E2. Release caps by AEP (L/s), and the duration that sets each cap	
E3. Clause 4.5.5 used (50 mm orifice deemed to comply, or the short-duration 2-yr relief)? Report any 2-yr exceedance	

F. Results (Clause 4.6; Clause 4.17, item 6)

Complete one row for each duration, in the format of Table 4.2. Mark the governing case for storage, for each outlet stage and for the spillway (Clause 4.6.2, step 12).

Table 4F.6 — Form 4-1: results by duration (L/s; m³)

Duration (h)	2-yr pre	2-yr post, detained	10-yr pre	10-yr post, detained	100-yr post, uncontrolled	100-yr post, detained	100-yr storage used
1							
2							

Duration (h)	2-yr pre	2-yr post, detained	10-yr pre	10-yr post, detained	100-yr post, uncontrolled	100-yr post, detained	100-yr storage used
3							
6							
12							
24							
48							
72							

G. Facility, drawdown and outlet (Clauses 4.7, 4.8, 4.10; Clause 4.17, items 7 to 9)

Table 4F.7 — Form 4-1: facility, drawdown and outlet

Field	Entry
G1. Facility type (Clause 4.10) and storage provided (m^3)	
G2. Stage–storage and stage–discharge tables and plots; inflow and outflow hydrographs for the governing cases (attach)	
G3. 10-yr drawdown: time to release 90% of the maximum stored volume (h), with the low-flow orifice 50% blocked (Clauses 4.7.1, 4.8.3)	
G4. WQv release time (h), 24 to 48 h (Clause 4.7.2)	
G5. Tidal outfall: drawdown with the tidal tailwater, and any pumped drawdown (Clause 4.7.4)	
G6. Each outlet stage: type, size (mm), invert level (m)	
G7. Trash racks: clear bar spacing (mm) and open area (m^2) (Clause 4.8.3)	
G8. Anti-vortex devices (Clause 4.8.4); outlet barrel diameter and seepage control (Clause 4.8.5); isolation (Clause 4.8.6)	
G9. Proprietary devices: certified head–discharge curve and minimum clear opening (Clause 4.6.5.3)	

H. Spillway, freeboard and embankment (Clause 4.9; Clause 4.17, item 10)

Table 4F.8 — Form 4-1: spillway and freeboard

Field	Entry
H1. Hazard classification, with reasons (Clause 4.9.2)	
H2. 1% AEP peak inflow (L/s); 0.2% AEP peak inflow for high-hazard facilities (L/s)	
H3. 1% AEP maximum water level with the outlet working (m); spillway crest level (m) (Clause 4.9.3)	
H4. Spillway or overflow route: type, dimensions, maximum level with the outlet blocked (m)	
H5. Freeboard to the embankment crest or wall top (m), at least 0.3 m (Clause 4.9.1)	
H6. Spillway location and discharge path (Clause 4.9.4)	
H7. Embankment height (m); geotechnical report where more than 2 m (Clause 4.9.6)	

I. RWH accounting, groundwater and flotation (Clauses 4.11, 4.12; Clause 4.17, items 11 and 12)

Table 4F.9 — Form 4-1: RWH, groundwater and flotation

Field	Entry
I1. RWH storage provided (m³), assumed full at the start of every storm (Clause 4.11.2)	
I2. Combined RWH and detention tanks: zone levels and the detention orifice level (Clause 4.11.3); attach tank sections	
I3. Design groundwater level and its basis (Clause 4.12.1)	
I4. Lined or unlined storage; volume below the design groundwater level not counted (Clause 4.12.2)	
I5. Flotation factor of safety, at least 1.2 (Clause 4.12.3)	

J. Downstream, tailwater, safety and maintenance (Clause 4.17, items 13 and 14)

Table 4F.10 — Form 4-1: downstream, tailwater, safety and maintenance

Field	Entry
J1. Downstream and Tailwater Report (Form 5-1) or Simplified Downstream Statement (Form 5-2) reference	
J2. Tailwater used in routing, and flap gate where tailwater governs (Clause 4.6.6)	
J3. Public access, depths in the 10% and 1% AEP storms, slopes, fencing, grates, signs and depth markers (Clause 4.15)	
J4. Draft maintenance declaration reference (Chapter 10)	

K. Statement by the registered professional (Clause 10.6)

I state that this report has been prepared under Chapter 4 of the Jammu and Kashmir Stormwater Design Manual (Draft v1.0), that the results reported are reproduced by the models submitted, and that every departure from Chapter 4 is listed with its reason. The Professional Design Certificate (Form 10-3) is attached.

Table 4F.11 — Form 4-1: statement by the registered professional

Field	Entry
Name	
Qualification and registration number	
Empanelment number, where Clause 10.6.1 requires it	
Organisation	
Signature	
Date	

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

Form 4-2 — Tier B Site Sheet

Supports Clauses 4.4.6.3, 4.14.1 and 4.14.2 of Chapter 4.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. This sheet replaces items 6 and 7 of the Site Runoff Control Report (Form 4-1) for Tier B sites using Clause 4.14.2. It can be used only after Table 4.3 is published in Annex 4B; until then, Tier B sites use Clause 4.6 or, for sites of 1 ha or less, the fixed-coefficient route (Clauses 4.14.1 and 4.14.3).

A. Eligibility (Clause 4.14.1)

Table 4F.12 — Form 4-2: eligibility

Field	Entry
A1. Local body (Tier B)	
A2. Site area A (ha): 2 ha or less outside flood-sensitive catchments; 0.5 ha or less inside them	
A3. Catchment class: standard or flood-sensitive (Annex 4A)	

B. Table 4.3 values (Clause 4.14.2, step 1)

Table 4F.13 — Form 4-2: values read from Table 4.3

Field	Entry
B1. Rainfall zone (Annex 2A)	
B2. Hydrologic soil group	
B3. Post-development imperviousness (%)	
B4. PSD 2-yr (L/s/ha)	
B5. PSD 100-yr (L/s/ha), for the catchment class	
B6. SSR (m³/ha), for the catchment class	

C. Storage and release (Clause 4.14.2, steps 2 and 3)

Table 4F.14 — Form 4-2: storage and release

Line	Quantity	Computation	Value
C1	RRV provided (m³)	Clause 4.4	
C2	C_R	Annex 4B; 0 until published	
C3	V_credit (m³)	C2 × C1 (Clause 4.4.6.3)	
C4	Required storage V (m³)	B6 × A − C3	
C5	Storage provided (m³)	From drawings	
C6	Q_PSD,2 (L/s)	B4 × A	

Line	Quantity	Computation	Value
C7	Q_PSD,100 (L/s)	B5 × A	

D. Outlet and other provisions (Clause 4.14.2, steps 4 and 5)

Table 4F.15 — Form 4-2: outlet and other provisions

Field	Entry
D1. Low-flow orifice: diameter (mm) from the Annex 4B outlet table, head (m), at least 50 mm	
D2. Upper control: type, size and level	
D3. Spillway or overflow (Clause 4.9)	
D4. RWH accounting (Clause 4.11)	
D5. Safety provisions (Clause 4.15)	

E. Statement

I state that the values above are taken from Annex 4B for the site's zone, soil group, imperviousness and catchment class, and that the storage and outlets shown on the drawings match them.

Table 4F.16 — Form 4-2: statement

Field	Entry
Name	
Qualification and registration number	
Signature	
Date	

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

Form 4-3 — Fixed-coefficient Route Sheet (Clauses 4.14.3 to 4.14.7)

Supports Clauses 4.14.3 to 4.14.7 of Chapter 4.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. This sheet replaces items 6 and 7 of the Site Runoff Control Report (Form 4-1) for sites using the fixed-coefficient route. Complete it for each point where runoff leaves the site (Clause 4.14.4). Figure 4.3 shows the method.

A. Eligibility (Clause 4.14.3)

Table 4F.17 — Form 4-3: eligibility

Check	Yes / No
A1. Site area 1 ha or less	
A2. The design does not count tank or waterbody storage (Clause 4.14.3(a))	
A3. No part of the site lies within a waterbody setback (Clause 4.14.3(b))	
A4. The site does not drain to a tank cascade whose storage is counted in a downstream design (Clause 4.14.3(c))	

B. Release caps (Clause 4.14.4)

Table 4F.18 — Form 4-3: release caps

Line	Quantity	Source or computation	Value
B1	Site area A (ha)	Survey	
B2	Area of each hydrologic soil group (ha)	Clause 3.7	
B3	C_10 and C_2, area-weighted	Table 4.3A	
B4	i_10 and i_2 (mm/h), 15-minute duration, with the climate factor	Form 2-1; Clause 2.8	
B5	Q_cap,10 (L/s)	2.78 × C_10 × i_10 × A	
B6	Q_cap,2 (L/s)	2.78 × C_2 × i_2 × A	
B7	Discharge of a 50 mm orifice at the corresponding stage (L/s), where a cap is smaller (Clause 4.5.5.1)	Orifice equation, Clause 4.6.5.2	

C. Volumetric coefficient (Clause 4.14.5)

Table 4F.19 — Form 4-3: volumetric coefficient C_v

Line	Quantity	Value
C1	Composite C of Table 3.2 (upper half of each range)	
C2	Cf of Table 3.3 for the 1% AEP	
C3	C_v for durations below 12 h (C1 × C2)	
C4	C_v for durations of 12 h or more, with C for every pervious surface not less than 0.50	

D. Storage (Clause 4.14.5)

For each duration: inflow = 10 × C_v × P(d) × A (m³); release = 1.8 × Q_{cap} × d (m³); difference = inflow − release. V_{100} and V_2 are the largest differences; V is the larger of the two.

Table 4F.20 — Form 4-3: storage by duration

d (h)	$P_{100}(d)$ (mm)	100-yr inflow (m³)	1.8 × $Q_{cap,10}$ × d (m³)	100-yr difference (m³)	$P_2(d)$ (mm)	2-yr inflow (m³)	1.8 × $Q_{cap,2}$ × d (m³)	2-yr difference (m³)
1								
2								
3								
6								
12								
24								
48								
72								

Table 4F.21 — Form 4-3: storage required and provided

Line	Quantity	Value
D1	V_{100} (m³) and governing duration	
D2	V_2 (m³) and governing duration	
D3	V = larger of D1 and D2 (m³)	
D4	Storage provided (m³)	

E. Outlet, retention and other checks (Clauses 4.14.3, 4.14.6, 4.14.7)

Table 4F.22 — Form 4-3: outlet, retention and other checks

Field	Entry
E1. Low-flow orifice: diameter (mm) and invert; discharge (L/s) with the storage holding V_2 full, not more than $Q_{cap,2}$	
E2. Upper orifice or weir: size and level; total release (L/s) at the top of V, not more than $Q_{cap,10}$	
E3. Retention volume of Clause 4.4 provided in addition to V (m³); no retention credit taken	
E4. Drawdown (Clause 4.7), trash racks (Clause 4.8), spillway (Clause 4.9): reference to Form 4-1 Sections G and H	
E5. Downstream and tailwater checks (Chapter 5) and water quality (Chapter 8): references	

F. Statement

I state that the site meets the eligibility conditions of Clause 4.14.3 and that the caps, storage and outlets above have been computed by Clauses 4.14.4 to 4.14.7.

Table 4F.23 — Form 4-3: statement

Field	Entry
Name	
Qualification and registration number	
Signature	
Date	

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

ANNEXES TO CHAPTER 5

Downstream and Tailwater Analysis

These annexes support Chapter 5. Annex 5C is a worked example of the outfall-closed check of Clause 5.10, for the illustrative facility of Annex 4C. Annexes 5A and 5B need tidal, surge, survey and river data that this draft does not yet contain; each lists what the chapter already sets, gives the intended layout and states the interim rule of Chapter 5 that applies until it is published. Forms 5-1 and 5-2 are the submittal forms required by Clause 5.14. They are draft forms and have no statutory status.

Annex 5A — Tidal datums (MSL, MHWS, HAT vs CD and Survey of India datum), surge allowances and 1% still-water levels by coastal segment

Supports Clauses 5.7, 5.9, 5.10, 5.11 and 5.12 of Chapter 5.

5A.1 Table 5A.1 shows how the values of this annex enter the design tailwater levels of Table 5.1. The sea-level allowance is set by Clause 5.7.4 and does not depend on this annex.

Table 5A.1 — Use of the Annex 5A values in the design tailwater (Table 5.1)

Design case	Tailwater	Annex 5A values used	Chapter value
Minor-system design	MHWS + SLA	MHWS	SLA ≥ +0.3 m (Clause 5.7.4)
Major-system and storage design	HAT + surge + SLA	HAT; 10% AEP surge (Clause 5.7.3(a))	SLA ≥ +0.3 m
Joint case (Clause 2.12(b))	1% AEP still-water level + SLA	1% AEP still-water level (Clause 5.7.3(b))	SLA ≥ +0.3 m
Datum conversion	Chart datum to project datum	Offset from chart datum to the Survey of India datum (Clause 5.7.2(b))	—

Not prepared for Jammu and Kashmir. Jammu and Kashmir has no coast, so no outfall in the Union Territory has a tidal tailwater, and this annex has no Jammu and Kashmir content (Clause 5.1.4). Its tables are kept, empty, so that the annex and table numbers match the other editions of this Manual. Rows F1 to F7 of Form 5-1 are entered as "not applicable", and the tailwater is derived under rows F8 to F10; for an outfall that the Jhelum can close, row F10 records the CWC gauge and its levels, the I&FC closing stage (named, not converted from feet), the river lock and the pumping stations credited of Clause 5.8.5(a); for an outfall to a khad or nallah, the study, the flood marks and the bed survey of Clause 5.8.5(c); and for an outfall to a reservoir, the custodian's levels of Clause 5.8.5(d).

Table 5A.2 — Tidal datums, surge and still-water levels by coastal segment (layout)

Coastal segment	Reference port and tide-table edition	MSL (m CD)	MHWS (m CD)	HAT (m CD)	CD to Survey of India datum (m)	10% AEP surge (m)	1% AEP still-water level (m CD)	Wave set-up (m), open-sea outfalls	Sources

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Annex 5B — Major drains, riverine outfall reaches, and river mouths subject to sand-bar closure; map

Supports Clauses 5.2, 5.3, 5.8 and 5.13 of Chapter 5.

5B.1 Table 5B.1 lists the water bodies that Chapter 5 already names. It is not complete: the annex will add the extents of each reach, the other rivers, canals and mouths of the State, and a map.

Table 5B.1 — Water bodies named in Chapter 5

Water body	Region	Listed as	Clause
Jhelum through Srinagar, past the Ram Munshi Bagh gauge, and the flood spill channel from Padshahi Bagh to the Wular	Srinagar, Budgam, Ganderbal	Riverine outfall reach and major drains; embanked, gated and pumped; design river level not below the transferred 1,589.65 m (8 September 2014; 1,588.99 m in the list of 2022: the higher applies [TBC]); 10% AEP and minor-system tailwater not below the danger level 1,585.48 m; gravity outfalls closed from the I&FC flood-declaration stage of 18 ft (danger 21 ft; gauge zero not published, not converted); single river lock of at least 7 days; flood spill channel at 4,000 cusecs (CAG) until I&FC confirms a later capacity; datum [TBC]	5.2, 5.8.1, 5.8.5
Jhelum past Khanabal and Sangam, at Anantnag, Bijbehara and Pampore	Anantnag, Pulwama	Riverine outfall reach; design river level not below the transferred 1,595.43 m (Khanabal, 3 September 2025) and 1,595.7 m (Sangam, September 2014; 1,595 m in 2022) [TBC]; danger levels 1,592.5 m (Khanabal) and 1,590.88 m (Sangam); I&FC stages at Sangam 21 ft and 25 ft, labels in conflict [TBC]; river lock of at least 7 days	5.8.1, 5.8.5
Jhelum past Safapora, at Sumbal and Bandipora; the Wular; the outlet reach at Ningli, Sopore and Baramulla	Bandipora, Baramulla	Riverine outfall reach and lake; design river level not below the transferred 1,582.1 m (Safapora, 9 September 2014; danger 1,579.66 m); Wular not below its I&FC danger level of 1,578 m (datum [TBC]); below Ningli, no CWC level found: model or surveyed 2014 flood marks [TBC]; WUCMA's consent; Ramsar site	5.8.1, 5.8.5
Tawi at Jammu, past the Jammu Tawi (Sidhra) gauge, and at Udhampur, past Kishanpur Manwal; the Tawi barrage	Jammu, Udhampur	Riverine outfall reach; design river level not below the transferred 321.1 m (Sidhra, 26 August 2025; 318.85 m in 2014) and 442.65 m (Kishanpur Manwal, 26 August 2025); level-monitoring sites with no danger level; barrage pond level, gates and operator not found [TBC]; rivers crossing the border: no lowering assumed	5.8.1, 5.8.3, 5.8.5
Chenab at Akhnoor, below Salal; at Doda (Prem Nagar), Ramban, Reasi and Kishtwar; the Neeru and Kalnai nallahs	Jammu, Doda, Ramban, Reasi, Kishtwar	Riverine outfall reach; design river level not below the transferred 324.29 m (Akhnoor, 10 September 1992) and 902.56 m (Prem Nagar, 2025); Neeru 1,075.33 m and Kalnai 932.7 m (2025); I&FC stages at Akhnoor 32 ft and 35 ft, with 43 ft (2025) and 61 ft (1992), not converted; no CWC level found at Ramban, Reasi or Kishtwar [TBC]; dam releases included	5.8.1, 5.8.3, 5.8.5

Water body	Region	Listed as	Clause
Ujh at Kathua, Basantar at Samba, Devak at Udhampur, Ravi at Basantpur	Kathua, Samba, Udhampur	Riverine outfall reach; Basantpur 318.35 m (26 August 2025); no CWC level found on the Ujh, Basantar or Devak [TBC]; Ujh at Panjtirthi alert 48,000 and danger 88,000 cusecs (I&FC, as reported); modelled or surveyed flood level required; no lowering assumed from the reach beyond the border	5.8.1, 5.8.5
Lidder, Rambiara, Romushi, Doodhganga, Vishow and Sind above the valley floor	Anantnag, Pulwama, Kulgam, Budgam, Ganderbal	Riverine outfall reach; Ganeshpura 1,871.78 m (28 August 2016), Rumshi 1,589.91 m (27 August 2025), Watchi 1,595.29 m and Kralpora 1,594.3 m (2025); I&FC gauges at Khudwani and Wachi on local zeros, not converted	5.8.1, 5.8.5
Balol, Thather and Bhalwal khads and the other khads of the Kandi belt; the nallahs and khads of the hill towns	Jammu, Samba, Kathua, Udhampur, Reasi, Ramban, Doda, Kishtwar, Rajouri, Poonch	Khads, nallahs and major drains; ungauged; 1% AEP study with bulking and blockage and surveyed flood marks (September 2014, August–September 2025); outfall at least 0.5 m above the highest surveyed bed level; no outfall in the active channel or on Gair Mumkin Khad land within the functional khad	5.2, 5.8.1, 5.8.5
Dal and Nigeen, with the Dal Gate, the Tsunth Kol and Nallah Amir Khan; Brari Nambal, Khushalsar, Gilsar and Anchar	Srinagar, Ganderbal	Lake outfalls; outlet levels and datums not found [TBC] (the reported "10.5 feet" is not a level); routed as closed storage while the Jhelum shuts the outlets; LCMA's consent; sediment trap and dry-weather-flow interception before every outfall; 200 m court line at the Dal and Nigeen	5.8.5
Hokersar, Nambal Narkur, Shallabugh, Hygam and the Rakh-e-Arth basin	Srinagar, Budgam, Baramulla, Ganderbal	Flood-absorption marshes; no storage credited without the custodian's records; no drain to bypass them; Wildlife Department's consent and, for Ramsar sites (Hokersar, Hygam, Shallabugh), the J&K Wetland Authority's	5.8.5
Manasbal; Mansar and Surinsar	Ganderbal, Samba, Jammu	Lake outfalls; no level found [TBC]; spill level plus head; Surinsar–Mansar a Ramsar site; 30 m bye-law line	5.8.5
Salal, Baglihar and Dul Hasti reservoirs on the Chenab; Ranjit Sagar on the Ravi	Reasi, Ramban, Kishtwar, Kathua	Reservoir outfalls; tailwater Salal 488.18 m (FRL 487.68 m + 0.5 m), Baglihar 840.5 m (FRL and quoted maximum design flood level 840 m + 0.5 m), Ranjit Sagar 528.41 m (the higher of the conflicting FRLs 527.91 m and 527.13 m, + 0.5 m) [TBC]; no level found for Dul Hasti [TBC]; consent of NHPC, JKSPDC or Ranjit Sagar's operator; releases and flushing included, announced or not	5.8.3, 5.8.5
Ranbir and Sindh canals; the Tsunth Kol, the Padshahi Canal and the other city channels; zamindari khuls; drains of SMC, JMC, Municipal Councils and Committees, UEED, SDA, JDA, LCMA, Smart City companies and the Public Works (R&B) Department 1.0 m wide or more	Jammu and Kashmir	Major drains; owner's consent (I&FC for canals, city channels, the flood spill channel and khuls), design water level and flap gate	5.2, 5.8.5
Salal, Baglihar, Dul Hasti and Ranjit Sagar dams; the Tawi barrage	Chenab, Ravi, Tawi	Releases and gate operation to be included in river levels (operating rules and release records [TBC]); releases reported unannounced since April 2025	5.8.3, 5.8.5
River mouths subject to sand-bar closure	None in Jammu and Kashmir	Not applicable (Clause 5.1.4)	5.13.1

To be prepared. This annex will list and map (a) the major drains of each basin plan, (b) the riverine outfall reaches where backwater shall be modelled, with their upstream and downstream limits and the source of their design flood levels, and (c) the river mouths and creek inlets subject to seasonal sand-bar closure, with the most recent pre-monsoon bar crest levels and any I&FC mouth-maintenance programme. It needs I&FC river and canal records, design and recorded flood levels, reservoir operating rules, mouth-condition, dredging and bar-cutting records and pre-monsoon bar surveys (I&FC), the drain inventories of SMC and other local bodies, basin stormwater master plans (Chapter 11), and base mapping from the Survey of India and NRSC. Until it is published: every river, I&FC canal, the flood spill channel of the Jhelum from Padshahi Bagh to the Wular, the Tsunth Kol, the Padshahi Canal and the other city channels of Srinagar, the Dal's outlets at Dal Gate and Nallah Amir Khan, the Telbal, Doodhganga, Sukhnag and Sind nallahs and the other nallahs that feed the lakes and marshes of the Kashmir valley, the Devak and the Basantar, the Balol, Thather and Bhalwal khads and the other khads of Jammu and the Kandi belt, the Ranbir and Sindh canals and any other canal or zamindari khul that receives storm water, any drain built or held by SMC, JMC, a Municipal Council or Municipal Committee, UEED, SDA, JDA, LCMA, a Smart City company or the Public Works (R&B) Department with an internal width of 1.0 m or more, and every khad or nallah that drains 8 ha or more and every tidal creek is a major drain (Clause 5.2); the water bodies of Table 5B.1 are riverine outfall reaches (Clause 5.8.1); and the mouths of the coastal States' rivers (there is none in Jammu and Kashmir) are assumed closed at the start of the SW monsoon unless I&FC certifies otherwise (Clause 5.13.2).

Table 5B.2 — Attributes of the Annex 5B layers (layout)

Field	Content	Unit or format
feature_id	Unique identifier	text
name	Name of the drain, river, canal, creek or mouth	text
category	Major drain; riverine outfall reach; mouth subject to sand-bar closure	text
clause	Clause of Chapter 5 under which it is listed	text
reach_limits	Upstream and downstream limits of the reach	text
design_flood_level_source	I&FC design or highest recorded flood level, or hydraulic model (Clause 5.8.2)	text
reservoir_release	Upstream reservoir or tank and its operating rule, where any (Clause 5.8.3)	text
bar_crest_level	Most recent pre-monsoon bar crest level, for mouths	m (Survey of India datum)
mouth_programme	I&FC mouth-maintenance programme and certification (Clause 5.13.2)	text
source	Source agency and date	text
geometry	Line (drains and reaches) or point (mouths)	line / point

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Annex 5C — Worked example: outfall-closed check for a site on a khad draining to the Tawi in Jammu

Supports Clauses 5.9, 5.10, 5.11 and 5.12 of Chapter 5 and Clause 4.6.6 of Chapter 4.

Illustrative — not design values. This example applies the outfall-closed check of Clause 5.10 to the revised detention facility of Annex 4C. The site, its levels and its receiving drain are invented to show the method. No tidal level is used: the tide enters only through the illustrative statements in Table 5C.1 about whether the receiving drain is above or below the site outlet.

Inputs

5C.1 The site is the 2.0 ha flood-sensitive site of Annex 4C, a colony in Jammu. It discharges through its own outlet chamber and a flap gate to a public storm drain that joins a khad running across the Kandi belt to the Tawi, whose level rises when the khad runs full and when the Tawi is in flood, as on 26 August 2025, so Clause 5.10.1 applies to the facility. To show the method, this example uses the two 6-hour lock windows of Clause 5.10.3, as the coastal editions of this Manual do. In Jammu and Kashmir an outfall to a khad or nallah whose invert is below its design level is closed for as long as the computed level of the stream stays above it, or for the whole storm where no hydrograph of the stream has been computed; an outfall that the Jhelum can close has a single lock of at least 7 days; and an outfall below the design level of a reservoir, lake or nambal is closed for the whole storm, all under Clause 5.8.5, so in each of those cases the facility must store or pump the whole storm volume (Clause 5.9.4); that needs more storage, or pumping, than this example shows. The routing, the volume balance of Clause 5.10.4 and the assessment are the same. The public drain's own outfall to the khad would also need the debris rack and the bulking factor of Clause 6.3.6 and an invert above the range of bed movement of Clause 5.8.5(c); on the Kandi the facility could infiltrate where the Kandi recharge rule allows it, while on the valley floor of Srinagar or a hill slope it would be a lined tank, not an infiltrating basin (Clause 4.11).

Table 5C.1 — Inputs (Illustrative — not design values)

Item	Value	Basis
Facility	Revised facility of Annex 4C: 2,500 m² plan area, vertical walls; 170 mm orifice at the floor; 460 mm orifice, invert 0.53 m	Annex 4C, Table 4C.14
Storm	1% AEP, 48 h, peak day last, AMC III; 72 h also run	Clause 5.10.2
Inflow	Post-development 1% AEP hydrographs of Annex 4C (48 h: 8,420 m³; 72 h: 9,468 m³)	Annex 4C
Receiving drain levels at the connection, J1, J2 and J3	Below the site outlet invert (from the drain owner's model)	Illustrative input
Receiving drain during each lock window	Backs up above the site outlet invert, so the site cannot discharge	Illustrative input; Clause 5.10.3(b)
Flap gate on the site outlet	Set 0.15 m below the orifice inverts in the outlet chamber, so that outside the lock windows its opening head and head loss do not affect the orifice control	Illustrative input; to be confirmed from the certified curve (Clause 5.11.2)
Lock windows	Two of 6 h each, starts 12.4 h apart (semi-diurnal tide)	Clause 5.10.3(a)
Pumps	None	—

5C.2 **Cases of Table 5.2.** Because the receiving drain stays below the site outlet in J1, J2 and J3 (Table 5C.1), those cases give the free-outfall results of Annex 4C: in J2 the 1% AEP maximum water level is **1.17 m** (2,913 m³), and in J3 (10% AEP, 48 h) it is 0.77 m. R1 and R2 do not apply, because the site does not drain to a river. J4, the outfall-closed check, is worked below.

Lock windows (Clause 5.10.3)

5C.3 The peak 1-hour block of the final 24 hours of the 48-hour storm is 35:35–36:35 h, with 98.2 mm (the 1-hour depth of Table 4C.2). Two runs are made:

- **Run A:** the first window is centred on that block: 33:05–39:05 h; the second starts 12.4 h later: 45:29–51:29 h.
- **Run B:** the first window starts at that block: 35:35–41:35 h; the second: 47:59–53:59 h.

For the 72-hour storm, every time is 24 h later.

5C.4 Gravity discharge is zero inside each window. Outside the windows the outlet discharges through the orifices of Table 4C.10. The routing is the same level-pool routing as in Annex 4C.

Results

Table 5C.2 — Outfall-closed check results (Illustrative — not design values)

Storm	Run	Lock windows (h:min)	Maximum stage (m)	Maximum storage (m³)	Time of maximum (h:min)	Largest release after a window (L/s)
1% AEP, 48 h	A	33:05–39:05; 45:29–51:29	2.01	5,019	39:05	566
1% AEP, 48 h	B	35:35–41:35; 47:59–53:59	**2.10**	**5,238**	41:35	584
1% AEP, 72 h	A	57:05–63:05; 69:29–75:29	2.00	5,012	63:05	565
1% AEP, 72 h	B	59:35–65:35; 71:59–77:59	2.09	5,233	65:35	584

Run B of the 48-hour storm governs. The first window closes the outlet just as the storm peak arrives, so the whole peak is stored. The second window arrives when the facility has drained to about 0.7 m, below the Stage 2 orifice, and adds little.

5C.5 **Volume balance (Clause 5.10.4).** Table 5C.3 gives the balance for Run B. The outflow in each period is found by continuity: outflow = storage at start + inflow − storage at end.

Table 5C.3 — Volume balance, 1% AEP 48-hour storm, Run B (Illustrative — not design values)

Period (h:min)	Inflow (m³)	Gravity outflow (m³)	Pumped (m³)	Storage at start (m³)	Storage at end (m³)
0:00–35:35, before window 1	3,817	2,213	0	0	1,604
35:35–41:35, window 1	3,634	0	0	1,604	5,238
41:35–47:59, between windows	941	4,423	0	5,238	1,756
47:59–53:59, window 2	28	0	0	1,756	1,784
After 53:59	0	1,784	0	1,784	0
Total	8,420	8,420	0	—	—

Check for window 1: V_inflow = 3,634 m³ ≤ V_storage available + V_pumped + V_gravity = (5,238 − 1,604) + 0 + 0 = 3,634 m³. The facility therefore needs **5,238 m³** of storage, which the routing confirms.

Table 5C.4 — Stage hydrograph, 1% AEP 48-hour storm, Run B (Illustrative — not design values)

Time (h)	Inflow (L/s)	Outlet	Outflow (L/s)	Stage (m)	Storage (m³)
24	20	Open	18	0.18	445
28	39	Open	24	0.25	621
32	59	Open	32	0.36	906
34	85	Open	37	0.47	1,166
36	286	Closed	0	0.78	1,944

Time (h)	Inflow (L/s)	Outlet	Outflow (L/s)	Stage (m)	Storage (m³)
38	106	Closed	0	1.73	4,321
40	66	Closed	0	1.96	4,904
42	51	Open	529	1.79	4,472
44	42	Open	204	0.87	2,181
46	37	Open	49	0.74	1,854
48	33	Open	47	0.70	1,756
50	0	Closed	0	0.71	1,784
54	0	Closed	0	0.71	1,784
56	0	Open	43	0.58	1,459
60	0	Open	32	0.37	921
66	0	Open	16	0.16	397
72	0	Open	7	0.06	162

Assessment

5C.6 **Clause 5.10.4(a).** The facility of Annex 4C reaches 1.17 m in J2, and its spillway crest is at 1.35 m (Annex 4C). In the outfall-closed check the stage reaches 2.10 m, so the spillway would operate. **The facility of Annex 4C fails the check.**

5C.7 **Remedy.** Pumping (Clause 5.12) does not help here: during the lock windows the receiving drain is itself closed, and pumping into it would raise its level, which Clause 5.12.3 does not permit. The remedy is more storage. Keeping the plan area of 2,500 m² and the outlets of Annex 4C:

- the facility must hold 5,238 m³, to a stage of **2.10 m**;
- the spillway crest is set above that stage, with the 0.15 m clearance recommended in Clause 4.9.3: **2.25 m**;
- with the 4.0 m spillway of Annex 4C (head 0.30 m), the maximum level with the spillway flowing is 2.55 m, and with 0.3 m freeboard the top of the walls is at least **2.85 m** above the floor.

The outfall-closed check therefore governs the storage: 5,238 m³ against 2,913 m³ from the release-rate checks, about 80% more. A larger plan area would make the facility shallower; the outlet, caps and drawdown would then have to be re-checked, because the stage–discharge relationship changes.

5C.8 **Release after the lock.** When the first window ends, the stored water is released under a head of about 2 m, at up to 584 L/s. This is above the 100-yr cap of 356 L/s. Clause 5.10.4 allows this, because the release reaches a drain that has itself just reopened, and requires it to be included in the J4 run of the downstream analysis (Clauses 5.4 and 5.9) and reported on Form 5-1, Section H.

5C.9 **Drawdown after the storm (Clause 5.10.5).** The J1 tidal curve stays below the site outlet (Table 5C.1), so the drawdown of Annex 4C applies: 45.3 h for 90% of the 10-yr storage with the low-flow orifice 50% blocked, within the 48-hour limit of Clause 4.7. In Run B, 90% of the maximum J4 storage is released 22.6 h after the maximum.

5C.10 **Other requirements.**

- The flap gate on the site outlet is inspected and operated before 15 June each year and after every event in which it closed against a storm flow (Clause 5.11.5).

- The deeper facility is checked for flotation with groundwater at the design groundwater level; in the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, the Sirowal belt of the Jammu plains, the river terraces and floodplains, and the lake, nambal and reservoir margins without piezometer readings that level is existing ground level (Clauses 4.12.1 and 4.12.3).
- The fence and signs of Annex 4C apply to the deeper facility (Clause 4.15).

Table 5C.5 — Summary (Illustrative — not design values)

Item	Value
Governing case	J4, 1% AEP 48-hour storm, Run B (first window starting at the peak 1-hour block)
Storage required	5,238 m³ (Annex 4C release-rate design: 2,913 m³)
Maximum stage	2.10 m, with 2,500 m² plan area
Spillway crest	2.25 m
Top of walls	≥ 2.85 m above the floor
Largest release after a lock window	584 L/s, to be included in the downstream J4 run
Drawdown	Annex 4C result applies: 45.3 h with the low-flow orifice 50% blocked

---

Form 5-1 — Downstream and Tailwater Report

Supports Clauses 5.3 to 5.14 of Chapter 5.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One report for each project. Sites of less than 0.5 ha that meet Clause 5.3.4 may submit Form 5-2 instead, where the Authority accepts it. Attach the plans, model files and hydrographs referred to.

A. Project

Table 5F.1 — Form 5-1: project

Field	Entry
A1. Project name, applicant and location	
A2. Project type: site under Chapter 4; drainage project under Chapter 6; regional detention or tank restoration (Clause 5.1.2)	
A3. Site or project area (ha) and outfalls	
A4. Site Runoff Control Report reference (Form 4-1), where applicable	

B. Extent of the analysis (Clause 5.3; Clause 5.14, item 1)

Table 5F.2 — Form 5-1: analysis points

Point	Location	Type (Clause 5.3.3 (a) to (e))	Contributing catchment (ha)	Project area as % of it

Table 5F.3 — Form 5-1: end point

Field	Entry
B1. End point and reason: 10% point, tank or talab, or major drain or the sea (Clause 5.3.1 (a) to (c))	
B2. Where the end point is a tank or talab: change in maximum water level (m) and in surplus-weir discharge (m³/s); continuation below the weir if the level rises (Clause 5.3.2)	
B3. Plan of the analysis extent, showing the site, each point with its contributing area and percentage, and the end point (attach)	

C. Model (Clause 5.4.4; Clause 5.14, item 2)

Table 5F.4 — Form 5-1: model

Field	Entry
C1. Software and version; hydrologic and hydraulic methods (Clause 5.4.4)	
C2. Network schematic, with the survey sources for drains and crossings (attach)	
C3. Land use and CN of off-site areas (present land use)	

Field	Entry
C4. Upstream detention included, with evidence that it is built, maintained and documented	
C5. Calibration or validation evidence, where available	
C6. Scenarios run: existing, with project, and future where the Authority requires it (Clause 5.4.1)	
C7. Storms run: AEPs and durations, AMC and areal reduction (Clause 5.4.3)	

D. Results at each analysis point (Clause 5.4.2; Clause 5.14, item 3)

Complete one row for each analysis point, AEP and duration. E = existing; P = with project.

Table 5F.5 — Form 5-1: results by analysis point

Point	AEP	Duration (h)	Peak flow E / P (m^3/s)	Time to peak E / P (h)	Maximum water level E / P (m)	Peak velocity E / P (m/s)	Duration of inundation E / P (h)

E. Acceptance (Clause 5.5; Clause 5.14, item 4)

Table 5F.6 — Form 5-1: acceptance criteria

Criterion	Met at every point?	Where not met, the remedy adopted (Clause 5.5.3)
E1. 1% AEP water level rise ≤ 10 mm at buildings, lowest openings and carriageways (Clause 5.5.1(a))		
E2. No building newly flooded; no building or road newly failing the Chapter 6 limits (Clause 5.5.1(b))		
E3. Peak flow not above existing at the minor-system AEP of each element or at 1% AEP (Clause 5.5.1(c))		
E4. Velocity in lined channels within the lining limit, 3.0 m/s maximum (Clause 5.5.1(d))		
E5. Velocity in unlined channels, 50% and 10% AEP, not increased by more than 10% (Clause 5.5.1(e))		
E6. Change in duration of road closure on arterial or emergency routes (Clause 5.5.2)		
E7. Timing exception requested (Clause 5.5.4)? Give the conditions met		

F. Tailwater derivation (Clauses 5.6 to 5.8; Clause 5.14, item 5)

Table 5F.7 — Form 5-1: tailwater derivation

Field	Entry
F1. Tide-table edition and port, or port authority source (Clause 5.7.2(a))	

Field	Entry
F2. MHWS, HAT and MSL (m above chart datum)	
F3. Connection from chart datum to the Survey of India benchmark and the project datum: offset (m) and source (Clause 5.7.2(b))	
F4. Estuary, creek or canal outfall: levels used and any evidence for a departure from open-coast levels (Clause 5.7.2(c))	
F5. 10% AEP surge and 1% AEP still-water level: values, source, method and record length (Clause 5.7.3)	
F6. Wave set-up, for outfalls facing the open sea (Clause 5.7.3(d))	
F7. SLA (m), at least +0.3 m; design life; sensitivity run at twice the SLA for design lives over 50 years (Clause 5.7.4)	
F8. Non-tidal tailwater: receiving-system level and source (Clauses 5.6.2, 5.6.3)	
F9. River levels and sources; reservoir or tank releases included (Clauses 5.8.2, 5.8.3)	
F10. Jhelum-locked outfalls, other rivers, khads and nallahs, reservoir and barrage outfalls, rivers below dams, lakes and nambals, and canals, city channels, khuls or drains of other bodies: operator of each gate and pumping station identified, gate sills, embankment or bund crest, installed permanent capacity, duty point, sump levels and gate-closing stage obtained, with every level tied to a Survey of India benchmark and the gauge and datum named; no I&FC reading in feet converted to metres without the I&FC gauge zero; for the Jhelum, 1% AEP river level from a model and not below the highest recorded level at the nearest CWC gauge transferred (1,589.65 m at Ram Munshi Bagh, 1,595.7 m at Sangam, 1,595.43 m at Khanabal, 1,582.1 m at Safapora; the Wular not below 1,578 m), 10% AEP and minor-system level not below the CWC danger level (1,585.48 m, 1,590.88 m, 1,592.5 m, 1,579.66 m), gravity outfalls closed from the I&FC flood-declaration stage (18 ft at Ram Munshi Bagh), single river lock of not less than 7 days and its source, drain routed as closed storage with its whole catchment and present storage, pumping confirmed available (permanent pumps only, not more than installed capacity less the largest pump; mobile units not counted), each station listed with its capacity, pumps operable at the design river level, the joint drain–pump–river analysis where a DPR is required, the breach depth reported at each station and flood-sensitive building, and the gate-failure check; for another river, the highest recorded CWC level transferred (321.1 m at Sidhra, 324.29 m at Akhnoor and the other levels of Clause 5.8.5(b)) or a modelled or surveyed flood level and its source; for a khad or nallah, the 1% AEP study with the bulking and blockage of Clause 6.3.6, the surveyed flood marks and their sources, any I&FC flood study, the bed survey and range of bed movement, the invert at least 0.5 m above the highest surveyed bed level, the scour depth of the foundation and the Gair Mumkin Khad status of the land; for a reservoir or barrage pond, the custodian's consent, MWL or FRL plus design-flood surcharge (FRL + 0.5 m where neither is published: Salal 488.18 m, Baglihar 840.5 m, Ranjit Sagar 528.41 m), not below the highest recorded level, outfall below it treated as closed for the whole storm, waterbody starting at FRL or pond level, no gate operation or reservoir attenuation credited without the custodian's written rule; for an outfall below a dam or barrage, the design storm with the largest recorded release, placed before, during and after the storm, whether announced or not; for a lake or nambal, the custodian's consent (LCMA, WUCMA, the Wildlife Department, the J&K Wetland Authority), the surveyed spill level plus head, closure for the river lock where the river shuts the outlet, no storage credited in a marsh without records, and the sediment trap and dry-weather-flow interception before the outfall; for a canal, city channel, the flood spill channel or a khul, I&FC's consent, its level computed with all the water it receives, the flood spill channel taken as Jhelum-locked; I&FC consent, and the bye-law, master-plan, wetland and court lines checked; owner's consent, permitted rate, design water level or computed channel level, and flap gate (Clause 5.8.5)	

G. Joint cases (Clause 5.9; Clause 5.14, item 6)

Table 5F.8 — Form 5-1: joint-case results

Case	Rainfall	Tailwater used (m, project datum)	Applies?	Governing result (storage, level, pipe size or pump capacity)
J1				
J2				
J3				
J4				
R1				
R2				

H. Outfall-closed check (Clause 5.10; Clause 5.14, item 7)

Table 5F.9 — Form 5-1: outfall-closed check

Field	Entry
H1. Reason the check applies (Clause 5.10.1)	
H2. Storm: AEP, 48 h and 72 h, AMC III (Clause 5.10.2)	
H3. Lock duration and basis: default of two 6-hour windows, or site study (Clause 5.10.6); extension for sand-bar closure (Clause 5.13.5)	
H4. Lock windows of the two runs (start and end times) (Clause 5.10.3(d))	
H5. Maximum stage in each facility, against its 1% AEP maximum water level (Clause 5.10.4(a))	
H6. Maximum stage in the minor and major systems, against the Chapter 6 limits (Clause 5.10.4(b))	
H7. Property connections: surcharge level, or non-return valves fitted (Clause 5.10.4(c))	
H8. Stage hydrographs (attach)	
H9. Drawdown after the storm under the J1 tidal curve, and pumping where needed (Clause 5.10.5)	

Table 5F.10 — Form 5-1: volume balance for each lock window (Clause 5.10.4)

Period	Inflow (m^3)	Gravity outflow (m^3)	Pumped (m^3)	Storage at start (m^3)	Storage at end (m^3)
Before window 1					
Window 1					
Between windows					
Window 2					
After window 2					

I. Gates and valves (Clause 5.11; Clause 5.14, item 8)

Table 5F.11 — Form 5-1: schedule of flap gates, tide gates and non-return valves

Location	Type	Size (mm)	Invert (m, project datum)	Certified head–discharge data (reference)	Stop-log or penstock (outfalls > 600 mm)

J. Pumped outfalls (Clause 5.12; Clause 5.14, item 9)

Table 5F.12 — Form 5-1: pumped outfalls

Field	Entry
J1. Reason pumping is needed (Clause 5.12.1)	
J2. Duty capacity (m^3/s) at the static head for the J2 tailwater; standby capacity (Clause 5.12.2)	
J3. Effect on the receiving water level (Clause 5.12.3)	

Field	Entry
J4. Power supply: two independent supplies, or standby generation with 72 h of fuel; automatic changeover (Clause 5.12.4)	
J5. Level of electrical panels, controls, generators and fuel, against the higher of the 1% AEP flood level + 0.5 m and HAT + surge + SLA + 0.5 m (Clause 5.12.5)	
J6. Discharge arrangement (Clause 5.12.6); controls, alarms and logging (Clause 5.12.7); screens (Clause 5.12.8)	

K. Sand bar (Clause 5.13; Clause 5.14, item 10)

Table 5F.13 — Form 5-1: sand-bar assumption

Field	Entry
K1. River mouth or creek inlet concerned	
K2. Mouth assumed closed, or open with I&FC certification attached (Clause 5.13.2)	
K3. Bar crest level from the most recent pre-monsoon survey (m) and the closed-mouth tailwater (Clause 5.13.3)	
K4. Extension of the lock duration, where required (Clause 5.13.5)	

L. Inspection and maintenance (Clause 5.14, item 11)

Table 5F.14 — Form 5-1: inspection and maintenance

Field	Entry
L1. Gate and valve inspection before 15 June and after closure events (Clause 5.11.5)	
L2. Pump test runs before 15 June (Clause 5.12.9)	
L3. Other requirements for the maintenance plan (Chapter 10)	

M. Statement by the registered professional (Clause 10.6)

I state that this report has been prepared under Chapter 5 of the Jammu and Kashmir Stormwater Design Manual (Draft v1.0), that the results reported are reproduced by the models submitted, and that every departure from Chapter 5 is listed with its reason. The Professional Design Certificate (Form 10-3) is attached.

Table 5F.15 — Form 5-1: statement by the registered professional

Field	Entry
Name	
Qualification and registration number	
Empanelment number, where Clause 10.6.1 requires it	
Organisation	
Signature	
Date	

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

Form 5-2 — Simplified Downstream Statement (small sites)

Supports Clause 5.3.4 of Chapter 5.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. For sites of less than 0.5 ha. The Authority may accept this statement in place of the full analysis only where every answer in Section B is "Yes". Otherwise submit Form 5-1.

A. Site

Table 5F.16 — Form 5-2: site

Field	Entry
A1. Project name, applicant and location	
A2. Site area (ha), less than 0.5 ha	
A3. Receiving public drain: name or reference, type and size	
A4. Site Runoff Control Report reference (Form 4-1)	

B. Conditions (Clause 5.3.4)

Table 5F.17 — Form 5-2: conditions

Condition	Yes / No	Evidence
B1. The receiving public drain has documented capacity for its minor-system design flow (Chapter 6)		
B2. No flood-prone location is recorded within 500 m downstream of the site outfall. Records checked: local body, SMC, J&K SDMA, I&FC (Clause 5.3.3(d))		
B3. The site does not drain to a tidal or backwater-affected outfall		

C. Route plan

Table 5F.18 — Form 5-2: attachments

Attachment	Attached?
C1. Plan of the drainage route from the site outfall for 500 m downstream, with the receiving drain and any recorded flood-prone locations	
C2. Copy or reference of the drain capacity record	

D. Statement

I state that the site meets the conditions of Clause 5.3.4 as shown above, and that the records listed have been checked.

Table 5F.19 — Form 5-2: statement

Field	Entry
Name	
Qualification and registration number	
Signature	
Date	

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

ANNEXES TO CHAPTER 6

Minor and Major Drainage Systems

These annexes support Chapter 6. Annex 6A (standard inlets and their capacity curves) and Annex 6B (sediment yield) need test and survey data that are not yet available; each states what it will contain and the interim rule to use until it is published. Annex 6C gives standard drawings that carry only the dimensions Chapter 6 and Chapter 9 already set; every other dimension is marked "to be confirmed in design". Form 6-1 is a draft form: it lists what Clause 6.15 requires and does not add to it.

Annex 6A — Standard inlet types for Jammu and Kashmir with capacity curves (on grade and sag)

Supports Clauses 6.6.1 to 6.6.7 of Chapter 6 and Clause 9.11 of Chapter 9.

To be prepared. This annex will contain a short list of standard inlet types for Jammu and Kashmir streets (kerb-opening, grate and combination inlets, including the road-level wall opening into a covered drain) and, for each type, capacity curves on grade and in a sag. It needs a fixed set of standard inlet geometries agreed with the road-owning agencies, and rating tests of those geometries (laboratory or full-scale), or HEC-22 calculations for each geometry checked against tests (data and likely sources: Public Works (R&B) Department, NHAI and Srinagar Municipal Corporation standard details, NIT Srinagar, IIT Jammu, NIH Roorkee or other hydraulic laboratories, manufacturers' tested ratings). Until it is published, compute the clean capacity of the inlet actually proposed by the methods of FHWA HEC-22 (4th edition, 2024) or from the manufacturer's tested rating for that exact geometry (Clause 6.6.2), reduce it by the clogging factors of Table 6.5 (Clause 6.6.3), and meet the interim requirements of Table 6A.1.

Table 6A.1 — Interim requirements for inlets until Annex 6A is published (from Chapters 6 and 9)

Item	Requirement	Clause
Inlet type on public streets	Kerb-opening or combination inlets, unless the Approving Authority accepts grate-only inlets for a location	6.6.1(a)
Inlet level	Openings at road level; gutter depression where practicable	6.6.1(b)
Clean capacity	FHWA HEC-22 (4th ed., 2024) or the manufacturer's tested rating for the exact geometry; CPHEEO §5.6.2 equations as a cross-check only	6.6.2
Clogging, on grade	Grate 50%; kerb opening 10%	6.6.3, Table 6.5
Clogging, in a sag	Grate 50%; kerb opening 20%	6.6.3, Table 6.5
Spacing	By sequential calculation from the top of each gutter run; not more than 30 m on kerbed roads	6.6.4
Kerb opening size	Clear height at least 100 mm; length at least 1.0 m	9.11.4

Item	Requirement	Clause
Grate pattern	Openings parallel to the direction of travel not wider than 25 mm	9.11.3(a)
Load class	D400 in carriageways and medians; C250 within 0.5 m of the kerb; B125 in footpaths and cycle tracks (or the equivalent IS class)	9.11.2
Connection pipe	At least 300 mm diameter; gradient giving at least 0.9 m/s at the inlet's design flow	6.6.6
Silt sump	At least 300 mm deep below the outlet pipe invert, cleanable from the surface	6.6.7, 9.11.6

The intended layout of the annex is given in Tables 6A.2 to 6A.4.

Table 6A.2 — Register of standard inlet types (layout)

Type code	Description	Grate size or kerb opening (mm)	Gutter depression (mm)	Load class	Standard drawing
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Table 6A.3 — Capacity on grade (layout; one table per inlet type)

Cross slope Sx (m/m)	Longitudinal slope SL (m/m)	Gutter flow Q (L/s)	Spread T (m)	Clean intercepted flow (L/s)	Design intercepted flow after clogging (L/s)	Bypass flow (L/s)
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

Table 6A.4 — Capacity in a sag (layout; one table per inlet type)

Ponded depth at the inlet (mm)	Clean capacity (L/s)	Clogging factor (Table 6.5)	Design capacity (L/s)	Flow regime (weir, orifice or transition)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Annex 6B — Sediment yield for silt-trap sizing and calibration of the sediment allowance

Supports Clauses 6.7.4, 6.7.8, 6.13.3 and 6.13.10 of Chapter 6.

To be prepared. This annex will contain sediment yields for urban drains in Jammu and Kashmir, by land use and drain type, for sizing the silt traps of Clause 6.13.3, and a calibration of the sediment allowance of Clause 6.7.8 against measured silt depths. It needs desilting records (volume or mass removed per drain length and per catchment area, with dates), silt-depth surveys before and after the south-west monsoon, and catchment land-use and soil data (data and likely sources: desilting records of Srinagar Municipal Corporation and other urban local bodies, I&FC records for channels, land cover from NRSC, soils from the Jammu and Kashmir soil survey and NBSS&LUP, rainfall from IMD). Until it is published, size each silt trap from the designer's stated estimate of the sediment expected between scheduled cleanings, based on the desilting records of the same drain or of similar drains in the same local body, and state the cleaning interval assumed; the interval shall not be longer than the yearly pre-monsoon desilting of Clause 6.13.10. Inlet silt sumps remain at least 300 mm deep (Clause 6.6.7), and the sediment allowance of Clause 6.7.8 applies unchanged.

The intended method is a simple volume balance, with every term to be stated in the design:

$$V_{trap} = Y \cdot A \cdot t_c$$

where V_{trap} is the sediment storage volume of the trap below its outlet invert (m^3), Y is the sediment yield for the catchment's land use and drain type (m^3/ha per year, from Table 6B.2 once published), A is the catchment area draining to the trap (ha), and t_c is the scheduled cleaning interval (years). The annex will state whether a safety margin is added.

Table 6B.1 — Sediment allowances already set by Chapter 6 (provisional, to be calibrated)

Element	Sediment allowance at the invert	Clause
Open and covered drains	Greater of 75 mm and 10% of the clear internal depth	6.7.8(a)
Pipes of 600 mm diameter or more	5% of the internal diameter	6.7.8(b)
Pipes below 600 mm	No allowance; minimum velocity of Clause 6.7.3(a) applies	6.7.8(c)
Drains and pipes that cannot reach the minimum velocity	Allowance doubled; mechanical desilting access provided	6.7.4(b), (c)
Inlet silt sumps	At least 300 mm below the outlet pipe invert	6.6.7

Table 6B.2 — Sediment yield by land use and drain type (layout)

Land use or catchment type	Drain type	Sediment yield Y (m^3/ha per year)	Bulk density (t/m^3)	Local body and records used	Years of record
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Table 6B.3 — Calibration of the sediment allowance (layout)

Drain or pipe ID	Clear internal depth or diameter (mm)	Allowance under Clause 6.7.8 (mm)	Measured silt depth before pre-monsoon desilting (mm)	Measured silt depth at the end of the monsoon (mm)	Ratio of measured to allowance
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Annex 6C — Standard drawings: covered roadside drain with removable covers, access chamber, inlet with silt sump

Supports Clauses 6.6, 6.7.6 to 6.7.10 and 6.13 of Chapter 6, and Clauses 9.11 and 9.12 of Chapter 9.

The drawings below are schematic standard drawings. They show only the dimensions that Chapter 6 and Chapter 9 set. Wall and slab thicknesses, reinforcement, concrete grade and cover, chamber plan sizes and frame details are to be confirmed in design: they come from the structural design (Clause 9.1.2) and the exposure class of Clause 9.13. Table 6C.1 lists the dimensions shown and their source clauses.

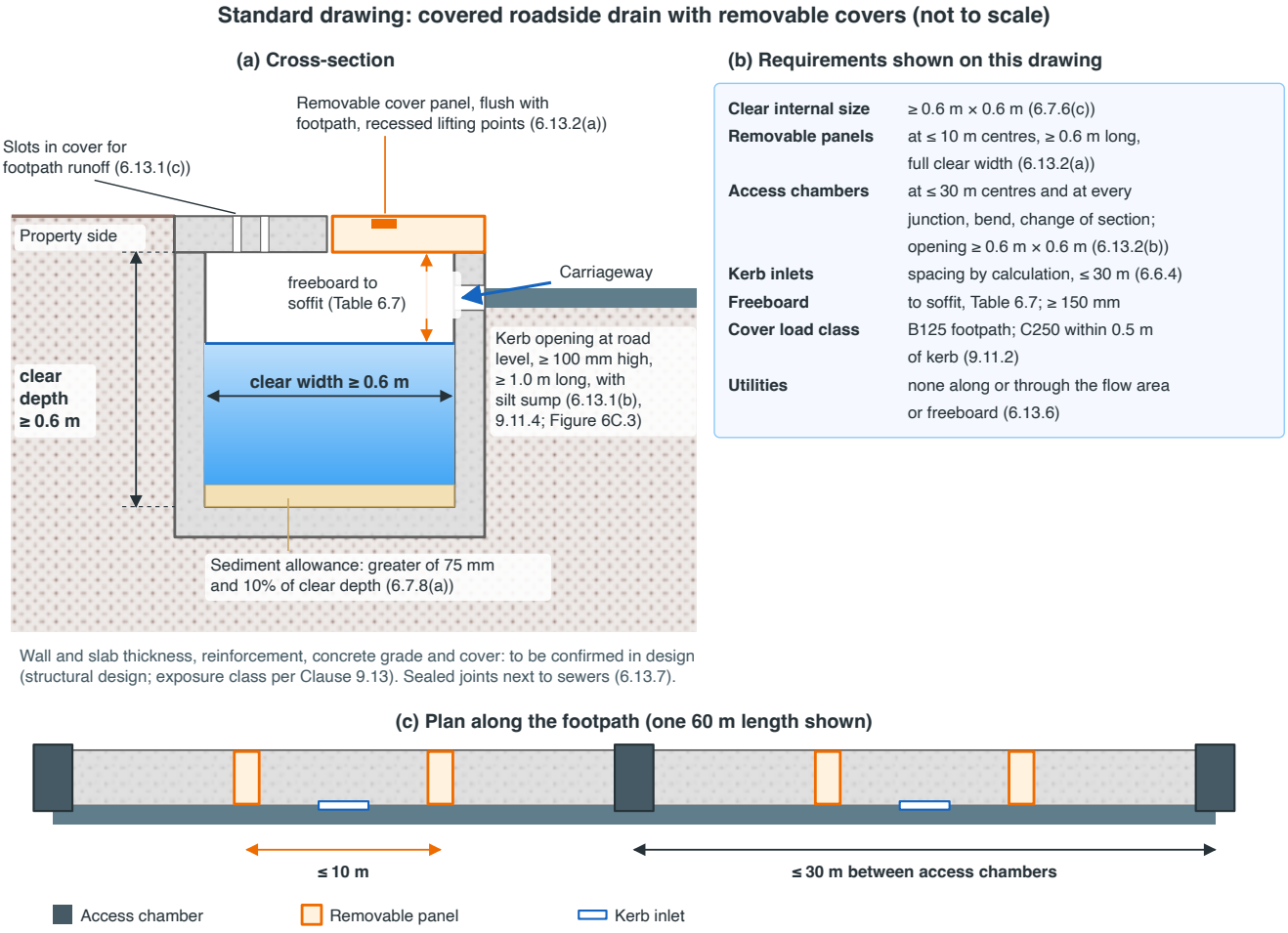


Figure 6C.1 — Standard drawing: covered roadside drain with removable covers, kerb inlets at road level, footpath slots, freeboard to the soffit and sediment allowance, with a plan of cover panels and access chambers along the footpath. Original drawing for this Manual, adapted from CPHEEO, Manual on Storm Water Drainage Systems (2019), Chapter 5, and IRC:SP:50-2013.

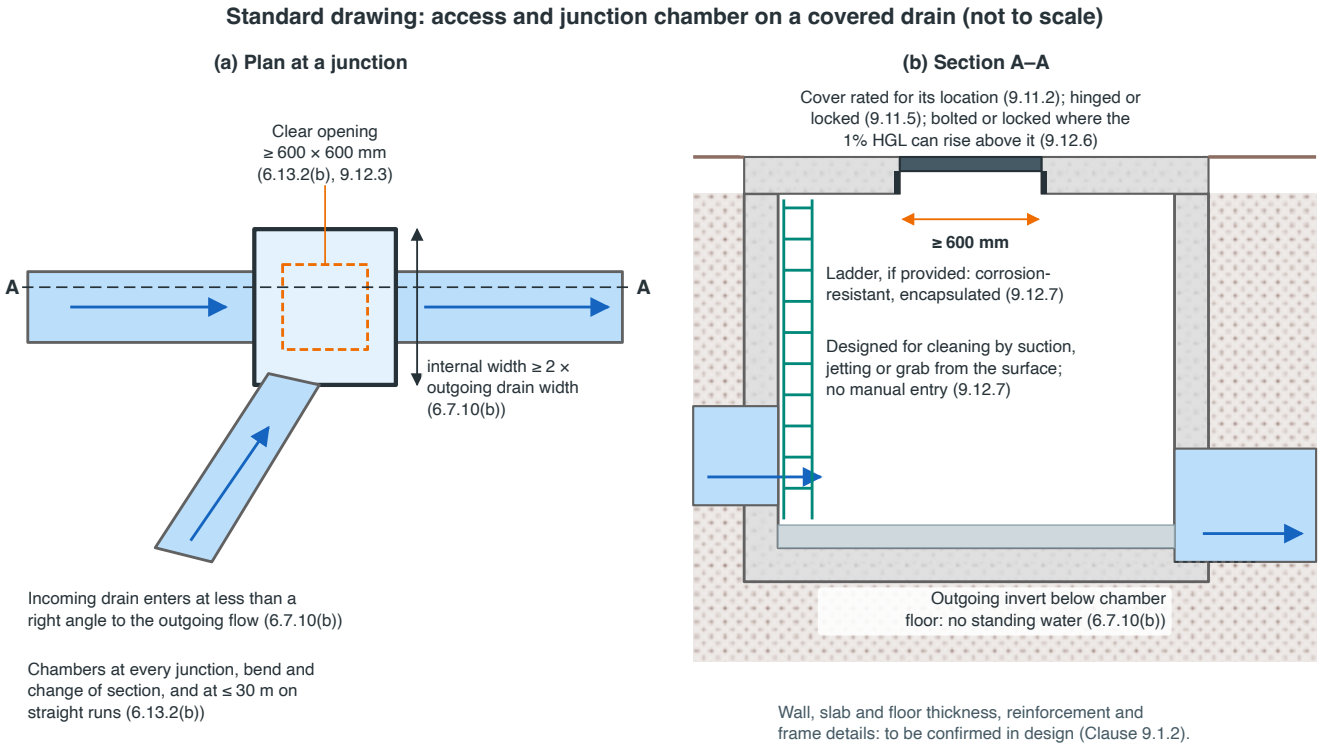


Figure 6C.2 — Standard drawing: access and junction chamber on a covered drain, with the clear opening, junction width, entry angle of the incoming drain, outgoing invert below the chamber floor, and cover requirements. Original drawing for this Manual, adapted from CPHEEO, Manual on Storm Water Drainage Systems (2019), §5.3.4 and Chapter 11.

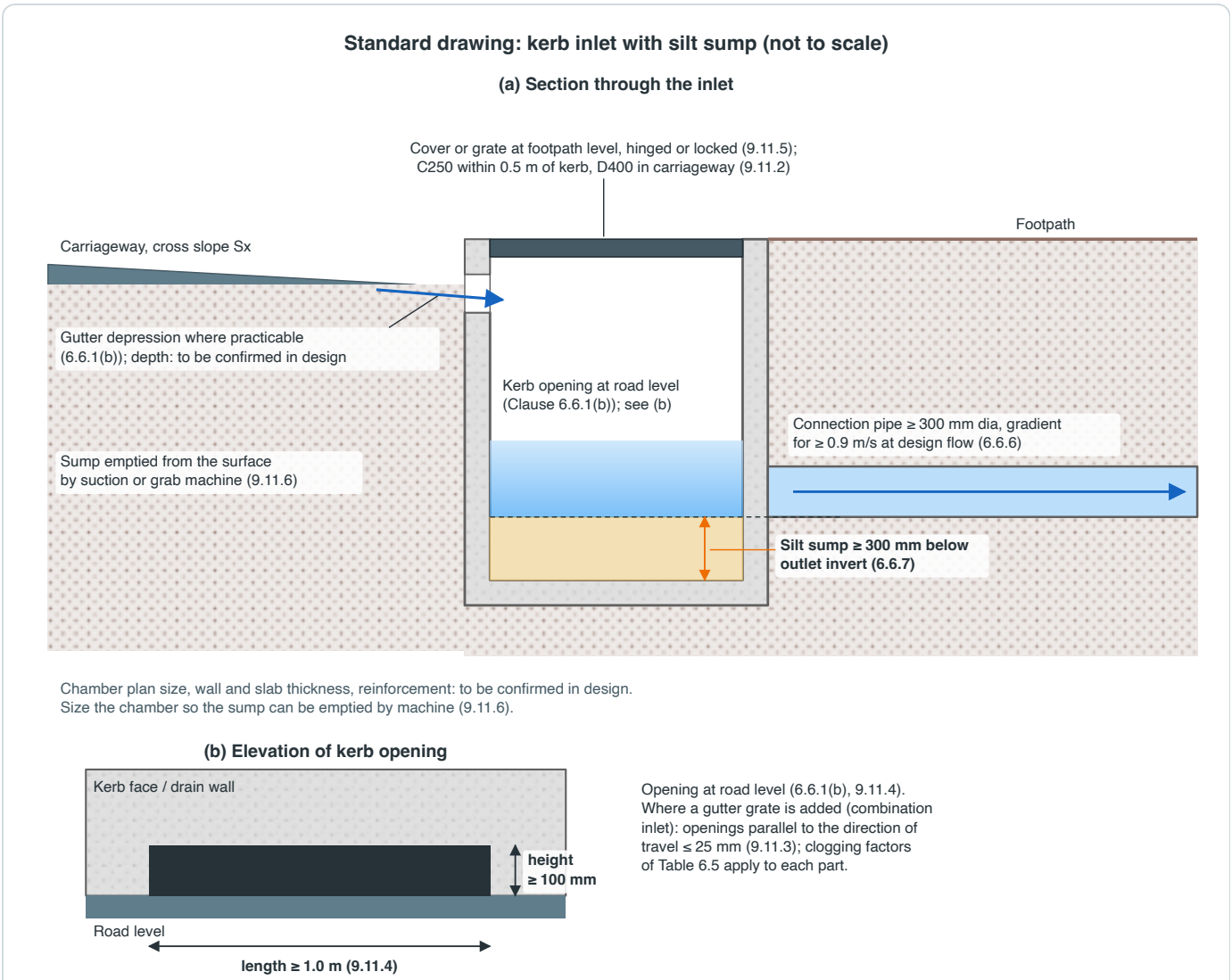


Figure 6C.3 — Standard drawing: kerb inlet at road level with silt sump, connection pipe and cover, and an elevation of the kerb opening. Original drawing for this Manual, adapted from CPHEEO, Manual on Storm Water Drainage Systems (2019), Figure 5.9, and FHWA, HEC-22 Urban Drainage Design Manual (4th ed., 2024).

Table 6C.1 — Dimensions on the standard drawings and their source clauses

Drawing	Item	Dimension or rule	Clause
6C.1	Clear internal size of a covered public drain	At least 0.6 m wide and 0.6 m deep	6.7.6(c)
6C.1	Freeboard to the cover soffit	Table 6.7; not less than 150 mm for any roadside drain	6.7.9, 6.13.1(a)
6C.1	Sediment allowance	Greater of 75 mm and 10% of clear depth	6.7.8(a)
6C.1	Removable cover panels	At not more than 10 m centres; each at least 0.6 m long and spanning the full clear width; recessed lifting points; flush with the footpath	6.13.2(a)
6C.1	Footpath runoff	Through slots or grated openings in the cover	6.13.1(c)
6C.1	Kerb inlets	Openings in the drain wall at road level, each with a silt sump; spacing by calculation, not more than 30 m	6.13.1(b), 6.6.4
6C.1, 6C.2	Access chambers	At every junction, bend and change of section, and at not more than 30 m centres on straight runs	6.13.2(b)

Drawing	Item	Dimension or rule	Clause
6C.2	Clear access opening	At least 0.6 m × 0.6 m (600 mm)	6.13.2(b), 9.12.3
6C.2	Junction chamber	Internal width at least twice the outgoing drain width; incoming drains at less than a right angle; outgoing invert below the chamber floor	6.7.10(b)
6C.2	Covers	Load class for the location; hinged or locked; bolted or locked where the 1% AEP HGL can rise above the cover	9.11.2, 9.11.5, 9.12.6
6C.2	Cleaning	By machine from the surface; ladders, where provided, corrosion-resistant and encapsulated	9.12.7
6C.3	Kerb opening	At road level; clear height at least 100 mm; length at least 1.0 m	6.6.1(b), 9.11.4
6C.3	Silt sump	At least 300 mm below the outlet pipe invert; emptied by suction or grab machine	6.6.7, 9.11.6
6C.3	Connection pipe	At least 300 mm diameter; at least 0.9 m/s at the design flow	6.6.6
6C.3	Grate in a combination inlet	Openings parallel to travel not wider than 25 mm; Table 6.5 clogging on each part	9.11.3, 6.6.3
All	Wall and slab thickness, reinforcement, concrete grade and cover, chamber plan size, gutter depression depth	To be confirmed in design	9.1.2, 9.13

Form 6-1 — Conveyance Design Report checklist

Supports Clause 6.15 of Chapter 6.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Not for statutory use.

Attach this checklist to the front of the Conveyance Design Report. For each item, enter Yes, No or Not applicable, and the drawing or page where it is shown.

Section A — Project

Table 6F.1 — Form 6-1, Section A: project

Field	Entry
Project name and location	_____
Local body, and Tier A or Tier B (Chapter 1)	_____
Applicant	_____
Designer (name and registration)	_____
Total catchment area served (ha)	_____
High-density area status for the 10% AEP minor system (Clause 6.4.4)	_____
Within the coastal band of Clause 6.11.6 (Yes / No)	_____
Date and revision	_____

Section B — Contents required by Clause 6.15

Table 6F.2 — Form 6-1, Section B: contents required by Clause 6.15

No.	Item	Clause	Provided (Yes / No / NA)	Drawing or page
1	Catchment plan: sub-catchments, minor system, inlet locations and the 1% AEP major-system overland flow paths	6.3.2		
2	Land-use and road-class AEP adopted for each element, and the high-density area status	Table 6.1, 6.4.4		
3	Design flows, with the rainfall sheet of Chapter 2 and the method of Chapter 3	6.3.4		
4	Gutter spread, depth and D·V checks for the minor, check and 1% events	Tables 6.2, 6.3		
5	Inlet schedule: clean capacity, clogging factor, design capacity and bypass flow	6.6		
6	Pipe and drain design tables: n, velocity, sediment allowance and freeboard	6.7		
7	HGL profiles for the minor and check events, with the tailwater used	6.8		
8	Sag ponding levels, including the fully-blocked check	6.10		
9	Floor-level schedule for every building	6.11		
10	Culvert and crossing calculations (with Form 9-1)	6.12, Chapter 9		

No.	Item	Clause	Provided (Yes / No / NA)	Drawing or page
11	Utilities-crossing schedule and access-opening layout for covered drains	6.13		

Section C — Design basis

Table 6F.3 — Form 6-1, Section C: design basis

Field	Entry	Clause
Minor-system design AEP adopted	_____	Table 6.1
Road class(es) and design / check AEPs for road drainage and crossings	_____	Table 6.1, 6.4.2
Rainfall source and climate factor applied	_____	6.3.4, Chapter 2
Method: Rational Method (catchment ≤ 16 ha, single element) or hydrograph method with routing	_____	6.3.4(a), (b)
Minimum time of concentration used (not less than 10 min)	_____	6.3.4(c)
Tailwater at the outfall for the HGL (MHWS + 0.3 m at tidal outfalls, or the receiving level)	_____	6.8.2
Any transfer of flow between natural catchments (none unless accepted under 6.3.5)	_____	6.3.5

Section D — Compliance checks

Table 6F.4 — Form 6-1, Section D: compliance checks

No.	Check	Limit	Clause	Complies (Yes / No / NA)
D1	Every inlet, sag, pipe, drain, culvert and storage element has a 1% AEP overland path	Shown on plan	6.3.2	
D2	Major-system flow = 1% AEP peak less the clogged minor-system capacity	Computed at each point	6.3.3	
D3	Spread in the minor event	Table 6.2	6.5.2	
D4	Depth in the check and 1% events	≤ 150 mm at the crown; ≤ 350 mm at the deepest point	Table 6.2	
D5	Flow hazard (D·V) by location	Table 6.3	6.5.3	
D6	Inlet clogging factors applied	Table 6.5	6.6.3	
D7	Inlet spacing on kerbed roads	≤ 30 m	6.6.4(a)	
D8	Sag inlet design capacity ≥ minor design flow arriving; flanking inlets where required	—	6.6.5	
D9	Inlet connection pipes and silt sumps	≥ 300 mm dia, ≥ 0.9 m/s; sump ≥ 300 mm	6.6.6, 6.6.7	
D10	Manning's n not less than the minimum design values	Table 6.6	6.7.2	
D11	Minimum velocity at the minor design flow	0.6 m/s drains; 0.9 m/s pipes	6.7.3(a)	
D12	Maximum velocity and Froude number	3.0 m/s lined drains and pipes; Fr ≤ 0.8	6.7.3(b), (d)	

No.	Check	Limit	Clause	Complies (Yes / No / NA)
D13	Where minimum velocity cannot be met: velocity reported, sediment allowance doubled, desilting access provided	—	6.7.4	
D14	Pipes sized for pipe-full capacity, not the 0.95-depth peak	—	6.7.5	
D15	Minimum sizes	Pipes 300 mm (450 mm public mains); open drain bed 0.3 m; covered public drains 0.6 m × 0.6 m	6.7.6	
D16	Cover to pipes; flotation check where groundwater is within 1 m of the crown	≥ 0.6 m; ≥ 0.9 m under carriageways	6.7.7	
D17	Sediment allowance in capacity	6.7.8 values	6.7.8	
D18	Freeboard, including superelevation at bends	Table 6.7	6.7.9	
D19	Bend radii and junction sumps	6.7.10	6.7.10	
D20	Manhole spacing on straight runs	Table 6.8	6.7.11	
D21	HGL below inlet rims and manhole covers in the minor event	≥ 0.3 m	6.8.3	
D22	Manholes that can surcharge above ground: bolted or locked covers	—	6.8.4	
D23	Soffits matched or outgoing soffit lower; outgoing invert not above the lowest incoming invert	—	6.8.6	
D24	Gate and valve losses included in the HGL; non-return valves on private connections where required	—	6.8.7, 6.8.8	
D25	Overland flow paths outside streets: width, tenure, no obstruction, continuous fall	≥ 1% top width + 0.5 m each side, ≥ 3.0 m	6.9.2	
D26	Compound walls across mapped flow paths: openings pass the 1% flow at 50% blockage	—	6.9.3	
D27	Access strip along open drains with top width ≥ 2 m	≥ 3.5 m, linked to a road at ≤ 500 m	6.9.4	
D28	Drainage reserve where required: width, separate plot, no structures, markers, services, 2 m stability check	Table 6.9	6.9.6–6.9.8	
D29	Sag ponding in the 1% event, overflow route, and fully-blocked check	≤ 350 mm at the deepest point	6.10.2, 6.10.3	
D30	Trapped sags and road underpasses	6.10.4, 6.10.5	6.10.4, 6.10.5	
D31	Floor levels	≥ 1% AEP level + 0.5 m; defaults of 6.11.3 where no level is computed	6.11.1–6.11.3	
D32	Basements and building services	6.11.4, 6.11.5	6.11.4, 6.11.5	
D33	Coastal band: floor ≥ 1% still-water level + 2 × SLA (+ wave set-up where applicable) + 0.5 m; no basement rooms or plant	—	6.11.6	
D34	Culverts: design AEP, overtopping, 50% / 20% blockage check, minimum size	≥ 900 mm	6.12	

No.	Check	Limit	Clause	Complies (Yes / No / NA)
D35	Covered drains: removable panels and access chambers	≤ 10 m; ≤ 30 m	6.13.1, 6.13.2	
D36	Silt traps, screens with bypass and 50% blockage check	—	6.13.3, 6.13.4	
D37	No building over drains; no utilities in the flow area or freeboard; existing crossings deducted with 50% blockage	—	6.13.5, 6.13.6	
D38	No sewage connections; sealed joints next to sewers; edge protection on open drains deeper than 1.0 m	—	6.13.7, 6.13.8	
D39	Outfalls: tailwater, flap gates or non-return valves below the 1% still-water level, outlet protection	—	6.14	

Section E — Variances

Table 6F.5 — Form 6-1, Section E: variances

Clause	Requirement not met	Reason and proposed alternative	Approved by and date
_____	_____	_____	_____

Section F — Signatures

The report shall be prepared and signed by a registered professional, and the Professional Design Certificate (Form 10-3) attached (Clauses 10.6.1 and 10.6.3 of Chapter 10). Where a structure stands within 2 m of the edge of a drainage reserve, the stability design shall also be signed by a qualified structural engineer (Clause 6.9.8(f)).

Table 6F.6 — Form 6-1, Section F: signatures

Role	Name	Registration or empanelment no.	Signature	Date
Designer	_____	_____	_____	_____
Structural engineer (Clause 6.9.8(f), where applicable)	_____	_____	_____	_____

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

ANNEXES TO CHAPTER 7

Waterbodies, Lakes, Marshes (Nambals) and Talabs (Ponds) and Setbacks

These annexes support Chapter 7. They give the inventory field specification, the fixed-width setback table, a template operating rule, the desilting and restoration specification, a glossary of Kashmiri and Urdu waterbody terms, and the three forms that Clause 7.15 requires. Where an annex cannot yet be completed it says so and gives the rule to use in the meantime. The forms are draft forms; the template and model text are for consideration by a competent authority and are not in force.

Annex 7A — Statewide waterbody GIS layer and inventory fields

Supports Clauses 7.3.1, 7.3.3 and 7.3.5 of Chapter 7.

To be prepared. This annex will contain the statewide GIS layer of waterbodies required by Clause 7.3.1, prepared by each Authority with I&FC and the Revenue Department. It needs the Revenue records and village maps of the Revenue Department, in which rivers, khads, nallahs, khuls, talabs, nambals and land covered by water are recorded, and in which drainage land in Jammu is largely recorded as Gair Mumkin Khad and marsh or grassland as nambal, rakh or kahcharai, classes that record the land, not its hydraulic extent; the "approximate location and size of any water body, flood affected areas and contours at an interval of 0.3m" that clause 2.6(b)(xi) of UBBL-2021 requires on the site plan of a sloping site, and the certificate of the registered technical person that the site is clear of drains and water bodies; the land use maps and buffer tables of the Srinagar Master Plan 2035 (Tables 8-2 to 8-4) and the Jammu Master Plan 2032 (§7.3.3), and the flood zonation of I&FC used in the Srinagar Master Plan (125 km² undevelopable and 136.50 km² vulnerable in the Srinagar planning area); the drains, nallahs and dewatering stations in the records of SMC, JMC, UEED and the other urban local bodies; I&FC's records of the rivers, khads, embankments, the flood spill channel and the city channels, and of its gauges; LCMA's records of Dal and Nigeen and WUCMA's of Wular; the boundaries of the five Ramsar sites, of the seven Wildlife Conservation Reserves and of any wetland notified under the Wetlands (Conservation and Management) Rules, 2017; NHPC's and JKSPDC's records of reservoir levels and acquired land; and the lists of wetlands, encroachments and water bodies filed before the High Court of Jammu & Kashmir and Ladakh and the National Green Tribunal, such as the 27 wetlands of more than 1 ha outside forests listed in 2026; the I&FC and Halqa Panchayat tank registers with FTL and MWL; surveyed levels on a common datum; the ISRO National Wetland Inventory and Assessment (NRSC); Survey of India topographic maps; and any list of waterbodies published under court directions. Until it is published, each Applicant identifies waterbodies from all the sources of Clause 7.3.3, with the larger extent governing, and records them on the Waterbody Sheet (Form 7-1).

The field specification below is complete. It is written so that every field the chapter asks for (Clause 7.3.1(a) to (g)) has a defined name, type and source, and so that the same fields can be filled from a project's Form 7-1.

7A.1 Layers

- **WB_POLY** — one polygon per waterbody: the Revenue record boundary (Clause 7.3.1(c)).

- **WB_FTL** — the surveyed FTL contour (tanks, lakes, ponds) or top of bank (channels), as a polygon or line.
- **WB_MWL** — the MWL contour of each tank, as a polygon.
- **WB_FLOOD** — the 1% AEP flood extent, where mapped (Clause 7.3.1(f)), with the floodway where delineated (Clause 7.6.1).
- **WB_STRUCT** — points for surplus weirs, sluices, regulators, inlets and drain outfalls.
- **WB_LINK** — lines for supply channels, surplus courses and the links between tanks in a cascade (Clause 7.3.1(e)).
- **WB_ENCR** — polygons of known encroachments, each with the date recorded (Clause 7.3.1(g)).
- **WB_SETBACK** — Zone 1 and Zone 2 polygons (Clause 7.4), derived from the layers above.

All layers shall carry the waterbody identifier (WB_ID) so that they can be joined. All levels shall be stated to one datum (Clause 7.3.5), named in the layer metadata.

Table 7A.1 — Attribute fields of the waterbody inventory (WB_POLY)

Field	Type	Unit / domain	Required	Content	Clause
WB_ID	Text	District code + serial	Yes	Unique identifier, never reused	7.3.1
WB_NAME	Text	—	Yes	Name as in Revenue and I&FC records, with local name	7.3.1(a)
WB_NAME_UR	Text	Urdu script	Yes	Name in Urdu	7.3.1(a)
WB_TYPE	Code	Table 7A.2	Yes	Waterbody type	7.2, 7.3.1(a)
SURVEY_NOS	Text	Village, survey and subdivision numbers	Yes	Revenue survey numbers of the waterbody	7.3.1(a)
VILLAGE	Text	—	Yes	Revenue village, tehsil and district	7.3.1(a)
CUSTODIAN	Code	Table 7A.2	Yes	Custodian body	7.3.1(b)
AREA_REC	Number	ha	Yes	Area within the Revenue record boundary	7.3.1(c)
AREA_FTL	Number	ha	Tanks	Waterspread at FTL, surveyed	7.2, 7.3.1(d)
FTL	Number	m (datum)	Tanks	Full tank level	7.3.1(d)
MWL	Number	m (datum)	Tanks	Maximum water level (Clause 7.2 definition)	7.3.1(d)
MWL_BASIS	Code	I&FC record / 1% AEP computed	Tanks	Which value governs MWL	7.2
TBL	Number	m (datum)	Tanks	Top bund level, lowest point	7.3.1(d)
WEIR_CREST	Number	m (datum)	Tanks	Surplus weir crest level	7.3.1(d)
WEIR_LEN	Number	m	Tanks	Surplus weir crest length	7.3.1(d)
WEIR_TYPE	Text	—	Tanks	Surplus weir type (for example fixed crest, with shutters or falling boards)	7.3.1(d)
SLUICE_N	Integer	—	Tanks	Number of sluices; details in WB_STRUCT	7.3.1(d)
SUPPLY_CH	Text	WB_ID(s)	Tanks	Supply channel(s) feeding the tank	7.3.1(d)
SURPLUS_CS	Text	WB_ID(s)	Tanks	Surplus course(s) leaving the tank	7.3.1(d)
UPSTR_WB	Text	WB_ID(s)	Cascades	Upstream tank(s) in the cascade	7.3.1(e)
DNSTR_WB	Text	WB_ID	Cascades	Downstream tank, river, drain or sea outfall	7.3.1(e)

Field	Type	Unit / domain	Required	Content	Clause
CATCH_AREA	Number	ha	Channels	Drainage area at the downstream end of the reach (for the 8 ha trigger of Clause 7.4.1(b) and Table 7.1)	7.4.1
DATUM	Text	—	Yes	Datum of all levels; conversion from any older I&FC datum	7.3.5
LEVEL_DATE	Date	—	Tanks	Date of the level survey	7.7.1(a)
SSC_DATE	Date	—	Tanks	Date of the latest stage–storage survey	7.7.1(b)
FLOOD_SRC	Code	Adopted map / site study / none	Yes	Source of the 1% AEP extent	7.3.4
FLOODWAY	Code	Delineated / whole 1% extent / below MWL	Yes	Basis of the floodway	7.6.1
ENCR_KNOWN	Code	Yes / No	Yes	Known encroachment; details in WB_ENCR	7.3.1(g)
CREDITED	Code	Yes / No	Tanks	Storage counted under Clause 7.7, with the scheme reference	7.7.1
WETLAND	Code	Notified / listed / other	Wetlands	Status under Clause 7.12.1	7.12.1
SOURCES	Text	—	Yes	Sources used, from the list in Clause 7.3.3(a) to (e)	7.3.3
UPDATED	Date	—	Yes	Date of the last edit, and by whom	7.3.1

Table 7A.2 — Code lists

Code list	Values	Clause
WB_TYPE	River; khad (seasonal torrent); nallah (natural or artificial drainage channel); kol (stream or canal); city channel or flood spill channel; canal; kuhl or zamindari khul (irrigation channel); lake or sar (with its gated or open outlet); nambal (marsh) or flood basin; talab (pond or tank; Kandi pond); reservoir or barrage pond (with its drawdown zone); spring (nag or cashma) and its recharge area; wetland (Ramsar site, Wildlife Conservation Reserve or other); glacial or moraine-dammed lake; supply channel; surplus course	7.2
CUSTODIAN	SMC, JMC, Municipal Council or Municipal Committee (Municipal Acts, 2000 [TBC]); UEED (with its Sewerage and Drainage Division (West) Jammu); Town Drainage (SMC or DULBK); I&FC (division; rivers, khads, nallahs, embankments, flood spill channel, city channels, canals and khuls); LCMA (Dal–Nigeen); WUCMA (Wular); Wildlife Department (Wildlife Conservation Reserve); Forest Department; PW (R&B) or NHAI (road drains and culverts); NHPC, JKSPDC or other dam operator; SDA, JDA, J&K Housing Board, Smart City SPV or developer (until handed over); State Government through the Deputy Commissioner or Tehsildar; Halqa Panchayat; Jammu and Kashmir Wetland Authority (wetland); private owner; other (name)	7.3.1(b)
Structure (WB_STRUCT)	Surplus weir; sluice; regulator; inlet; drain outfall; gross pollutant trap; crossing	7.3.1(d), 7.10
Encroachment (WB_ENCR)	Building; fill; road; wall; dumping; cultivation; other — each with date recorded, area (m²) and source	7.3.1(g), 7.13

Table 7A.3 — Attribute fields of structures (WB_STRUCT)

Field	Type	Unit	Content	Clause
STR_ID	Text	—	Unique identifier	7.3.1(d)
WB_ID	Text	—	Waterbody served	7.3.1(d)
STR_TYPE	Code	Table 7A.2	Structure type	7.3.1(d)
CREST_SILL	Number	m (datum)	Weir crest or sluice sill level	7.7.1(a)

Field	Type	Unit	Content	Clause
LENGTH_SIZE	Text	m	Weir crest length, or sluice opening size	7.7.1(a)
GATED	Code	Yes / No	Controllable outlet (needed for a flood cushion, Clause 7.8.2(a))	7.8.2
CONDITION	Code	Serviceable / defective	Result of the latest pre-monsoon inspection, with date	7.7.1(d), 7.14.4

Annex 7B — Fixed-width setback table (alternative S-3, with Annex 1C)

Supports Clauses 7.3.4, 7.4.3, 7.4.6 and 7.4.7 of Chapter 7, and alternative S-3 of the Policy Supplement (Annex 1C).

7B.1 When the table may be used

The fixed-width setback may be used only where all of the following apply:

- (a) the Authority has not adopted a 1% AEP flood extent map for the waterbody (Clause 7.3.4);
- (b) Clause 7.3.4 does not require the Applicant to determine the 1% AEP extent by a hydraulic study: the site is not in a flood-sensitive catchment, is not a site of 1 ha or more adjoining a waterbody, and the Authority has not asked for a study; and
- (c) the waterbody is one to which setbacks apply (Clause 7.4.1): any recorded or found waterbody, and any natural channel draining 8 ha or more at the site.

Where an Authority adopts alternative S-3 under Clause 1.7, the table below is the S-3 table. Clause 1.7.3(e) provides for the S-3 table to be issued by the State Stormwater Technical Committee. Until it is issued, the values are those of Clause 7.4.6, repeated here without change.

Table 7B.1 — Fixed-width setback by waterbody class (alternative S-3)

Waterbody class	Drainage area at the site	Total setback (Zone 1 + Zone 2)	Of which Zone 1	Measured from
Channel, small	8 ha to 65 ha	25 m	15 m	Top of bank (Clause 7.4.3)
Channel, medium	65 ha to 20 km²	40 m	15 m	Top of bank
Channel, large, and rivers	More than 20 km²	50 m	20 m	Top of bank
Tank, lake or pond	Any	MWL contour + 25 m	To the MWL contour, and not less than 15 m from FTL	FTL contour (Zone 1); MWL contour (total)
Marsh, estuary or backwater	Any	As notified by the Authority, and not less than 50 m	15 m	The waterbody boundary of Clause 7.13.1

Values from Clause 7.4.6 (Table 7.1). Zone 2 is the total setback less Zone 1.

7B.2 Rules of application

- (a) **Measurement.** Measure horizontally on plan, outward from the boundary of Clause 7.13.1: the larger of the Revenue record boundary and the surveyed FTL (or top of bank). Where FTL and top of bank both apply, use whichever gives the wider zone (Clause 7.4.3).
- (b) **Drainage area.** For a channel, use the drainage area at the downstream end of the reach that adjoins the site. Where a reach crosses a class limit within the site, apply the wider setback to the whole reach within the site.
- (c) **Both banks.** The setback applies on each bank of a channel and all round a tank, lake, pond or marsh.

- (d) **Minimum set by this Manual.** Zone 1 is never less than 15 m (Clause 7.4.7). A wider statutory or approval setback governs for the uses it restricts (Clause 7.4.5).
- (e) **Stricter of the two.** Where a hydraulic study is made voluntarily, the setback is the wider of Table 7B.1 and Clauses 7.4.3 and 7.4.4.
- (f) **Record.** The basis of the setback (fixed width) shall be stated on the Waterbody Sheet (Form 7-1) and in the approval (Clause 7.4, Disclosure).
- (g) **Review.** The table shall be reviewed within 2 years of the Authority adopting 1% AEP flood maps (Clause 7.16.1).

7B.3 Source of the channel widths

The channel widths were set by this Manual with reference to the 2006 Kansas City APWA default stream buffers, rounded up and floored at the 15 m minimum (Clause 7.4.6, commentary). The source values, as cited in the chapter, are:

Table 7B.2 — Source buffers cited in Clause 7.4.6 (KC APWA 5600, 2006, §5605.3)

Drainage area (source, acres)	Approximate SI equivalent	Source buffer
Less than 40 ac	Less than 16 ha	40 ft (12 m)
40–160 ac	16–65 ha	60 ft (18 m)
160–5,000 ac	65 ha – 20 km²	100 ft (30 m)
More than 5,000 ac	More than 20 km²	120 ft (37 m)

The 65 ha and 20 km² class limits in Table 7B.1 are the SI equivalents of 160 ac and 5,000 ac. The 8 ha lower limit is the 20-acre trigger of APWA 2025.01 (Clause 7.4.1(b)).

Annex 7C — Template tank operating rule, with flood cushion

Supports Clauses 7.7.1(c), 7.7.3, 7.8 and 7.14.4 of Chapter 7.

Model text for consideration by a competent authority. Not in force. For tanks under I&FC control, the operating rule is I&FC's rule (Clause 7.8.4); this template sets out the content that Clause 7.8 asks for, so that the custodian's rule can be checked against it. Text in square brackets is to be completed for each tank.

7C.1 Identification

1. Tank: [name, WB_ID of Annex 7A, village, tehsil, district].
2. Custodian: [I&FC division / ULB / Halqa Panchayat / other].
3. Cascade position: upstream tank(s) [ ]; downstream tank, river or drain [ ].
4. Datum: [ ]. Surveyed levels (Clause 7.7.1(a)), date of survey [ ]: FTL [ ] m; MWL [ ] m; TBL (lowest point) [ ] m; surplus weir crest [ ] m, length [ ] m; sluice sills [ ] m.
5. Stage–storage curve (Clause 7.7.1(b)): survey date [ ]; attached as Schedule 1.
6. Controllable outlets (Clause 7.8.2(a)): [gated sluice / regulator / none]; capacity at FTL [ ] m³/s.

7C.2 Purposes and priority

7. The tank serves [irrigation of a command area of [ ] ha / drinking water supply / recharge / flood storage]. Irrigation and water supply remain primary unless the custodian records otherwise (Clause 7.8.2(d)).

7C.3 Levels and dates through the year (Clause 7.8.1(a))

8. The tank shall be operated to the levels in Table 7C.1.

Table 7C.1 — Rule levels by period (to be completed for each tank)

Period	Target level (m)	Upper limit (m)	Lower limit (m)	Purpose
[1 Jan – date]	[ ]	FTL	[ ]	Holding for irrigation / supply
[date – start of cushion period]	[ ]	FTL	[ ]	Holding
[Flood-cushion period, if any]	Cushion level [ ]	Cushion level [ ]	[ ]	Flood cushion (Clause 7.8.2)
[End of cushion period – 31 Dec]	[ ]	FTL	[ ]	Refilling

9. Where no flood cushion is adopted, the starting level for design is FTL (Clause 7.7.3) and the row for the cushion period is deleted.

7C.4 Flood cushion (Clause 7.8.2)

10. Cushion level: [ ] m, which is [ ] m below FTL, giving a cushion volume of [ ] m³ from Schedule 1.
11. Dates: the cushion applies from [ ] to [ ].
12. Drawdown: the tank can be drawn down from FTL to the cushion level through [outlet] in [ ] hours, with a release not exceeding the maximum release rate of paragraph 18.
13. Reliability: continuous simulation (Clause 3.13) over the record [years] shows that the cushion is available at the start of a design storm in [ ]% of SW monsoon seasons, which shall be at least 90%. The simulation report is Schedule 2.
14. Yield: the custodian accepts the loss of irrigation or supply yield stated in Schedule 3 [and the compensation recorded there].
15. Where the tank has no controllable outlet, this section does not apply and no flood cushion is assumed (Clause 7.8.3).

7C.5 Releases (Clause 7.8.1(b) to (d))

16. Sluice and regulator settings at each level: Table 7C.2.
17. Operator: the sluices and regulators are operated by [post]. A release above [ ] m³/s may be ordered only by [post], or, in an emergency, by [post].
18. Maximum release rate: [ ] m³/s. This rate, added to the flow from the downstream catchment, does not flood buildings downstream (Schedule 4 gives the downstream check).
19. No person shall cut, lower or breach the bund or surplus weir except under the custodian's emergency procedure (Clause 7.14.5).

Table 7C.2 — Outlet settings by level (to be completed for each tank)

Tank level (m)	Sluice 1	Sluice 2	Regulator	Expected outflow (m³/s)	Notes
Below cushion level	[ ]	[ ]	[ ]	[ ]	
Cushion level to FTL	[ ]	[ ]	[ ]	[ ]	
FTL (weir begins to spill)	[ ]	[ ]	[ ]	[ ]	
Above FTL to MWL	[ ]	[ ]	[ ]	[ ]	Check freeboard to TBL (Clause 7.7.4(b))

7C.6 Forecasts, warnings and communication (Clause 7.8.1(e) and (f))

20. The triggers and actions are in Table 7C.3.
21. Before any release under this rule, the operator shall inform the ULBs and the district administration downstream, and residents by the means stated in Schedule 5, at least [ ] hours before the release where the forecast allows.

Table 7C.3 — Triggers and actions (to be completed for each tank)

Trigger	Source	Action	By whom
IMD district heavy-rainfall warning for the catchment	IMD	Read gauges [ ] hourly; check outlets are free; confirm the tank is at or below its rule level	[ ]
IMD or J&K SDMA red alert	IMD, J&K SDMA	Begin releases needed to reach the rule level, within the maximum release rate; notify downstream bodies (paragraph 21)	[ ]
City forecast system warning, where available	[ ]	[ ]	[ ]
Tank level reaches FTL	Gauge	Record outflow hourly; inspect bund and weir	[ ]
Tank level reaches [MWL − [ ] m]	Gauge	Emergency procedure; warning to the breach area of any emergency action plan (Clause 7.14.3(c))	[ ]

7C.7 Records and review (Clause 7.8.1(g))

22. During the SW monsoon (15 June to 31 October) the operator shall record daily: the tank level, every release (time, rate and duration), and every gate setting. Outside the SW monsoon, records shall be kept [weekly].
23. Records shall be kept with the O&M plan (Chapter 10) and given to the Authority on request.
24. The tank shall be inspected before the SW monsoon (by 31 May) and after every heavy-rainfall event (Clause 7.14.4).
25. This rule shall be reviewed after any event in which the tank surplused at a level above [ ] m, after any change to the weir, sluices or bund (Clause 7.7.6), and in any case with the review of the Manual.

Schedules: 1 stage–storage curve; 2 continuous simulation report; 3 yield and compensation; 4 downstream check of the maximum release; 5 communication list.

Annex 7D — Desilting and restoration specification

Supports Clauses 7.7.1(b), 7.9 and 7.14.4 of Chapter 7.

This specification applies to every desilting, restoration or deepening of a tank, pond or other waterbody under Clause 7.9. Values are those of Chapter 7. Where the chapter does not set a value, it is marked "to be confirmed in design" and shall be stated in the works design.

7D.1 Pre-works survey (Clause 7.9.1)

- (a) **Topographic and bathymetric survey** of the waterspread, foreshore (to the MWL contour), bund, surplus weir and sluices, levelled to the datum of Clause 7.3.5. Survey grid and point density: to be confirmed in design.
- (b) **Original bed level** found by test pits or augering on a grid (grid spacing to be confirmed in design), and from historical records where available. Each pit log shall show the silt thickness, the level of the original bed, and any clay or silt layer below it.

- (c) **Silt testing** where the tank receives urban runoff or sewage: samples from the pits of (b), tested for heavy metals and other contaminants before disposal is planned. The parameters and limits shall be those the Jammu and Kashmir Pollution Control Committee (JKPCC) directs.
- (d) **Structures:** condition of the bund (seepage, slips, cracks, animal burrows, trees), surplus weir and sluices, as in Clause 7.14.4.
- (e) **Existing stage–storage curve** from the survey of (a).

7D.2 Limits of excavation (Clauses 7.9.2 and 7.9.3)

- (a) Desilting removes accumulated sediment down to the original bed level of 7D.1(b), and no deeper.
- (b) Deepening below the original bed only with a hydrogeological report showing each of Clause 7.9.3(a) to (c).
- (c) Storage created below the lowest sluice sill is not flood storage, and shall not be shown as such in the revised stage–storage curve.
- (d) Excavation shall stay clear of the bund toe by a distance to be confirmed in design, so that the bund's stability is not reduced.

7D.3 Edges and safety (Clause 7.9.4)

Where the public has access to the edge:

- (a) side slopes no steeper than **1V:4H** from **0.5 m above FTL** down to **1.2 m below FTL**; or
- (b) a level safety bench at least **3 m** wide, between **0.3 m and 0.5 m below FTL**; and
- (c) no isolated deep pit or vertical cut left in the bed. Borrow pits shall be regraded to the bed.

7D.4 Storage not reduced (Clause 7.9.5)

- (a) Islands, walkways, bund widening into the waterspread, ring roads, parking, buildings and lake-front platforms within the waterspread or foreshore are lost storage.
- (b) Lost storage shall be offset by compensatory storage at equivalent levels, band by band, using Form 7-3.

7D.5 Silt handling and disposal (Clause 7.9.6)

- (a) Desilted material shall not be placed within the setback, on the bund (except approved bund strengthening), or on any flood path.
- (b) Contaminated silt shall be disposed of as the Jammu and Kashmir Pollution Control Committee (JKPCC) directs.
- (c) Haul routes and temporary stockpiles shall meet the construction erosion and sediment control rules of Clause 8.12, including stockpiles outside Zone 1.

7D.6 Inlets (Clause 7.9.7)

Every inlet that brings urban runoff shall have a sediment forebay, a constructed wetland inlet zone or a gross pollutant trap, designed under Chapter 8 (Annex 8D).

7D.7 Timing (Clause 7.9.8)

Desilting shall be complete, and the waterbody made safe, by **31 May**. No excavation shall be left open, and no sluice or weir left dismantled, during the SW monsoon.

7D.8 Completion records

- (a) As-built survey and revised stage–storage curve. The curve is the one that Clause 7.7.1(b) requires "after the last desilting".
- (b) Volume removed, its disposal site, and the silt test results.
- (c) Photographs of the bund, weir, sluices and inlet works.
- (d) Update of the inventory record (Annex 7A: SSC_DATE, LEVEL_DATE, CONDITION).

Table 7D.1 — Hold points for desilting and restoration works

Hold point	Check	Clause
1. Before excavation	Pre-works survey, pit logs, silt tests, and hydrogeological report if deepening	7.9.1, 7.9.3
2. Original bed reached	Levels checked against pit logs; no excavation below the original bed unless approved	7.9.2
3. Edges formed	Side slopes or safety bench as 7D.3	7.9.4
4. Inlet works	Forebay, wetland inlet zone or GPT built	7.9.7
5. Completion (by 31 May)	As-built survey, stage–storage curve, silt disposal record	7.9.8, 7.7.1(b)

Annex 7E — Glossary of Kashmiri and Urdu waterbody terms and regional variants

Supports Clause 7.2 and Clause 7.3 of Chapter 7.

The terms below are Kashmiri and Urdu words, with the Jammu usage of the instruments, for waterbodies, springs, channels and land in Jammu and Kashmir. Many of them appear in the names of lakes, marshes, springs and places (Hokersar, Brari Nambal, Kokernag, Tsunth Kol, Rani Talab). The name used in the Revenue, I&FC, LCMA, WUCMA or municipal record for each waterbody should be recorded in the inventory (Annex 7A) alongside the Manual's term. A meaning is given below only where it was confirmed in G. A. Grierson, *A Dictionary of the Kashmiri Language* (1916–1932), or in J. T. Platts, *A Dictionary of Urdu, Classical Hindi, and English* (1884), both as served by the Digital South Asia Library, with the page shown there, or in a Jammu and Kashmir statute, bye-law or plan. **Three cautions apply.** Grierson gives Kashmiri headwords in Roman and in the Kashmiri form of Devanagari, and gives a Perso-Arabic spelling only for words borrowed from Persian or Arabic (such as *cashma*, *hōz* and *talab*); no Perso-Arabic spelling is given here for a Kashmiri word unless a dictionary gives it, and the Kashmiri Perso-Arabic spellings of *nāg*, *kŏl*, *sar* and *nambal* are to be supplied by an editor. **No Dogri dictionary was consulted**, so the Jammu terms (*khad*, *kuhl*, *talab*) are given in the sense the Jammu Master Plan 2032 and UBBL-2021 use them, and their Dogri forms are to be checked. Meanings are the dictionaries' English glosses, and modern usage may be narrower or wider. Every term whose meaning or regional use was not confirmed is in Table 7E.4. The list is to be extended by the State Stormwater Technical Committee, with modern Revenue, I&FC and municipal usage and with a Dogri dictionary.

The Manual's term for a pond or tank in Jammu and Kashmir is **talab (तालाब; تالاب; Kashmiri *talāv*)**: it is the word the Union Territory's own instruments use ("Talav" and "talab, village tanks" in UBBL-2021; "talabs" in the Jammu Master Plan 2032), it is found with the pond or tank sense in both the Kashmiri and the Urdu dictionary, and it names places in Jammu (Rani Talab, Talab Tillo). Because Kashmiri *talab* (طلب) is a different word meaning "pay, wages, salary" (Grierson, p. 1000), it is always written with its script or glossed on first use as "talab (pond or tank)". Natural waterbodies keep their own words in names: *sar* (lake), *nambal* (marsh) and *nāg* (spring); and an engineered detention basin is never called a talab, sar, nambal or nag: it is a detention pond, with the local word in brackets where that helps.

Table 7E.1 — Waterbodies

Term	Meaning	Source of the term	Manual term (Clause 7.2)
तालाब / تالاب (tālāb); Kashmiri तलाव् (talāv)	Platts: "Pond, pool, tank, reservoir of water (= talā'o; cf. tāl)"; Grierson: *talāv*, "an artificial pond, a tank". UBBL-2021: "water body, pond and Talav"; "talab, village tanks" (clause 7.12(c)); Jammu Master Plan 2032: "talabs"	Platts, p. 306; Grierson, p. 1003; UBBL-2021; JMP 2032	Talab (pond or tank), see the definitions after Clause 7.2
सर् (sar)	"a lake, a large sheet of water" (Grierson, *sar 1*); *saras*, "a lake, pool, pond"	Grierson, pp. 928 and 938	A lake, in names only (Hokersar, Khushalsar, Gilsar, Mansar, Surinsar, Budsar); a lake for this chapter
डल् (ḍal)	"a lake; N. of a large lake near Śrīnagar" (Grierson, *ḍal 1*); *Ḍal-darwāza*, "the Ḍal gate, the flood-gate of the Ḍal lake. When the Jihlam … is low, the gates remain open; but when the river rises to a certain height, they automatically close, thus preventing inundation of the land round the lake". Not the same word as Grierson's *dal 1* and *dal 2* (a leaf; pounding)	Grierson, p. 210	The name Dal only; Dal Gate is the lake's outlet under Clause 7.8
नंबल् (nambal)	"a grass-grown lake, a lake choked by vegetation, a shallow lake, a marsh, swamp"; *nambala-syomu*, "the silt of a marsh"; *nambali-boṭhu*, "the edge, bank, or margin of a marsh"	Grierson, p. 637	Nambal (marsh; flood-absorption marsh), see the definitions after Clause 7.2; a wetland under Clause 7.12
होज़ / حوض (hōz)	"a reservoir, cistern, pond, pool, tank, vat, trough, basin of a fountain"	Grierson, p. 368	A built cistern or pool; a talab for this chapter where it holds water
ल्यम्ब् (lĕmb)	"the mud at the bottom of standing or running water, sediment …; land in which springs occur"	Grierson, p. 524	Spring-fed wet land; optional, always glossed

Table 7E.2 — Springs, streams and channels

Term	Meaning	Source of the term	Manual term (Clause 7.2)
नाग् (nāg)	Grierson, *nāg 2*: "a snake, esp. a fabulous serpent-demon … In Kashmīr, they are the deities of springs …; a fountain, a spring of water"; *nāga-wuziñ*, "the steady perpetual flow of water from a spring". Platts gives ناگ only the sense of a snake	Grierson, p. 624; Platts, p. 1116	Spring (nag), as in Kokernag and Verinag, see the definitions after Clause 7.2
چشمہ (cashma)	"a spring, source, fountain" (Grierson); *Cashma Shāhī*, "N. of a fountain on the northern shore of the Śrīnagar city lake"; Platts, *ćashma*: "A spring, source, fount; a fountain; — spectacles"	Grierson, p. 177; Platts, p. 434	Spring (cashma), see the definitions after Clause 7.2
क्वल् (kŏl)	Grierson, *kŏl 2*: "a river, a stream, a brook …; an artificial stream, canal, irrigation channel"; *kŏla-boṭhu*, "the bank of a river"; *kŏla-gaṇḍ*, "stopping the flow of water through an irrigation channel". Not Platts's *kūl* (کول, "bank … a pool, pond, lake"), a different word	Grierson, p. 437; Platts, p. 863	Kol (stream or canal), as in the Tsunth Kol, see the definitions after Clause 7.2
नाल / نالا (nāla; nālā)	Grierson, *nāla 1*: "an artificial watercourse, a channel, a canal (esp. when forming a boundary between two pieces of land)"; Platts, *nālā*: "A watercourse; channel …, a ravine; a rivulet, brook, canal; a drain, gutter". UBBL-2021: "Nallas" (clause 5.2.5); the master plans: "Nallah"	Grierson, p. 633; Platts, p. 1117; UBBL-2021; SMP 2035; JMP 2032	Nallah (natural or artificial drainage channel)
खड्ड (khaḍḍ; khad)	Jammu usage: "ravines, locally called Khads are transformed into gushing torrents" (JMP 2032, §2.4); "any other river/khad" (UBBL-2021, clause 7.12(b)). Grierson's *khŏḍ* is "a pit, a hole dug in the ground; a ditch" and Platts's *khaḍḍā* "Pit, cavity, hollow", with no stream sense	JMP 2032; UBBL-2021; Grierson, p. 392; Platts, p. 873	Khad (seasonal torrent or ravine stream), see the definitions after Clause 7.2; always glossed

Term	Meaning	Source of the term	Manual term (Clause 7.2)
कूहल (kuhl); khul	An irrigation channel. The Water Resources Act, 2010 counts "zamindari khuls" among its hydraulic works; Grierson has no *kuhul* headword (his *kúl* is a spelling of *kŏl 2*)	Water Resources Act, 2010, section 2 [TBC]; Grierson, p. 437	Kuhl or khul (irrigation channel), see the definitions after Clause 7.2; always glossed

Table 7E.3 — Land and Revenue classes

Term	Meaning	Source of the term	Use in this Manual
Gair Mumkin Khad (also "Ghir Mumkin Khad")	A Revenue class of drainage land in Jammu, covering "more than thirty percent of the JDA land"	JMP 2032, §§2.4 and 12.2.3	A Revenue class only, glossed as land recorded as uncultivable stream-bed; its hydraulic extent is the functional khad (definitions after Clause 7.2)
رکھ (rakh)	Platts: "A preserve (for grass, or game, &c.), a grassy wood". Official usage: "Wetlands Reserves (Game Reserves and State Rakhs)" (Wildlife Department, 2024); names such as Rakh-e-Arth, Rakhi Shalbug and Rakh-e-Gund Aksha. Grierson's *rakh* headwords have no water sense	Platts, p. 597; Wildlife Department, 2024; SMP 2035	Rakh (reserved wetland or grassland), in names only; not used as a generic term for a marsh

Table 7E.4 — Terms not yet verified

These terms or senses are in use but were not confirmed in a dictionary during research for this Manual. They shall not be used in a record or a drawing as defined terms until verified.

Term	Reported meaning or use	Status
kahcharai	Land recorded as grazing land (Kahcharai Act, Svt. 2011)	The Act was not read; dictionary meaning not checked; used in this Manual only as a Revenue class
ghair-mumkin	"Impossible", that is, land that cannot be cultivated	Dictionary meaning not checked; the gloss in Table 7E.3 is this Manual's
Dogri forms of talab, khad, kuhl and nallah, and other Dogri waterbody words	Regional words and spellings of the Jammu division	No Dogri dictionary was consulted
Kashmiri Perso-Arabic spellings of nāg, kŏl, sar and nambal	Spellings for signs and records in Urdu script	Not given by Grierson; to be supplied by an editor

The Manual uses the terms in the last column of Tables 7E.1 and 7E.2, the land terms of Table 7E.3, and the Jammu and Kashmir terms defined after Clause 7.2.

Form 7-1 — Waterbody Sheet

Supports Clauses 7.3.2, 7.4 and 7.15(1) of Chapter 7.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One sheet per waterbody. Attach the plan of Clause 7.3.2 at 1:1,000 or larger.

Table 7F.1 — Form 7-1, Section A: Project and waterbody

No.	Field	Entry	Clause
A1	Project name and Authority file number	_____	—
A2	Waterbody name (English and Urdu) and inventory ID (Annex 7A), if any	_____	7.3.1
A3	Waterbody type (Clause 7.2)	_____	7.2
A4	Position: within the site / within 100 m of the site boundary / downstream within the Chapter 5 extent	_____	7.3.2
A5	Survey numbers and village	_____	7.3.1(a)
A6	Custodian	_____	7.3.1(b)
A7	Sources checked (tick): Revenue records and village maps (Gair Mumkin Khad, nambal, rakh, kahcharai), UBBL-2021 site plan (water bodies, flood areas, 0.3 m contours), SMP 2035 and JMP 2032 buffers and land use, I&FC flood zonation, channel and gauge records, SMC, JMC and UEED drain and dewatering-station records, LCMA and WUCMA records, Ramsar, conservation-reserve and wetland boundaries, dam-operator records, High Court and NGT lists □; I&FC / Halqa Panchayat registers □; Authority inventory or court list □; historical maps and imagery, including NWIA □; site survey □	_____	7.3.3
A8	Where sources conflict: which extent governs (the larger)	_____	7.3.3
A9	Datum of all levels, and conversion from any I&FC datum	_____	7.3.5

Table 7F.2 — Form 7-1, Section B: Levels and features

No.	Field	Entry	Clause
B1	FTL (tanks, lakes, ponds) or top of bank (channels), m	_____	7.2
B2	MWL (tanks), m, and basis (I&FC record or 1% AEP computed)	_____	7.2
B3	TBL, lowest point (tanks), m	_____	7.3.1(d)
B4	1% AEP flood level, m, and source (adopted map / hydraulic study / not available)	_____	7.3.4
B5	Drainage area at the site (channels), ha	_____	7.4.1(b)
B6	Supply channels, surplus courses, sluices and surplus weirs shown on plan (yes / no)	_____	7.3.2
B7	Known encroachments, with date recorded	_____	7.3.1(g)

Table 7F.3 — Form 7-1, Section C: Setback

No.	Field	Entry	Clause
C1	Basis of setback: mapped extent / hydraulic study / fixed width (Annex 7B)	_____	7.15(1)
C2	Is a hydraulic study required under Clause 7.3.4 (a) / (b) / (c)?	_____	7.3.4
C3	Floodway outer edge, m from FTL or top of bank, and how delineated	_____	7.6.1

No.	Field	Entry	Clause
C4	Zone 1 width, m (greatest of 15 m, floodway edge, MWL contour)	_____	7.4.3
C5	Zone 2 width, m (to 1% AEP extent + 10 m, or 10 m)	_____	7.4.4
C6	Wider statutory or approval setback, if any, and its source	_____	7.4.5
C7	Setback applied: Manual standard / a wider statutory, plan, court or approval line: UBBL-2021, clause 7.12(b), 50 m (major rivers and any other river or khad), 30 m (lakes) or 20 m (unlisted rivulets, tributaries, minor canals and watercourses) from the edge of the bank; clause 5.2.5, 30 m green buffer from the highest water level along nallahs and rivers; a buffer of the Srinagar Master Plan 2035 (Tables 8-2 and 8-3; 100 m round an unlisted wetland reserve, §8.2.3) or of the Jammu Master Plan 2032 (§7.3.3, from Full Tank Level; its 15 m and 5 m khad lines are overridden by clause 7.12 where the bye-laws apply); the High Court's 200 m round Dal and, as reported, round Wular, and the 200 m round Nigeen applied by LAWDA (as quoted); the boundary of a Ramsar site, a Wildlife Conservation Reserve or a notified wetland; an I&FC line under the Water Resources Act, 2010; a flood basin notified under Part VI of that Act or a flood plain zone under the Flood Plain Zones Act, 2005 (none notified); or other (state which)	_____	7.4, Disclosure
C8	Uses proposed in Zone 1 and Zone 2, and the custodian's NOC for any work in Zone 1	_____	7.5, 7.15(5)
C9	Fill proposed in the flood fringe (yes / no); if yes, Form 7-3 attached	_____	7.6.3
C10	Zone 1 marker positions shown (not more than 30 m apart)	_____	7.13.4

Table 7F.4 — Form 7-1, Section D: Prepared by

Field	Entry
Name, registration and empanelment number (Clause 10.6)	_____
Signature and date	_____
Licensed surveyor for the levels (name, licence number)	_____

Form 7-2 — Tank Storage Credit Sheet

Supports Clauses 7.7, 7.8, 7.11, 7.14 and 7.15(4) of Chapter 7.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One sheet per tank whose storage is counted. Storage that fails any item in Section B shall not be counted (Clause 7.7.1).

Table 7F.5 — Form 7-2, Section A: Tank and scheme

No.	Field	Entry	Clause
A1	Tank name and inventory ID (Annex 7A); custodian	_____	7.3.1
A2	Scheme in which storage is counted: basin plan / regional facility / fee-in-lieu (S-5)	_____	7.7.1, 7.11
A3	Cascade modelled: uppermost tank _____ to outfall _____	_____	7.7.2
A4	Datum	_____	7.3.5

Table 7F.6 — Form 7-2, Section B: Conditions for counting storage

No.	Condition	Date / reference	Met (yes / no)	Clause
B1	FTL, MWL, TBL, weir crest and length, sluice sills surveyed within the previous 5 years	_____	_____	7.7.1(a)
B2	Stage–storage curve from a bathymetric and topographic survey within 5 years or after the last desilting, whichever is later	_____	_____	7.7.1(b)
B3	Documented operating rule agreed with the custodian (Annex 7C)	_____	_____	7.7.1(c), 7.8
B4	Weir, sluices and bund under an O&M plan; latest pre-monsoon inspection found them serviceable	_____	_____	7.7.1(d), 7.14.4
B5	Custodian's written concurrence	_____	_____	7.7.1(e)

Table 7F.7 — Form 7-2, Section C: Levels and creditable volume

No.	Item	Value	Clause
C1	Starting level: FTL, or cushion level under a rule meeting Clause 7.8.2, m	_____	7.7.3
C2	If a cushion is used: controllable outlet (type) and drawdown time, h	_____	7.8.2(a)
C3	If a cushion is used: reliability from continuous simulation, % of SW monsoon seasons (≥ 90%)	_____	7.8.2(c)
C4	Computed maximum level, 1% AEP inflow with climate factor routed through the cascade, m	_____	7.7.4
C5	MWL, m; is C4 ≤ MWL?	_____	7.7.4(a)
C6	Freeboard C4 to TBL, m; I&FC freeboard standard, m; met?	_____	7.7.4(b)
C7	Storage between C1 and C4, from the stage–storage curve, m^3	_____	7.7.5
C8	Volume already committed to another facility or scheme, m^3	_____	7.7.5
C9	Creditable volume = C7 − C8, m^3	_____	7.7.5
C10	Register entry under Clause 10.17 (fee-in-lieu storage)	_____	7.11.2(d)

Table 7F.8 — Form 7-2, Section D: Bund safety

No.	Item	Entry	Clause
D1	Specified dam under the Dam Safety Act, 2021? Height, crest length, capacity, maximum flood discharge	_____	7.14.1
D2	Hazard class: high / low	_____	7.14.2
D3	High hazard: weir passes 1% AEP at MWL with freeboard; 0.2% AEP check without overtopping	_____	7.14.3(a)
D4	High hazard: breach analysis and emergency action plan (references)	_____	7.14.3(b), (c)
D5	High hazard: independent check under Clause 10.6 (name)	_____	7.14.3(d)

Table 7F.9 — Form 7-2, Section E: Signatures

Role	Name and designation	Signature and date
Designer (Clause 10.6)	_____	_____
Independent checker, where Clause 7.14.3(d) applies	_____	_____
Custodian's concurrence (Clause 7.7.1(e))	_____	_____

Form 7-3 — Compensatory Storage Calculation (by elevation band)

Supports Clauses 7.6.3 to 7.6.5, 7.9.5 and 7.15(3) of Chapter 7.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

Method

1. Fix the **lower limit**: the normal water level of the waterbody, or the 50% AEP (2-yr) level where higher (Clause 7.6.4(b)).
2. Fix the **upper limit**: the 1% AEP flood level (with the climate factor).
3. Divide the range into **bands of not more than 0.3 m**. The top band may be thinner.
4. For each level z at a band boundary, measure on plan:
    - A_fill(z): the area of the fill footprint where existing ground is below z; and
    - A_cut(z): the area of the excavation where finished ground is below z and existing ground was above z (new flooded area).
5. For each band, by the average end-area method: V = (A(z_bottom) + A(z_top)) / 2 × band thickness. Do this for fill (volume lost) and for excavation (volume gained).
6. **Check each band:** volume gained ≥ volume lost. A surplus in one band does not make up a shortfall in another (Clause 7.6.4(b)).
7. Check the other conditions of Clause 7.6.4(c) to (f) in Section C.

Figure 7.2 in Chapter 7 shows the method.

Table 7F.10 — Form 7-3, Section A: Levels

No.	Field	Entry	Clause
A1	Waterbody, reach, and inventory ID	_____	7.6.4(c)
A2	Normal water level, m; 50% AEP level, m; lower limit (the higher), m	_____	7.6.4(b)
A3	1% AEP flood level with climate factor, m (upper limit)	_____	7.6.4(b)
A4	Band thickness, m (≤ 0.3) and number of bands	_____	7.6.4(b)
A5	Datum	_____	7.3.5

Table 7F.11 — Form 7-3, Section B: Band-by-band balance

Band	From (m)	To (m)	A_fill bottom (m²)	A_fill top (m²)	Volume lost (m³)	A_cut bottom (m²)	A_cut top (m²)	Volume gained (m³)	Gained ≥ lost?
1	_____	_____	_____	_____	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____	_____	_____	_____	_____
Total					_____			_____	

Add rows as needed.

Table 7F.12 — Form 7-3, Section C: Other conditions

No.	Condition	Met (yes / no) and evidence	Clause
C1	Fill is in the flood fringe, not the floodway, and for a permitted use	_____	7.6.2, 7.6.3
C2	Excavation is in the same reach of the same waterbody, hydraulically connected, and not further downstream than the fill	_____	7.6.4(c)
C3	Excavation drains by gravity as the flood recedes; no pumping; no permanent pool below normal water level	_____	7.6.4(d)
C4	Excavation built before, or at the same time as, the fill	_____	7.6.4(e)
C5	Covenant or handover so that it is never filled (reference)	_____	7.6.4(f)
C6	Not counted as detention or retention under Chapter 4	_____	7.6.5
C7	Signature of designer (Clause 10.6) and date	_____	10.6

Worked example

Illustrative — not design values. A site in the flood fringe of a channel needs a fill pad for a permitted Zone 2 use (Clause 7.5.2). The inputs are assumed.

- Normal water level 10.00 m; 50% AEP level 9.80 m. Lower limit = 10.00 m (the higher).
- 1% AEP flood level 11.20 m. Range 1.20 m, so four bands of 0.30 m.
- The fill footprint is 1,600 m². Existing ground across the footprint rises evenly from 10.00 m to 11.20 m, so the area of footprint below each level is: 0 m² at 10.00 m; 400 m² at 10.30 m; 800 m² at 10.60 m; 1,200 m² at 10.90 m; 1,600 m² at 11.20 m.
- The excavation is a graded cut beside the channel, with its floor at 10.00 m. The new flooded area below each level (first trial) is: 300 m² at 10.00 m; 900 m² at 10.30 m; 1,100 m² at 10.60 m; 1,500 m² at 10.90 m; 1,500 m² at 11.20 m.

Step 1 — volume lost, band by band (V = average area × 0.3 m):

- Band 1: (0 + 400) / 2 × 0.3 = 60 m³
- Band 2: (400 + 800) / 2 × 0.3 = 180 m³
- Band 3: (800 + 1,200) / 2 × 0.3 = 300 m³
- Band 4: (1,200 + 1,600) / 2 × 0.3 = 420 m³
- Total: 960 m³

Step 2 — volume gained, first trial:

Table 7F.13 — Worked example: first trial (illustrative)

Band	From (m)	To (m)	Volume lost (m³)	A_cut bottom (m²)	A_cut top (m²)	Volume gained (m³)	Gained ≥ lost?
1	10.00	10.30	60	300	900	180	Yes
2	10.30	10.60	180	900	1,100	300	Yes
3	10.60	10.90	300	1,100	1,500	390	Yes
4	10.90	11.20	420	1,500	1,500	450	Yes
Total			960			1,320	

Every band passes. Note that a simple total balance would hide a failure if, for example, the cut were made deeper and narrower: suppose the designer instead offers a cut with new flooded areas of 1,400 m² at 10.00 m, 1,400 m² at 10.30 m, 1,000 m² at 10.60 m, 600 m² at 10.90 m and 200 m² at 11.20 m.

Table 7F.14 — Worked example: deeper, narrower cut (illustrative)

Band	From (m)	To (m)	Volume lost (m³)	A_cut bottom (m²)	A_cut top (m²)	Volume gained (m³)	Gained ≥ lost?
1	10.00	10.30	60	1,400	1,400	420	Yes
2	10.30	10.60	180	1,400	1,000	360	Yes
3	10.60	10.90	300	1,000	600	240	**No**
4	10.90	11.20	420	600	200	120	**No**
Total			960			1,140	

The total gained (1,140 m³) exceeds the total lost (960 m³), but bands 3 and 4 are short by 60 m³ and 300 m³. The surplus low down cannot be counted against them: the low storage fills early in every flood and is not available when the fill takes away storage near the peak. This design fails Clause 7.6.4(b) and must be regraded so that the upper bands gain at least as much as they lose, as in the first trial.

ANNEXES TO CHAPTER 8

Water Quality and Recharge

These annexes support Chapter 8. They give the layout of the water quality rainfall tables, the Level of Service and Value Rating method in detail, the layout of the BMP calibration programme, design sheets for each BMP, standard details for construction erosion and sediment control, and the two forms that Clause 8.14 requires. Annexes 8A and 8C need data that are not yet available; they say so and give the rule to use in the meantime. The forms are draft forms.

Annex 8A — 3-month ARI 24-hour depth and IDF by zone

Supports Clauses 8.2, 8.4.1 and 8.4.5 of Chapter 8.

To be prepared. This annex will contain, for each rainfall zone of Chapter 2, the 24-hour 3-month ARI depth P_3m and the 3-month ARI intensity–duration relationship used for Q_wq. It needs long-term daily and sub-daily rainfall records (IMD station and gridded data, with NIH as the Chapter 2 primary source), analysed as a partial-duration series. Until it is published, the designer shall compute P_3m from the longest available daily record for the site's zone, as the 24-hour depth equalled or exceeded on average four times a year (Clause 8.2), state the record, its length and the method on the Water Quality Sheet (Form 8-1), and use P_wq = max (P_ret, P_3m) (Clause 8.4.1). The climate factor is not applied (Clause 8.4.3).

8A.1 Method to be used in preparing the annex

- (a) Use daily records of at least 30 years where available (as for station IDF in Chapter 2).
- (b) Form the partial-duration series of 24-hour depths, with independent events separated by at least one dry day.
- (c) Choose the threshold so that the number of events above it averages four per year; P_3m is that threshold.
- (d) Derive the 3-month ARI intensities for durations from 10 minutes to 24 hours from sub-daily records, or by the Chapter 2 method of scaling from the daily value, stating which.
- (e) Do not apply the climate factor (Clause 8.4.3).

Table 8A.1 — Water quality rainfall depths by zone (layout)

Zone (Chapter 2)	Representative stations or grid	Record (years)	P_ret, Annex 2E (mm)	P_3m (mm)	P_wq = max (mm)
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Table 8A.2 — 3-month ARI intensity by duration (layout)

Zone	10 min (mm/h)	15 min (mm/h)	30 min (mm/h)	1 h (mm/h)	2 h (mm/h)	6 h (mm/h)	24 h (mm/h)
_____	_____	_____	_____	_____	_____	_____	_____

Zone	10 min (mm/h)	15 min (mm/h)	30 min (mm/h)	1 h (mm/h)	2 h (mm/h)	6 h (mm/h)	24 h (mm/h)
_____	_____	_____	_____	_____	_____	_____	_____

Annex 8B — Redevelopment LoS table and treatment-train composite VR

Supports Clauses 8.6.2 to 8.6.5 of Chapter 8.

8B.1 Required Level of Service for redevelopment

To be prepared. This part will give the required Level of Service for redevelopment sites (existing impervious cover of 20% or more of the site, Clause 8.6.2). The MARC/APWA BMP Manual (2012, Table 4.3) sets the redevelopment LoS from the percentage of impervious cover within the disturbed area; the Jammu and Kashmir values need to be set by the State Stormwater Technical Committee and checked against local redevelopment cases. Until it is published, the required LoS for a redevelopment site is **6** for the disturbed area. Where Table 8.2, applied to the change in CN from the existing condition to post-development, gives a higher LoS, that higher LoS applies. This interim value is set by this Manual. A redevelopment site that retains its whole WQv on site under Chapter 4 needs no further treatment for that area, apart from pretreatment, hotspot controls and the outfall requirements (Clause 8.4.4).

Table 8B.1 — Required LoS for redevelopment (layout)

Existing impervious cover within the disturbed area (%)	Change in impervious cover	Required LoS
_____	_____	_____
_____	_____	_____
_____	_____	_____

8B.2 Composite Value Rating: area-weighted method

The composite VR of a site is the area-weighted average of the VRs of the BMPs serving each part of the site (Clause 8.6.3):

$$VR_{site} = \Sigma (A_i \times VR_i) / \Sigma A_i + VR_{signage}$$

where:

- A_i = the area of part i of the site, ha;
- VR_i = the Value Rating (Table 8.3) of the BMP serving part i, which counts only if the BMP meets Clause 8.6.4 for the whole of A_i;
- ΣA_i = the whole site area: every part of the site is assigned to one BMP, or to preserved native vegetation; a part served by no BMP is entered with $VR_i = 0$; and
- $VR_{signage} = 0.25$ where public education signage is provided (Table 8.3), otherwise 0.

The site complies where $VR_{site} \geq$ required LoS (Clause 8.6.3).

Illustrative — not design values. A 1.0 ha site that is not redevelopment, with ΔCN = 18. Required LoS = 8 (Table 8.2).

Table 8B.2 — Worked example: composite VR (illustrative)

Part	Area A_i (ha)	BMP	VR_i (Table 8.3)	A_i × VR_i
Roofs and paving draining to bioretention	0.60	Bioretention	8.5	5.100
Car park	0.25	Permeable pavement	7.5	1.875
Preserved strip along boundary	0.15	Native vegetation (preserved)	9.25	1.388
Total	1.00			8.363

- Area-weighted VR = 8.363 / 1.00 = 8.36
- Signage provided: + 0.25
- VR_site = 8.61 ≥ 8. The site complies.

Without the permeable pavement (car park draining untreated, VR = 0): (5.100 + 0 + 1.388) / 1.00 + 0.25 = 6.74 < 8. The site would not comply.

8B.3 Treatment trains

To be prepared. This part will give the composite VR of BMPs in series (a treatment train), following the approach of the MARC/APWA BMP Manual (2012, Table 4.6), with values to be confirmed for Jammu and Kashmir by the calibration programme of Clause 8.13.4 (Annex 8C). Until it is published, each part of the site is credited with the VR of one BMP in the train that meets Clause 8.6.4 for that part, normally the last BMP before discharge, and no extra credit is given for BMPs in series. Pretreatment devices, silt traps and oil-grit separators upstream of the credited BMP earn no VR of their own (Clauses 8.6.4(c), 8.7.11(c) and 8.7.12(c)).

Table 8B.3 — Composite VR of treatment trains (layout)

First BMP	Second BMP	Composite VR	Conditions
_____	_____	_____	_____
_____	_____	_____	_____

Annex 8C — Jammu and Kashmir BMP performance calibration

Supports Clauses 8.6.3, 8.13 and 8.15.1 of Chapter 8.

To be prepared. This annex will report the BMP performance calibration programme of the State Stormwater Technical Committee (Clause 8.13.4): measured inflow and outflow concentrations and volumes for BMPs built in Jammu and Kashmir, and the revised Value Ratings that follow from them. It needs wet-weather monitoring of BMPs over several SW monsoon seasons, with laboratory analysis to the CPCB methods, and the outfall monitoring of Clause 8.13.1 published under Clause 10.17. Until it is published, the Value Ratings of Table 8.3 (MARC/APWA 2012) apply, and a proprietary device earns a VR only from verified test data (Table 8.3).

The layouts below set the minimum records the programme shall keep, so that results from different authorities can be pooled.

Table 8C.1 — Monitoring site register (layout)

Site ID	BMP type (Table 8.3)	Location and authority	Catchment area (ha)	Impervious (%)	Soil and groundwater setting	Date commissioned	Pretreatment
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____

Table 8C.2 — Event record (layout; parameters of Clause 8.13.2)

Site ID	Event date	Rainfall (mm)	Inflow volume (m^3)	Outflow volume (m^3)	TSS in / out (mg/L)	BOD in / out (mg/L)	COD in / out (mg/L)	Faecal coliform in / out (MPN/100 mL)	TN in / out (mg/L)	TP in / out (mg/L)	Oil and grease in / out (mg/L)	Heavy metals (industrial catchments)
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Table 8C.3 — Performance summary and proposed VR (layout)

BMP type	Sites	Events	Volume reduction (%)	Median effluent TSS (mg/L)	Other findings	VR in Table 8.3	Proposed VR
_____	_____	_____	_____	_____	_____	_____	_____

Annex 8D — BMP design sheets, media specification, plant lists

Supports Clauses 8.5, 8.7, 8.8 and 8.11 of Chapter 8.

Each design sheet collects the requirements of Chapter 8 for one BMP. Values marked "recommended starting value" in Clause 8.7.1 may be departed from with justification. Values that the Manual does not set are marked "to be confirmed in design"; the designer shall state and justify them. Every BMP also needs: sizing for the WQv or Q_wq (Clause 8.6.4(a)), pretreatment (Clause 8.5.3), a safe bypass for flows above Q_wq (Clause 8.4.6) and maintenance access (Chapter 10).

8D.1 Design sheets

Table 8D.1 — Pretreatment (all BMPs)

Item	Requirement	Clause
Where needed	Every bioretention cell, infiltration facility, permeable pavement receiving run-on, wet pond and constructed wetland, at each concentrated inflow	8.5.3
Types	Sediment forebay, grass filter strip, silt trap or proprietary device	8.5.3
Size	Holds at least 10% of the WQv of its contributing area; or sized for Q_wq (flow-through devices)	8.5.3
Access	Cleanable without entering or disturbing the main BMP	8.5.4
Silt traps and catch pits	At every inlet receiving runoff from unpaved ground, and at the inlet of every drain discharging to a BMP or waterbody; sump at least 300 mm below the outlet invert; earn no VR	8.7.12

Table 8D.2 — Bioretention and rain gardens (Figure 8.2)

Item	Requirement	Clause
Ponding depth	≤ 300 mm above the mulch, with an overflow at maximum ponding level	8.7.2(a)
Ponding drawdown	Within 48 h	8.7.2(b)
Filter media	600–900 mm engineered sandy loam, low fines, low phosphorus (Table 8D.12)	8.7.2(c)
Mulch	50–75 mm	8.7.2(c)
Transition (choker) and gravel drainage layers	Required; thickness and grading to be confirmed in design	8.7.2(d)
Underdrain	Perforated; required where the design infiltration rate cannot meet the 48 h drawdown, or where lined; diameter to be confirmed in design	8.7.2(e)
Lining	Required where Clause 8.8 cannot be met, and at hotspots	8.7.2(f)
Plants	Native or naturalised, tolerant of waterlogging and long dry spells (Tables 8D.13 and 8D.14)	8.7.2(g)
VR	8.5 (rain garden / infiltration 9.0)	Table 8.3

Table 8D.3 — Vegetated swales

Item	Requirement	Clause
Section	Trapezoidal or parabolic; side slopes no steeper than 1V:3H	8.7.3(a)
Longitudinal slope	0.5% to 4%; check dams where steeper	8.7.3(b)
Flow at Q_wq	Depth not more than grass height; velocity ≤ 0.3 m/s	8.7.3(c)
1% AEP or bypass flow	No erosion (Chapter 9 permissible velocities)	8.7.3(d)
Underdrained ("dry") swale	Where slope < 1% or subsoil is poorly drained; filter media as Table 8D.12	8.7.3(e)
VR	4.0 (native vegetation swale)	Table 8.3

Table 8D.4 — Vegetated filter strips

Item	Requirement	Clause
Inflow	Sheet flow only; level spreader where flow arrives concentrated	8.7.4(a)
Length in flow direction	≥ 5 m	8.7.4(b)
Slope	1% to 8%	8.7.4(b)
Use	Mainly pretreatment for bioretention, infiltration and swales	8.7.4(c)
VR	5.0	Table 8.3

Table 8D.5 — Permeable pavement

Item	Requirement	Clause
Run-on	Impervious run-on area ≤ 2 × permeable area; none from unpaved or eroding areas	8.7.5(a)
Base reservoir	Clean open-graded aggregate holding its share of the WQv in its voids; void ratio confirmed by test	8.7.5(b)
Open (infiltrating) base	Only where Clause 8.8 is met; otherwise lined with underdrain and counted as filtration only	8.7.5(c)

Item	Requirement	Clause
Structure	Designed for traffic loading to the road authority's standards	8.7.5(d)
Exclusions	Not at hotspots; not where it will be resurfaced with impermeable material	8.7.5(e)
VR	7.5	Table 8.3

Table 8D.6 — Infiltration trenches and basins (Figure 8.3)

Item	Requirement	Clause
Pretreatment	Always (Table 8D.1)	8.7.6(a)
Fill	Clean washed aggregate, void ratio confirmed by test; geotextile on sides and top; sand base	8.7.6(b)
Observation well	To the base of each trench	8.7.6(c)
Storage	WQv (or Chapter 4 retention volume, if greater) held in the voids	8.7.6(d)
Drawdown	Empty within 72 h at the design infiltration rate	8.7.6(d), 8.8.7
Overflow	At grade, to the minor or major system	8.7.6(e)
Commissioning	Not in service until the contributing area is stabilised	8.7.6(f)
Criteria	All of Clause 8.8 (Table 8D.11)	8.8

Table 8D.7 — Wet ponds (extended wet detention)

Item	Requirement	Clause
Permanent pool	≥ WQv	8.7.7(a)
Extended detention	WQv above the pool, released over 24–48 h	8.7.7(a), 8.4.7
Forebay	At each inlet	8.7.7(b)
Flow path	Length-to-width ≥ 3:1; no short-circuiting	8.7.7(c)
Pool depth	1.0–2.5 m, with safety bench (Clause 7.9.4)	8.7.7(d)
Water balance	Monthly balance with IMD rainfall and pan evaporation: ≥ 50% of pool volume kept through the driest year in 10; no top-up with groundwater, potable water or sewage	8.7.8
Flood detention	Chapter 4 detention may sit above the extended detention level	8.7.7(f)
VR	5.0	Table 8.3

Table 8D.8 — Constructed wetlands

Item	Requirement	Clause
Layout	Inlet sedimentation pond (forebay), then shallow macrophyte zone	8.7.9(a)
Extended detention	WQv above normal water level, released over 24–48 h; depth ≤ 0.5 m	8.7.9(b)
Flow path	Length-to-width ≥ 3:1; deep zones across the flow path	8.7.9(c)
Bypass	High-flow bypass so that floods do not scour the macrophyte zone	8.7.9(d)
At a tank inlet	Within the tank's setback, outside its waterspread; not counted as tank storage	8.7.9(e)
Water balance	As wet ponds (minimum wetland depth kept)	8.7.8

Item	Requirement	Clause
VR	7.0 (extended detention wetland)	Table 8.3

Table 8D.9 — Gross pollutant traps and outfall screens

Item	Requirement	Clause
Treatment flow	Q_wq; all flows up to 1% AEP pass without washing out captured material	8.7.10(a)
Capture size	Down to about 5 mm	8.7.10(b)
Head loss	In the drain HGL (Chapter 9), screen 50% blocked	8.7.10(c), 8.10.3(a)
Storage	For the O&M cleaning interval; not less than 3-monthly cleaning	8.7.10(d)
Access	Vehicle access for suction or grab cleaning; safe cleaning platform	8.7.10(e), 8.10.3(d)
Blocked screen	Overflow or bypass path so that a fully blocked screen does not flood property	8.10.3(b)
Bar spacing	Chosen for the hazard: closer for litter capture, wider where blockage would cause flooding; to be confirmed in design	8.10.3(c)

Table 8D.10 — Oil-grit separators

Item	Requirement	Clause
Where	Fuel stations; vehicle workshops and washing bays; bus and truck depots; parking areas of more than 50 spaces	8.7.11(a)
Sizing	Q_wq, with high-flow bypass	8.7.11(b)
Not alone	Followed by a filtering BMP where the site needs a VR above 5; lined filtering BMP before any infiltration at hotspots	8.7.11(c), 8.8.8

Table 8D.11 — Infiltration and recharge criteria (all infiltrating BMPs)

Item	Requirement	Clause
Groundwater separation	Seasonal high groundwater ≥ 1.0 m below base (roof-only runoff in notified coastal sand: ≥ 0.5 m with mounding check, mound ≥ 0.3 m below base)	8.8.1, 8.8.9(d)
Bedrock or impermeable layer	Base ≥ 1.0 m above, unless designed for rock-aquifer recharge under Clause 8.8.10	8.8.2
Tests	Double-ring (ASTM D3385) for basins, bioretention, permeable pavement; falling-head borehole or trial-pit soakage (e.g. BRE Digest 365) for trenches, soakaways, pits, wells; ≥ 2 per facility and ≥ 1 per 100 m² of base or per 50 m of trench; Form 8-2	8.8.3
Design rate	Measured rate ÷ 2.0 (tests meet 8.8.3(c) and vary by no more than a factor of 2), otherwise ÷ 3.0	8.8.4
Minimum rates	≥ 13 mm/h full infiltration; 3–13 mm/h partial, with underdrain, credit only for volume infiltrated within 72 h; < 3 mm/h no credit	8.8.5
Setbacks (runoff from paved surfaces)	Foundations 3 m, basements 5 m; property boundary 1.5 m; drinking-water well or borewell 30 m; septic tank or soak pit 15 m; crest of slope steeper than 1V:3H 6 m	8.8.6
Expansive soils	Foundation setback doubled	8.8.11(b)

Item	Requirement	Clause
Drawdown	Empty within 72 h at design rate; tested after construction	8.8.7
Hotspots	No infiltration without treatment; none at all for waste sites and contaminated land	8.8.8
Road runoff	Never led directly into a well, borewell or recharge shaft	8.11.3(b)

8D.2 Bioretention drawdown check

The 48-hour ponding drawdown (Clause 8.7.2(b)) and the minimum rates of Clause 8.8.5 together decide whether a cell needs an underdrain.

- Rate needed to drain the maximum ponding depth in 48 h = 300 mm / 48 h = 6.25 mm/h.
- Design rate ≥ 13 mm/h: full infiltration, no underdrain, provided Clause 8.8 is met.
- Design rate from 6.25 mm/h to 13 mm/h: the ponding drains in time, but Clause 8.8.5(b) applies, so an underdrain is required.
- Design rate below 6.25 mm/h: the ponding cannot drain in 48 h by infiltration; an underdrain is required (Clause 8.7.2(e)), and below 3 mm/h no infiltration credit is given.

Illustrative — not design values. Two tests at the base of a proposed cell give 30 mm/h and 22 mm/h. The two results differ by a factor of 30 / 22 = 1.36, which is not more than 2, and the number of tests meets Clause 8.8.3(c), so the safety factor is 2.0. Taking the lower result, the design rate = 22 / 2.0 = 11 mm/h. This is above 6.25 mm/h, so the ponding drains in 300 / 11 = 27 h, within 48 h. It is below 13 mm/h, so the cell is a partial-infiltration design with an underdrain (Clause 8.8.5(b)).

8D.3 Filter media specification

Table 8D.12 — Bioretention filter media and layers

Layer	Requirement from Chapter 8	Values to be confirmed in design
Mulch	50–75 mm (Clause 8.7.2(c)); shredded hardwood or similar organic mulch that does not float away at the ponding depth	Material and source
Filter media	600–900 mm engineered sandy loam with low fines and low phosphorus content (Clause 8.7.2(c))	Particle size grading; fines (silt + clay) limit; organic matter content; phosphorus limit; saturated hydraulic conductivity of the compacted media; source and test certificate for each batch
Transition (choker) layer	Between media and gravel, to stop media washing into the gravel (Clause 8.7.2(d))	Thickness and grading, matched to the media and gravel
Gravel drainage layer	Below the transition layer, surrounding the underdrain (Clause 8.7.2(d))	Thickness, grading, washed
Underdrain	Perforated pipe where Clause 8.7.2(e) applies, with cleanouts	Diameter, slope, perforation, outlet level
Liner	Where Clause 8.7.2(f) applies (cannot meet Clause 8.8; hotspots)	Liner type and protection

Media shall be tested before placing, and placed in lifts without heavy compaction. The State Stormwater Technical Committee should set numeric limits for grading, fines, organic matter and phosphorus, with local sources of sand and compost, when it reviews this annex.

8D.4 Plant lists

No Jammu and Kashmir source on planting for stormwater BMPs was found during research for this Manual, and none of the sources read names the native species to be used in bioretention, swales, filter strips or constructed wetlands in the Union Territory. This annex therefore lists **no species** for Jammu and Kashmir, and gives no Kashmiri, Dogri or Urdu plant names, rather than carry over lists drawn up for other States, whose climates are unlike the Kashmir valley's cold winters or the Kandi's dry stony fans. Until the State Stormwater Technical Committee issues lists, the species for each BMP shall be chosen, and recorded on the BMP design sheet, by a horticulturist or the Forest Department for the site's sub-area of Annex 2A, its altitude, its soil and its water table, under the following rules (set by this Manual):

- (a) **Native or long naturalised species only**, as the Forest Department confirms for the site; no species named in Table 8D.15 or otherwise known to be invasive in the Union Territory.
- (b) **Frost and snow.** On the Kashmir valley floor, in the Karewas and in every town above about 1,500 m, species hardy to the frost and snow of December to March; above that height no species that is not frost-hardy is used in any BMP.
- (c) **Wet and dry ground.** On the valley floor, the Sirowal and lake and nambal margins, where the water table is within 2 m, species tolerant of long waterlogging; on the Kandi fans and the hill slopes, species tolerant of dry, stony ground, chosen first on banks, cut slopes and the margins of khads and nallahs to bind the soil.
- (d) **Not in the waterway.** No planting in the bed or on the banks of a river, nallah, khad, kol or khul, or on an embankment, without the authorisation of I&FC (Water Resources Act, 2010, section 81 [TBC]), and none that would obstruct the flow of a channel or the outlet of a lake.
- (e) **Not in the waterbodies.** No planting under this annex in a lake, nambal, talab, Kandi pond, spring or wetland, whose vegetation, such as the reed beds of Hygam, "the largest remaining reed-bed area" (Wildlife Department, 2024), is managed by its custodian under Chapter 7.

Table 8D.13 — Indicative plants for bioretention, swales and filter strips

Use	Botanical name	Local name	Notes
All BMPs of Clause 8.7	None listed for Jammu and Kashmir in this draft	—	Chosen under rules (a) to (e) above and recorded on the BMP design sheet (Annex 8D)

Table 8D.14 — Indicative plants for constructed wetlands and wet ponds

Zone	Botanical name	Local name	Notes
All zones	None listed for Jammu and Kashmir in this draft	—	Chosen under rules (a) to (e) above; constructed wetlands are built outside the waterspread of any natural waterbody (Clause 8.7.9(e))

Table 8D.15 — Species not to be planted

Botanical name	Local name	Reason
Any species the Forest Department lists as invasive in the Union Territory	—	No list of invasive species for Jammu and Kashmir was read for this Manual [TBC]

Annex 8E — Erosion and sediment control standard details

Supports Clause 8.12 of Chapter 8.

The details below show the arrangement of each measure. Dimensions set by the Manual are given. Dimensions the Manual does not set are labelled "to be confirmed in design" and shall be shown on the ESC plan (Clause 8.12.1). Temporary measures are designed with the rainfall of Chapter 2 and a climate factor of 1.0 (Clause 8.12.4).

Table 8E.1 — Selection of measures (Clause 8.12.3)

Situation	Measure	Detail
Sheet flow leaving a disturbed area, along its downslope edge	Silt fence	Figure 8E.1
Concentrated flow from a disturbed area of up to 2 ha	Sediment trap	Figure 8E.2
Disturbed area of more than 2 ha	Sediment basin with surface dewatering outlet	Figure 8E.2
Existing drain inlet receiving site runoff	Inlet protection	Figure 8E.4
Vehicle exit to a public road	Stabilised construction exit, with wheel washing	Figure 8E.3
Stockpiles	Outside Zone 1 of any waterbody setback; ≥ 10 m from any drain; covered in the SW monsoon	Notes to Figure 8E.1
Dewatering	Through a sediment basin, settling tank or filter bag; never pumped directly to a drain or waterbody	Notes to Figure 8E.2
Concrete washout	Lined pit; never into a drain	Notes to Figure 8E.3

8E.1 Silt fence

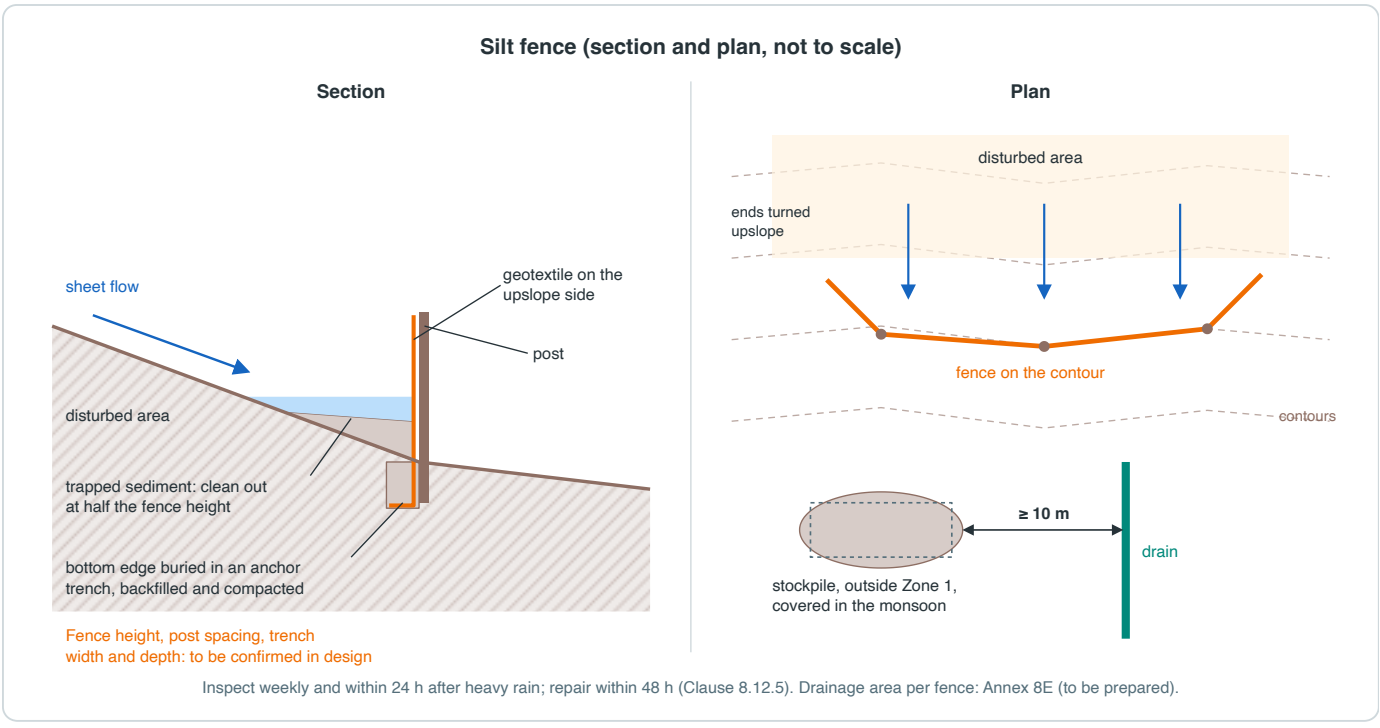


Figure 8E.1 — Silt fence: section showing geotextile on posts with the bottom edge buried in an anchor trench on the upslope side, and plan showing the fence on the contour with returns at the ends. Dimensions not set by the Manual are to be confirmed in design. Original drawing for this Manual, adapted from US EPA, NPDES Construction General Permit (2022), and CIRIA, The SuDS Manual (C753), 2015.

To be prepared. Clause 8.12.3(a) refers to this annex for the limit on the area draining to each silt fence. That limit, and the maximum slope length above a fence, need to be set by the State Stormwater Technical Committee for Jammu and Kashmir rainfall. Until they are published, the following interim limits apply, taken from common US practice (US EPA, Stormwater Best Management Practice fact sheet: Silt Fence):

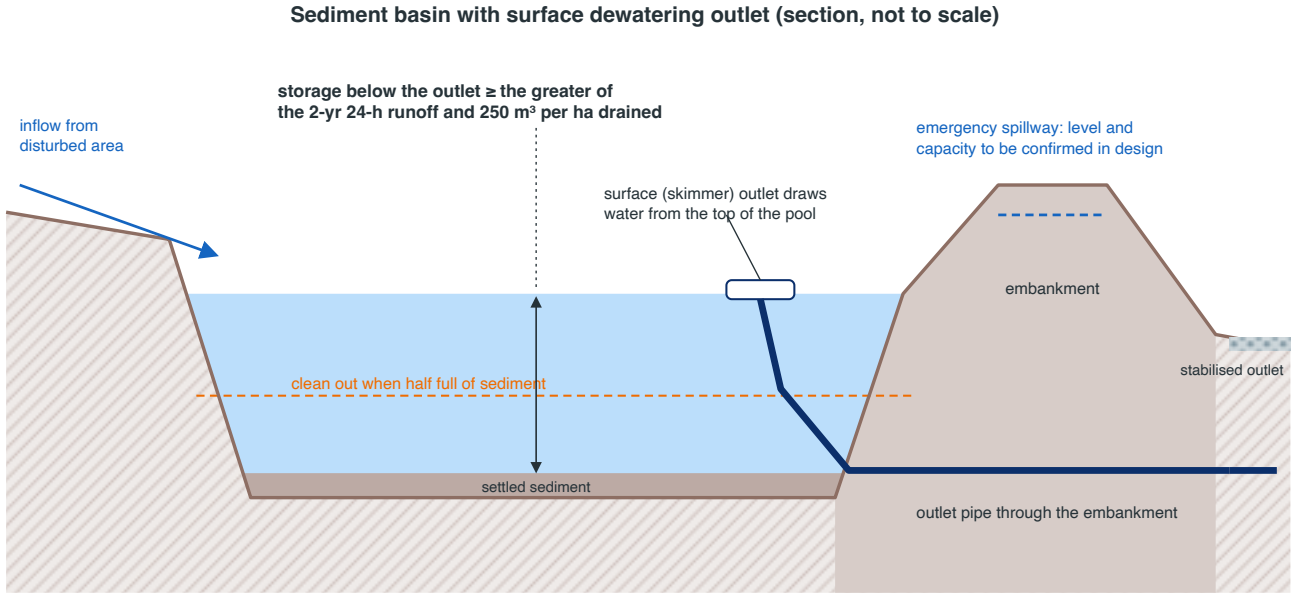
- drainage area: not more than **0.1 ha per 30 m** of fence;
- slope length above the fence: not more than 30 m on slopes under 2%, 23 m at 2–5%, 15 m at 5–10%, 8 m at 10–20% and 5 m steeper than 20%;
- wherever flow arrives concentrated, or a limit cannot be met, a sediment trap (Figure 8E.2) is used instead.

The designer shall show the drainage area and slope length served by each fence on the ESC plan.

Notes:

1. Place along the contour at the downslope edge of the disturbed area, never across a concentrated flow path.
2. Turn the ends upslope so that water cannot run round them.
3. Inspect weekly and within 24 hours after every heavy-rainfall event; repair within 48 hours; remove sediment when the deposit reaches half the fence height (Clause 8.12.5).
4. Remove only after the area draining to it is stabilised (Clause 8.12.6).
5. Stockpiles: outside Zone 1, at least 10 m from any drain, and covered during the SW monsoon (Clause 8.12.3(f)).

8E.2 Sediment trap and sediment basin



Sediment trap: disturbed area up to 2 ha. Sediment basin: more than 2 ha (Clause 8.12.3(b), (c)).
Design rainfall from Chapter 2 with climate factor 1.0 (Clause 8.12.4). Dewatering of excavations passes through the basin, a settling tank or a filter bag.

Figure 8E.2 — Sediment trap or basin in section: inflow, storage volume below the outlet, surface dewatering outlet (skimmer) drawing water from the top of the pool, emergency spillway, and sediment cleanout level at half the storage. Original drawing for this Manual, adapted from US EPA, NPDES Construction General Permit (2022).

Notes:

1. **Sediment trap:** for concentrated flow from disturbed areas of up to 2 ha (Clause 8.12.3(b)). Storage volume, depth and outlet: to be confirmed in design.

2. **Sediment basin:** for disturbed areas of more than 2 ha. Storage below the outlet ≥ the greater of (a) the runoff from the 50% AEP (2-yr) 24-hour storm and (b) 250 m³ per hectare of drainage area (Clause 8.12.3(c)).
3. The dewatering outlet draws water from the surface (Clause 8.12.3(c)).
4. An emergency spillway and its capacity: to be confirmed in design. Where the basin is also a permanent detention facility, the Chapter 4 spillway rules apply.
5. Clean out when half full of sediment (Clause 8.12.5). Remove sediment from any permanent facility before its as-built survey (Clause 8.12.6).
6. Dewatering of excavations shall pass through a sediment basin, settling tank or filter bag (Clause 8.12.3(g)).

Illustrative — not design values. A sediment basin serves 3.0 ha of disturbed land. Assume a 2-yr 24-hour rainfall of 100 mm (climate factor 1.0, Clause 8.12.4) and a curve number of 86 for bare compacted ground under the antecedent moisture condition of Chapter 2.

- $S = 25{,}400 / 86 - 254 = 41.35$ mm; $I_a = 0.2S = 8.27$ mm
- $Q = (P - I_a)^2 / (P - I_a + S) = (100 - 8.27)^2 / (100 - 8.27 + 41.35) = 8{,}414 / 133.08 = 63.2$ mm
- (a) Runoff volume = $10 \times Q \times A = 10 \times 63.2 \times 3.0 = 1{,}896$ m³
- (b) 250 m³/ha × 3.0 ha = 750 m³
- Required storage below the outlet = max (1,896, 750) = 1,896 m³. Here the 2-yr runoff governs.

8E.3 Stabilised construction exit and concrete washout

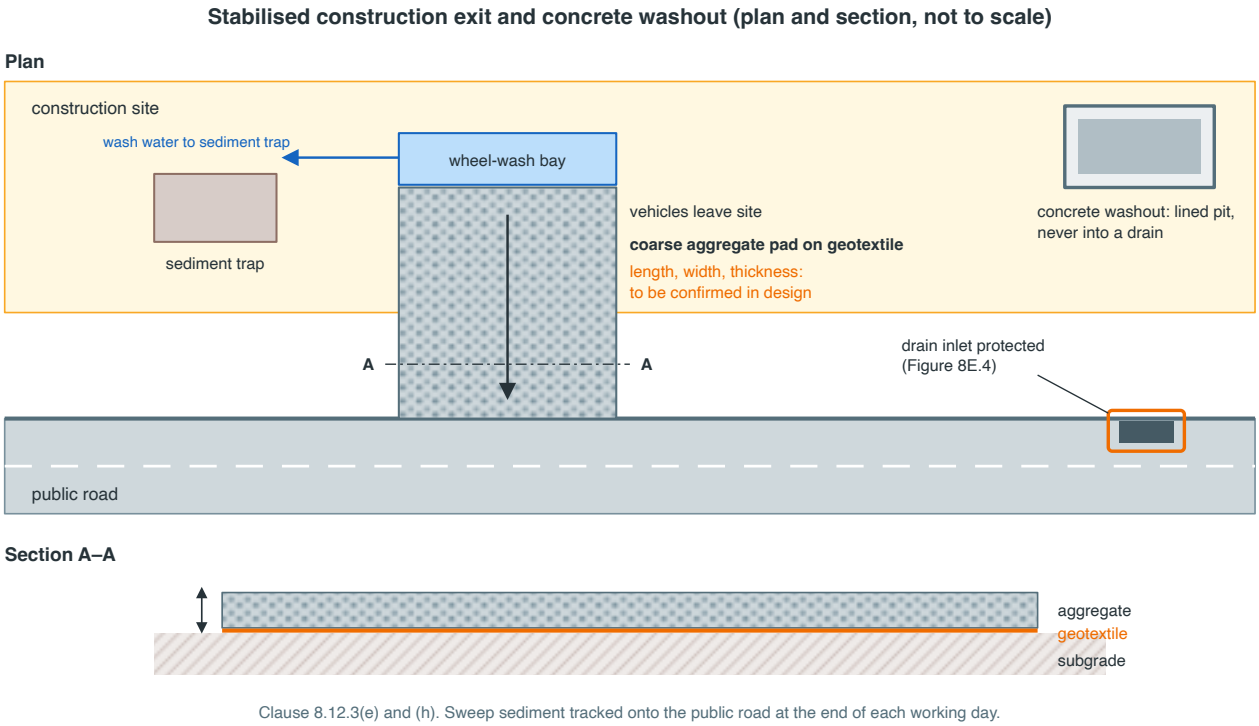


Figure 8E.3 — Stabilised construction exit: plan and section showing a coarse aggregate pad on geotextile between the site and the public road, a wheel-wash bay draining to a sediment trap, and a lined concrete washout pit. Dimensions not set by the Manual are to be confirmed in design. Original drawing for this Manual, adapted from US EPA, NPDES Construction General Permit (2022).

Notes:

1. Provide at every point where vehicles leave the site onto a public road, with wheel washing (Clause 8.12.3(e)).
2. Pad length, width, thickness and aggregate size: to be confirmed in design.
3. Wash water drains to a sediment trap or basin, never to a drain.
4. Concrete washout in a lined pit, never into a drain (Clause 8.12.3(h)).

5. Sweep any sediment tracked onto the public road at the end of each working day.

8E.4 Inlet protection

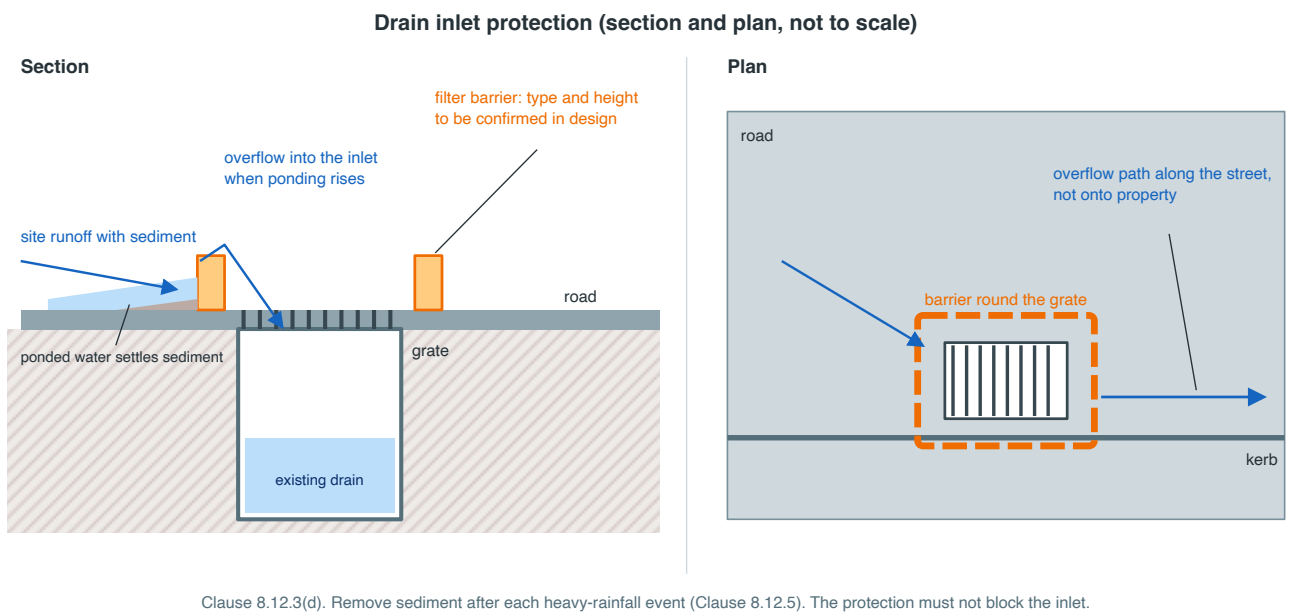


Figure 8E.4 — Inlet protection at an existing drain inlet: a filter barrier around a grate or kerb inlet, with an overflow path so that ponding does not flood the road or property. Original drawing for this Manual, adapted from US EPA, NPDES Construction General Permit (2022), and CIRIA, The SuDS Manual (C753), 2015.

Notes:

1. At every existing drain inlet that receives runoff from the site (Clause 8.12.3(d)).
2. The protection must not block the inlet: water ponding behind it must be able to overflow into the inlet or along the street.
3. Barrier type and height: to be confirmed in design.
4. Remove sediment after each heavy-rainfall event (Clause 8.12.5).

8E.5 Timing and inspection

Table 8E.2 — ESC timing and inspection (Clauses 8.12.2 and 8.12.5)

Item	Requirement
Completed earthworks	Stabilised by vegetation, mulch, matting or paving by 31 May
Area cleared between 15 June and 31 October	Sediment controls in place before clearing
Area exposed in the SW monsoon	As small as practicable
Inspection	Weekly, and within 24 h after every heavy-rainfall event (Chapter 10)
Repair	Within 48 h
Cleaning	When half full of sediment
Removal	Only after the area draining to the measure is stabilised

Form 8-1 — Water Quality Sheet

Supports Clauses 8.4, 8.6 and 8.14 of Chapter 8.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

Table 8F.1 — Form 8-1, Section A: Site and rainfall

No.	Field	Entry	Clause
A1	Project name and Authority file number	_____	—
A2	Tier (A / B) and site area, ha	_____	8.6.1
A3	Rainfall zone (Chapter 2)	_____	8.4.1
A4	P_ret, mm (Annex 2E)	_____	8.4.1
A5	P_3m, mm (Annex 8A, or the interim calculation: record, years, method)	_____	8.4.1
A6	P_wq = max (P_ret, P_3m), mm (no climate factor)	_____	8.4.1, 8.4.3
A7	WQv method: SCS-CN, or Rv (sites < 0.5 ha and Tier B simplified method only)	_____	8.4.2
A8	Redevelopment (existing impervious ≥ 20%)?	_____	8.6.2

Table 8F.2 — Form 8-1, Section B: Water quality volume and flow by drainage area

Area ID	Area (ha)	Impervious I (%)	Q_wq runoff depth (mm) or Rv	WQv (m^3)	Q_wq (m^3/s)	Volume retained, Chapter 4 (m^3)	WQv not retained (m^3)	BMP serving the area	Pretreatment
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
Total	_____			_____		_____	_____		

Table 8F.3 — Form 8-1, Section C: Level of Service and Value Rating (Tier A)

No.	Field	Entry	Clause
C1	CN pre-development; CN post-development; ΔCN	_____	8.6.2
C2	Required LoS (Table 8.2, or Annex 8B for redevelopment)	_____	8.6.2
C3	Composite VR (Annex 8B calculation attached)	_____	8.6.3
C4	Composite VR ≥ required LoS?	_____	8.6.3
C5	Tier B: route used under Clause 8.6.5 (a) retained on site / (b) bioretention, rain garden or infiltration	_____	8.6.5

Table 8F.4 — Form 8-1, Section D: Other submittals (Clause 8.14)

No.	Item	Attached (yes / no / not applicable)	Clause
D1	BMP designs to Clause 8.7 and Annex 8D, with pretreatment	_____	8.14(3)

No.	Item	Attached (yes / no / not applicable)	Clause
D2	Infiltration Test Record (Form 8-2), seasonal high groundwater level and source, design rate, drawdown time, setbacks	_____	8.14(4)
D3	Sewage and sullage connection plan; dye or smoke test record	_____	8.9.2, 8.14(5)
D4	GPT and first-flush design for any outfall to a waterbody	_____	8.10, 8.14(6)
D5	RWH layout separating harvesting, recharge and detention	_____	8.11, 8.14(7)
D6	ESC plan	_____	8.12, 8.14(8)
D7	Hotspot controls, where Clause 8.8.8 applies	_____	8.8.8

Table 8F.5 — Form 8-1, Section E: Prepared by

Field	Entry
Name, registration and empanelment number (Clause 10.6)	_____
Signature and date	_____

Form 8-2 — Infiltration Test Record

Supports Clauses 8.8.1 to 8.8.7 and 8.11.4 of Chapter 8.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. One record per facility. Attach a plan showing the test locations, and the readings for each test.

Table 8F.6 — Form 8-2, Section A: Facility

No.	Field	Entry	Clause
A1	Project and facility ID; facility type	_____	8.8.3
A2	Infiltration base area (m²) or trench length (m)	_____	8.8.3(c)
A3	Proposed base level of the facility, m (datum)	_____	8.8.3
A4	Runoff source: roof only / paved surfaces / mixed; hotspot (yes / no)	_____	8.8.6, 8.8.8
A5	Ground setting: sandy coastal / laterite or hard rock / delta clay or black cotton / other	_____	8.8.9–8.8.11

Table 8F.7 — Form 8-2, Section B: Tests

Test no.	Location (grid ref.)	Date	Method: double-ring (ASTM D3385) / falling-head borehole or trial-pit soakage (e.g. BRE Digest 365)	Test level, m	Groundwater level at time of test, m	Measured rate (mm/h)
1	_____	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____	_____

Minimum number of tests: 2 per facility, and 1 per 100 m² of base area or per 50 m of trench (Clause 8.8.3(c)).

Table 8F.8 — Form 8-2, Section C: Design rate and drawdown

No.	Item	Entry	Clause
C1	Number of tests made; number required	_____	8.8.3(c)
C2	Highest and lowest measured rates; ratio (highest ÷ lowest)	_____	8.8.4
C3	Safety factor: 2.0 (tests meet 8.8.3(c) and ratio ≤ 2) or 3.0	_____	8.8.4
C4	Design rate = measured rate used ÷ safety factor, mm/h (state which measured rate was used)	_____	8.8.4
C5	Category: ≥ 13 mm/h full infiltration / 3–13 mm/h partial with underdrain / < 3 mm/h no credit	_____	8.8.5
C6	Depth of water to infiltrate, mm; drawdown time = depth ÷ design rate, h (≤ 72 h)	_____	8.8.7

Table 8F.9 — Form 8-2, Section D: Separation and setbacks

No.	Item	Entry	Clause
D1	Seasonal high groundwater level, m, and its source (Clause 3.10.2)	_____	8.8.1
D2	Separation from facility base to seasonal high groundwater, m (≥ 1.0; ≥ 0.5 for roof-only runoff in notified coastal sand with mounding check)	_____	8.8.1, 8.8.9(d)

No.	Item	Entry	Clause
D3	Depth to bedrock or impermeable layer below base, m (≥ 1.0 unless Clause 8.8.10)	_____	8.8.2
D4	Distances to: foundations / basement / property boundary / drinking-water well or borewell / septic tank or soak pit / crest of slope steeper than 1V:3H, m	_____	8.8.6
D5	Expansive soils: foundation setback doubled?	_____	8.8.11(b)

Table 8F.10 — Form 8-2, Section E: Declaration

Field	Entry
Tester: name, qualification in geotechnical testing, organisation	_____
I certify that the tests were made at the stated locations and levels, by the stated methods, and that the readings attached are complete. Signature and date	_____
Designer (Clause 10.6): name and signature	_____

ANNEXES TO CHAPTER 9

Hydraulic Design of Structures

These annexes support Chapter 9. Annex 9A gives the FHWA HDS-5 inlet-control equations in SI units, with published coefficients for common inlets, and a full worked culvert example. Annex 9B gives standard drawings that carry only the dimensions Chapter 9 and Chapter 6 already set; every other dimension is marked "to be confirmed in design". Annex 9C is a pump station design checklist with a standard control philosophy drawn from Clause 9.9. Form 9-1 is a draft form: it lists what Clause 9.14 requires and does not add to it.

Annex 9A — HDS-5 inlet-control coefficients and worked culvert example in SI units

Supports Clauses 9.4.1 to 9.4.7 of Chapter 9 and Clause 6.12 of Chapter 6.

9A.1 Inlet-control equations

FHWA *Hydraulic Design of Highway Culverts*, HDS-5, 3rd edition (2012), Appendix A, gives three inlet-control equations. In SI units:

> Unsubmerged, Form 1: HWi/D = Hc/D + K · [Ku · Q / (A · D^0.5)]^M + Ks · S

> Unsubmerged, Form 2: HWi/D = K · [Ku · Q / (A · D^0.5)]^M

> Submerged: HWi/D = c · [Ku · Q / (A · D^0.5)]² + Y + Ks · S

where HWi is the headwater depth above the inlet invert under inlet control (m), D is the interior height (rise) of the barrel (m), Hc is the specific head at critical depth, dc + Vc²/2g (m), Q is the discharge (m³/s), A is the full cross-sectional area of the barrel (m²), S is the barrel slope (m/m), K, M, c and Y are the constants of Table 9A.1, Ku = 1.811 in SI units (1.0 in US units), and Ks is the slope correction: −0.5, or +0.7 for mitred inlets.

Which equation applies depends on X = Ku · Q / (A · D^0.5):

- X ≤ 3.5: unsubmerged equation (Form 1 or Form 2 as listed in Table 9A.1);
- X ≥ 4.0: submerged equation;
- 3.5 < X < 4.0 (transition): use FHWA HY-8, which implements the HDS-5 transition. Where a hand calculation is used, take the higher of the unsubmerged and submerged results. This is a conservative simplification made by this annex, not an HDS-5 rule.

Table 9A.1 — HDS-5 inlet-control coefficients for common inlets

Barrel	Inlet edge	Form	K	M	c	Y
Circular concrete	Square edge with headwall	1	0.0098	2.0	0.0398	0.67
Circular concrete	Groove (socket) end with headwall	1	0.0018	2.0	0.0292	0.74
Circular concrete	Groove (socket) end projecting	1	0.0045	2.0	0.0317	0.69
Circular corrugated metal	Headwall	1	0.0078	2.0	0.0379	0.69
Circular corrugated metal	Mitred to slope	1	0.0210	1.33	0.0463	0.75
Circular corrugated metal	Projecting	1	0.0340	1.50	0.0553	0.54
Rectangular box	Wingwalls flared 30° to 75°	1	0.026	1.0	0.0347	0.81
Rectangular box	Wingwalls flared 90° and 15°	1	0.061	0.75	0.0400	0.80
Rectangular box	Wingwalls at 0° (extensions of the sides)	1	0.061	0.75	0.0423	0.82
Rectangular box	90° headwall with 19 mm (3/4 in) chamfers	2	0.515	0.667	0.0375	0.79
Rectangular box	90° headwall with 45° bevels	2	0.495	0.667	0.0314	0.82
Rectangular box	90° headwall with 33.7° bevels	2	0.486	0.667	0.0252	0.865

Source: FHWA HDS-5 (2012), Appendix A, Table A.1 (the coefficients are dimensionless and apply in SI units with Ku = 1.811). The values were checked against HIF-12-026, Table A.1 (chart and scale numbers 1/1–1/3, 2/1–2/3, 8/1–8/3 and 10/1–10/3). Where a later edition of HDS-5 differs, the later table governs. Entrance loss coefficients for outlet control are in Table 9.1 of Chapter 9.

9A.2 Worked example: pipe culvert under a collector road

Illustrative — not design values. The inputs below are invented to show the method; the results are not design values for any site.

Inputs.

Table 9A.2 — Inputs for the worked example

Item	Value	Source
Road class	Collector; design AEP 4% (25-yr), check event 2% (50-yr), and the 1% AEP check	Table 6.1, Clause 6.12.2
Design flow, 4% AEP	1.80 m³/s (including the climate factor)	Illustrative
Check flow, 2% AEP	2.20 m³/s	Illustrative
1% AEP flow	3.00 m³/s	Illustrative
Barrel	One 1,200 mm RCC pipe with collar joints, n = 0.015	Table 6.6
Inlet	Square edge with headwall: ke = 0.5; K = 0.0098, M = 2.0, c = 0.0398, Y = 0.67, Form 1	Tables 9.1 and 9A.1
Length and slope	L = 20.0 m; S = 0.005 (inlet invert 20.00 m, outlet invert 19.90 m, local datum)	Illustrative
Road levels at the inlet	Shoulder edge 22.00 m; lowest point of the road crest 22.10 m	Illustrative
Tailwater above the outlet invert, TW	0.60 m at 1.80 m³/s; 0.70 m at 2.20 m³/s; 0.85 m at 3.00 m³/s (normal depth in the downstream channel)	Illustrative; Clause 9.4.4
Receiving channel	Unlined sandy loam	Table 9.2

Minimum size: 1,200 mm ≥ 900 mm (Clause 6.12.5). The span is below 1.5 m, so the blockage check uses 50% of the inlet area blocked (Clause 6.12.4(a)).

Step 1 — Barrel properties. A = π · 1.2² / 4 = 1.131 m²; full-barrel hydraulic radius R = D/4 = 0.300 m; D^0.5 = 1.095.

Step 2 — Critical depth. For each flow, dc is found by trial from the critical-flow condition for a circular section, $Q^2 \cdot T / (g \cdot Ac^3) = 1$, where Ac and T are the flow area and top width at depth dc.

Table 9A.3 — Critical depth and specific head (D = 1.2 m)

Q (m³/s)	dc (m)	Ac (m²)	T (m)	Vc = Q/Ac (m/s)	Hc = dc + Vc²/2g (m)	Hc/D
1.80	0.737	0.728	1.168	2.471	1.048	0.873
2.20	0.817	0.820	1.119	2.683	1.184	0.987
3.00	0.952	0.962	0.972	3.118	1.447	1.206

Step 3 — Headwater under inlet control. X = 1.811 · Q / (1.131 × 1.095) = 1.462 · Q.

Table 9A.4 — Inlet-control headwater

Q (m³/s)	X	Equation	HWi/D	HWi (m)
1.80	2.631	Unsubmerged, Form 1: 0.873 + 0.0098 × 2.631² − 0.5 × 0.005 = 0.873 + 0.068 − 0.003	0.939	1.127
2.20	3.216	Unsubmerged, Form 1: 0.987 + 0.0098 × 3.216² − 0.003 = 0.987 + 0.101 − 0.003	1.085	1.302
3.00	4.385	Submerged: 0.0398 × 4.385² + 0.67 − 0.003 = 0.765 + 0.67 − 0.003	1.433	1.719

Step 4 — Headwater under outlet control (Clause 9.4.3). The friction term is 19.63 · n² · L / R^1.33 = 19.63 × 0.015² × 20.0 / 0.300^1.33 = 0.0883 / 0.2016 = 0.438, so H = (1 + 0.5 + 0.438) · V²/2g = 1.938 · V²/2g. L · S = 20.0 × 0.005 = 0.100 m.

Table 9A.5 — Outlet-control headwater

Q (m³/s)	V = Q/A (m/s)	V²/2g (m)	H (m)	(dc + D)/2 (m)	TW (m)	ho (m)	HWo = ho + H − L·S (m)
1.80	1.592	0.129	0.250	0.969	0.60	0.969	1.119
2.20	1.945	0.193	0.374	1.009	0.70	1.009	1.283
3.00	2.653	0.359	0.695	1.076	0.85	1.076	1.671

Step 5 — Governing headwater (Clause 9.4.1): the greater of HWi and HWo.

Table 9A.6 — Governing headwater and checks

Event	Q (m³/s)	HWi (m)	HWo (m)	Control	HW (m)	HW level (m)	HW/D
Design, 4% AEP	1.80	1.127	1.119	Inlet	1.127	21.13	0.94
Check, 2% AEP	2.20	1.302	1.283	Inlet	1.302	21.30	1.09
1% AEP	3.00	1.719	1.671	Inlet	1.719	21.72	1.43

Step 6 — Headwater limits at the design AEP (Clause 9.4.5):

- (a) HW/D = 0.94 ≤ 1.2. Complies.
- (b) HW level 21.13 m ≤ shoulder edge 22.00 m − 0.30 m = 21.70 m. Complies.

- (c) Water levels at upstream buildings and property boundaries are compared with the existing condition under Clause 6.12.2(d). This needs the upstream survey and is not shown here.

Step 7 — Road overtopping (Clauses 6.12.2, 6.12.3 and 9.4.6). The 1% AEP headwater level, 21.72 m, is below the lowest road crest, 22.10 m, so the road is not overtopped in the check or 1% AEP events. Had the headwater exceeded the crest, the overtopping flow Qr = Cd · L · h^1.5 (Cd ≤ 1.66) would be balanced with the culvert flow at a common headwater, and the overtopping depth checked against Clause 6.12.2(a).

Step 8 — Outlet velocity (Clause 9.4.7). Under inlet control, the outlet velocity is the velocity at normal depth in the barrel. The barrel's full-flow capacity is (1/n) · A · R^(2/3) · S^0.5 = (1/0.015) × 1.131 × 0.448 × 0.0707 = 2.39 m³/s.

- 1.80 m³/s: normal depth 0.778 m, outlet velocity 2.32 m/s.
- 2.20 m³/s: normal depth 0.908 m, outlet velocity 2.40 m/s.
- 3.00 m³/s: above the full-flow capacity, so the barrel flows full at the outlet; velocity = Q/A = 2.65 m/s.

The receiving channel is unlined sandy loam, with a permissible velocity of 0.53 m/s (Table 9.2), so outlet protection is required (Clause 9.6.1). All barrel velocities are below 3.0 m/s (Clause 6.7.3(b)).

Step 9 — Riprap apron (Clause 9.6.3; Figure 9.2). D50 = 0.2 · D · [Q / (g^0.5 · D^2.5)]^(4/3) · (D/TW), with g^0.5 · D^2.5 = 3.132 × 1.577 = 4.941.

Table 9A.7 — Riprap apron sizing

Q (m³/s)	TW (m)	Q / (g^0.5 · D^2.5)	[ ]^(4/3)	D50 (m)
1.80	0.60	0.364	0.260	0.2 × 1.2 × 0.260 × 2.00 = 0.125
2.20	0.70	0.445	0.340	0.2 × 1.2 × 0.340 × 1.71 = 0.140
3.00	0.85	0.607	0.514	0.2 × 1.2 × 0.514 × 1.41 = 0.174

Clause 9.4.7 requires the outlet to be protected for the design AEP and the 1% AEP, so the apron is sized here for the largest D50, 0.174 m. From Table 9.3, Class 2 (D50 = 150 mm) is too small, so **Class 3** (D50 = 250 mm) is used:

- apron length 5D = 5 × 1.2 = 6.0 m;
- apron thickness 2.4 × D50 = 2.4 × 0.25 = 0.60 m;
- apron width at the outlet at least 3D = 3.6 m, flaring to the downstream channel;
- stone placed on a granular filter or geotextile (Clause 9.6.4).

Step 10 — Blockage check (Clause 6.12.4(a)). Steps 3 to 7 are repeated for the 1% AEP flow with 50% of the inlet area blocked, and the results must meet Clause 6.12.2(a) and (d). This Manual does not yet set a standard way of representing a partly blocked inlet, so this check is carried out in HY-8 or by a method agreed with the Approving Authority. It is not worked here.

Table 9A.8 — Summary of the worked example (Illustrative — not design values)

Check	Result	Clause
Minimum size	1,200 mm ≥ 900 mm	6.12.5
Design HW/D	0.94 ≤ 1.2	9.4.5(a)
Design HW below shoulder edge	21.13 m ≤ 21.70 m	9.4.5(b)
Overtopping in the check and 1% events	None (21.72 m < 22.10 m)	6.12.2, 9.4.6
Outlet protection	Class 3 riprap apron, 6.0 m long, 0.60 m thick, 3.6 m wide at the outlet	9.6.1, 9.6.3
Blockage check	To be run in HY-8 or by an agreed method	6.12.4

Annex 9B — Standard drawings: headwalls, riprap aprons, drop structures, trash racks, detention risers

Supports Clauses 9.4, 9.6, 9.7 and 9.8 of Chapter 9.

The drawings below are schematic standard drawings. They show only the dimensions and rules that Chapter 9 and Chapter 6 set. Structural dimensions, reinforcement, foundations and fixings are to be confirmed in design (Clause 9.1.2). The riprap apron standard drawing is Figure 9.2 of Chapter 9, with dimensions from Table 9.3; it is not repeated here. Table 9B.1 lists the dimensions shown and their source clauses.

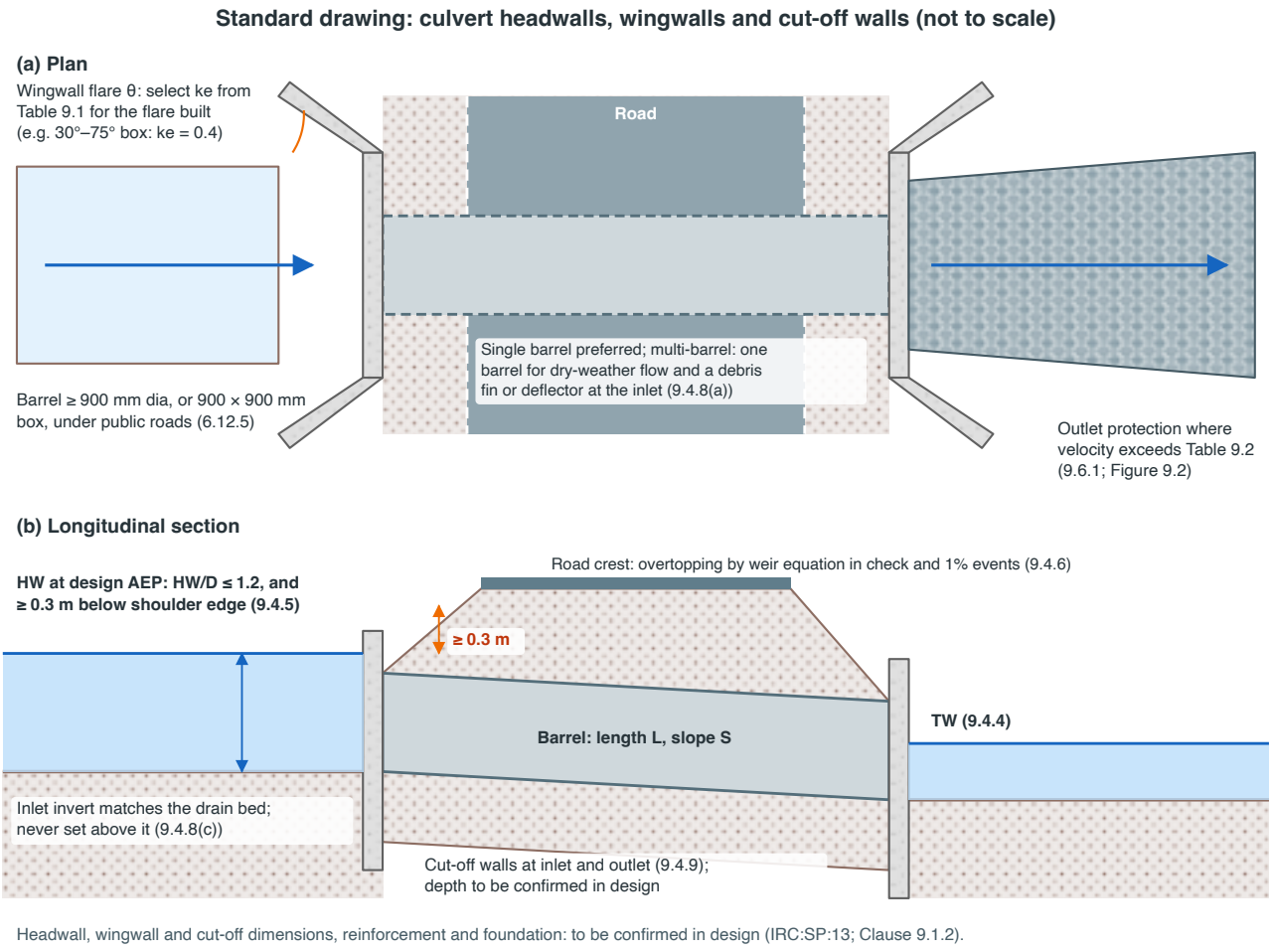


Figure 9B.1 — Standard drawing: culvert headwalls, wingwalls and cut-off walls, in plan and long section, with the headwater limits, invert rule and debris provisions. Original drawing for this Manual, adapted from FHWA, Hydraulic Design of Highway Culverts, HDS-5 (3rd ed., 2012).

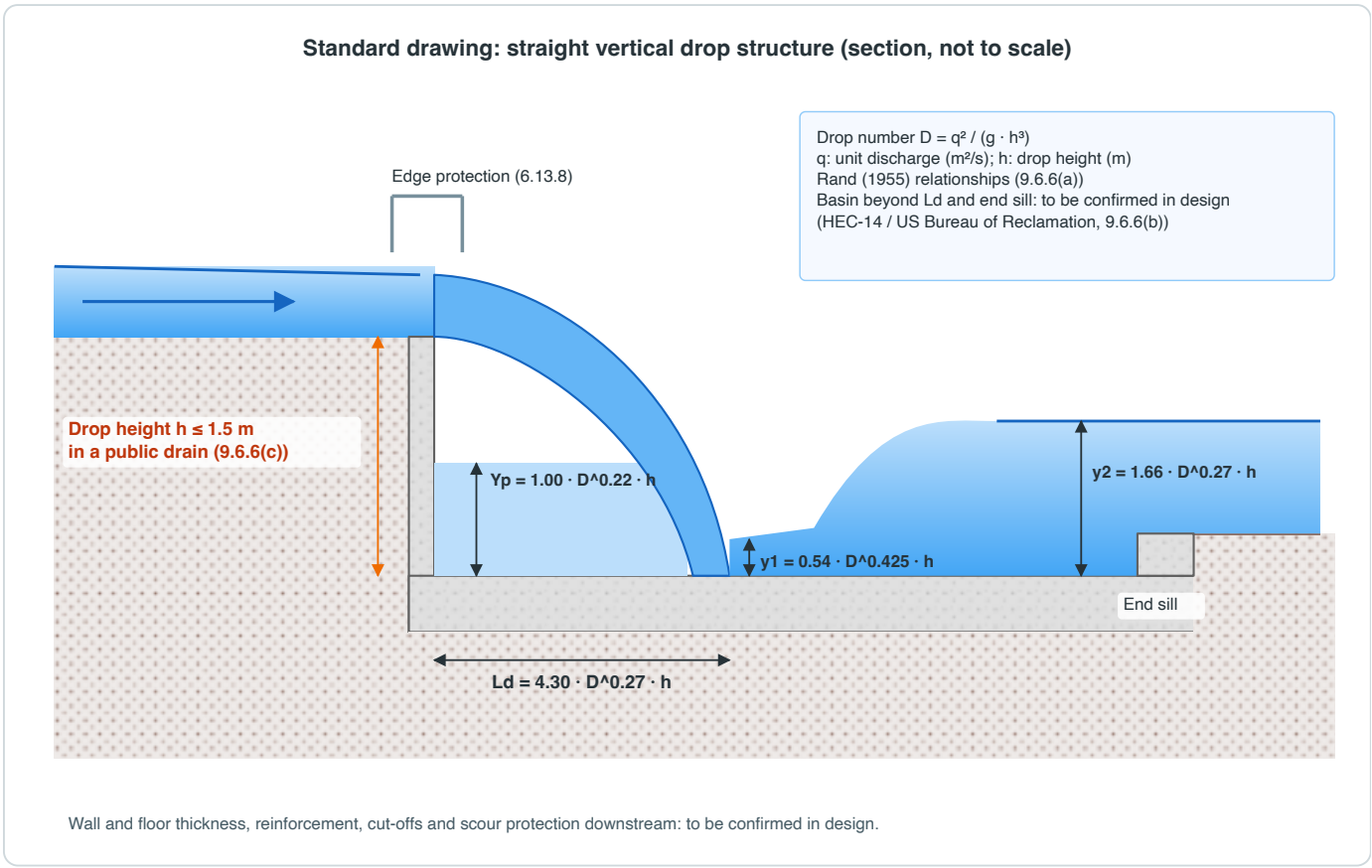


Figure 9B.2 — Standard drawing: straight vertical drop structure with the Rand (1955) pool geometry and the 1.5 m height limit. Original drawing for this Manual, adapted from Chow, Open-Channel Hydraulics (1959), and FHWA, HEC-14 (3rd ed., 2006).

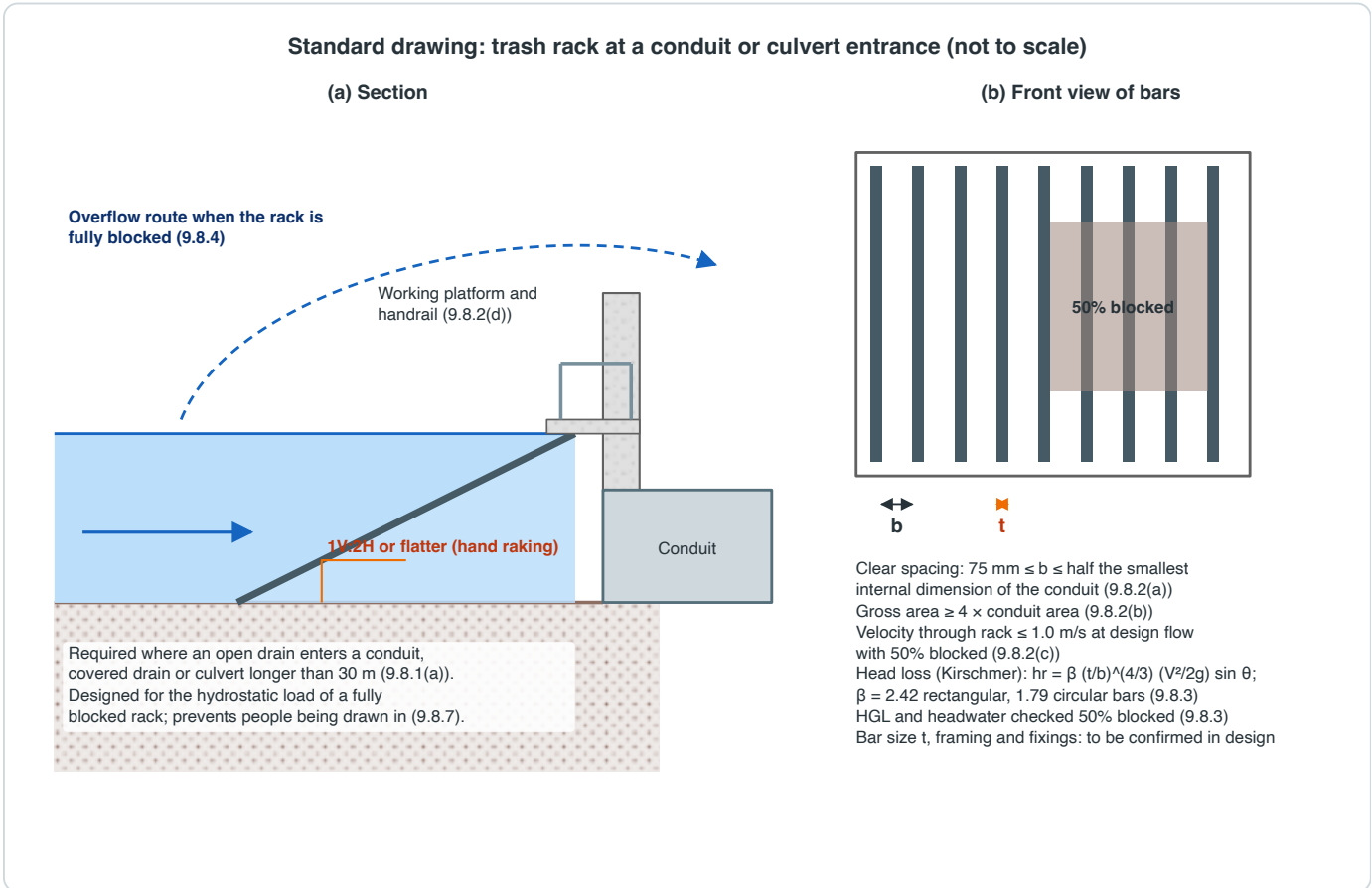


Figure 9B.3 — Standard drawing: trash rack at a conduit or culvert entrance, in section and front view, with bar spacing, area, velocity, slope and overflow requirements. Original drawing for this Manual, adapted from CIRIA, Culvert, screen and outfall manual, C786 (2019), and CPHEEO, Manual on Storm Water Drainage Systems (2019), §8.3.1.3.

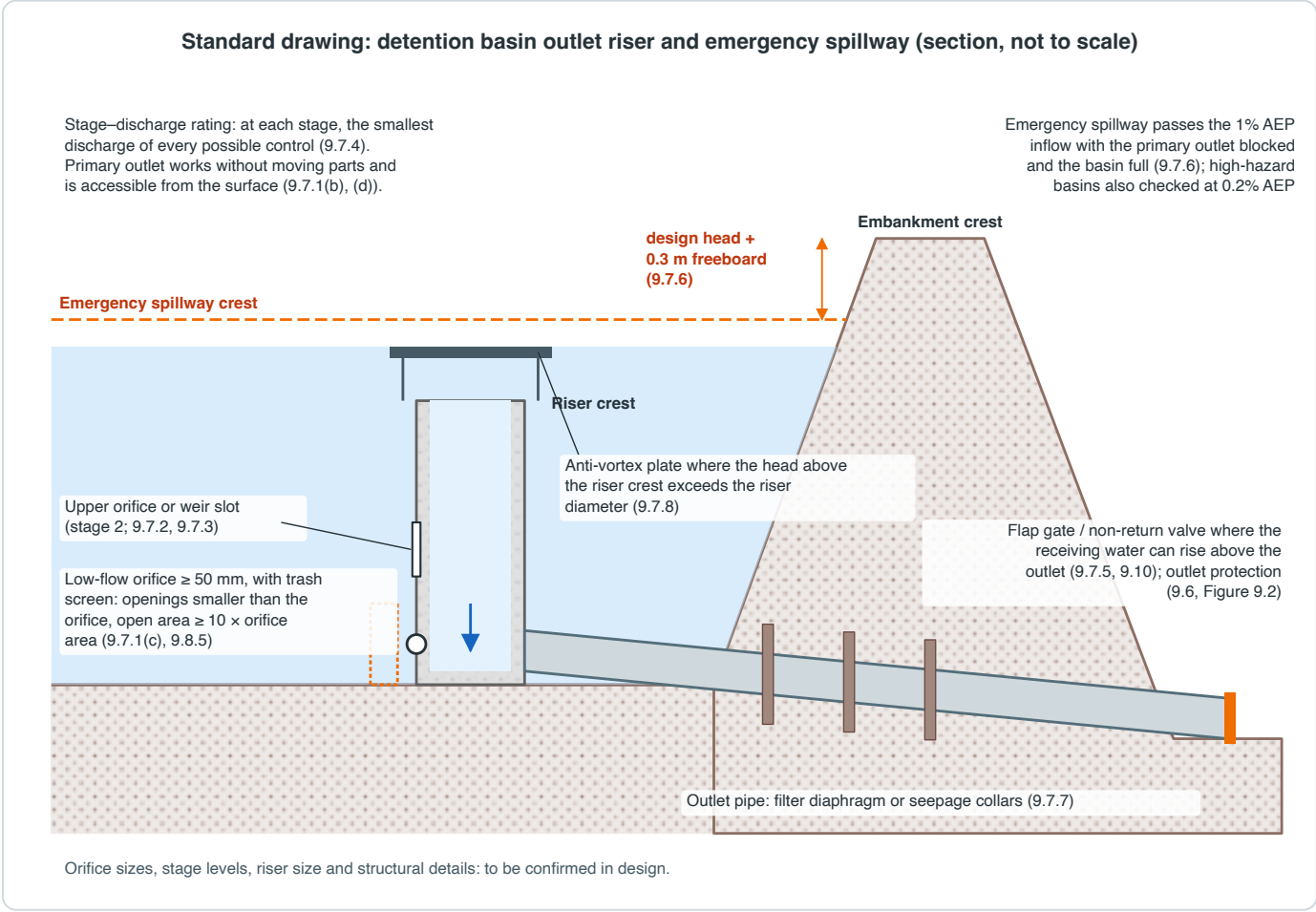


Figure 9B.4 — Standard drawing: detention basin outlet riser with low-flow orifice and screen, upper stage, anti-vortex plate, outlet pipe through the embankment, flap gate and emergency spillway. Original drawing for this Manual, adapted from Kansas City Metro APWA, Section 5600 (2006, 5608.4).

Table 9B.1 — Dimensions and rules on the standard drawings and their source clauses

Drawing	Item	Dimension or rule	Clause
9B.1	Minimum culvert size under public roads	900 mm diameter, or 900 mm × 900 mm box	6.12.5
9B.1	Headwater at the design AEP	HW/D ≤ 1.2; at least 0.3 m below the shoulder edge at the upstream face	9.4.5
9B.1	Entrance loss coefficient	From Table 9.1 for the inlet built (for example 0.4 for a box with wingwalls at 30°–75°)	9.4.3
9B.1	Inverts	Match the drain bed; never above it	9.4.8(c)
9B.1	Multi-barrel culverts	Avoided in debris-prone drains; where used, one barrel for dry-weather flow and a debris fin or deflector	9.4.8(a)
9B.1	Headwalls, wingwalls, cut-off walls	Required; dimensions to be confirmed in design	9.4.9
9B.1	Road overtopping	Qr = Cd · L · h^1.5, Cd ≤ 1.66	9.4.6
Figure 9.2	Riprap apron	Width at the outlet ≥ 3D, flaring to the channel; length and thickness from Table 9.3; filter or geotextile	9.6.3, 9.6.4

Drawing	Item	Dimension or rule	Clause
9B.2	Single vertical drop in a public drain	Height h ≤ 1.5 m; edge protection	9.6.6(c), 6.13.8
9B.2	Pool geometry	D = q²/(g h³); Ld/h = 4.30 D^0.27; Yp/h = 1.00 D^0.22; y1/h = 0.54 D^0.425; y2/h = 1.66 D^0.27	9.6.6(a)
9B.2	Basin beyond Ld, end sill	To be confirmed in design (HEC-14 or US Bureau of Reclamation)	9.6.6(b)
9B.3	Where required	Where an open drain enters a conduit, covered drain or culvert longer than 30 m	9.8.1(a)
9B.3	Clear bar spacing b	Not less than 75 mm and not more than half the smallest internal dimension of the conduit	9.8.2(a)
9B.3	Gross rack area	At least 4 times the conduit area	9.8.2(b)
9B.3	Velocity through the rack	Not more than 1.0 m/s at the design flow with 50% blocked	9.8.2(c)
9B.3	Inclination	No steeper than 1V:2H where raked by hand; working platform and handrail	9.8.2(d)
9B.3	Head loss and blocked check	Kirschmer equation; HGL and headwater checked with 50% blocked	9.8.3
9B.3	Overflow and safety	Overflow route for a fully blocked rack; designed for the full hydrostatic load	9.8.4, 9.8.7
9B.4	Low-flow orifice	Not smaller than 50 mm; trash screen with openings smaller than the orifice and open area at least 10 times the orifice area	9.7.1(c), 9.8.5
9B.4	Orifice and weir flow	Q = Cd · A · (2gh)^0.5, Cd = 0.60 sharp-edged; weir coefficients of Clause 9.7.3	9.7.2, 9.7.3
9B.4	Stage–discharge rating	Smallest discharge of every possible control at each stage	9.7.4
9B.4	Anti-vortex plate	Where the design head above the riser crest exceeds the riser diameter	9.7.8
9B.4	Outlet pipe through the embankment	Filter diaphragm or seepage collars; flared or headwalled inlet	9.7.7
9B.4	Flap gate or non-return valve	Where the receiving water can rise above the outlet	9.7.5, 9.10
9B.4	Emergency spillway	Passes the 1% AEP inflow with the primary outlet blocked and the basin full, with 0.3 m freeboard to the embankment crest; 0.2% AEP check for high-hazard basins	9.7.6
All	Structural dimensions, reinforcement, foundations, bar sizes, orifice sizes and stage levels	To be confirmed in design	9.1.2

Annex 9C — Pump station design checklist and standard control philosophy

Supports Clauses 9.8.6, 9.9 and 9.10 of Chapter 9, with Clause 6.10.5 of Chapter 6 and the outfall-closed check of Chapter 5.

9C.1 Design checklist

Submit this checklist with the pump station design report of Clause 9.14, item 6.

Table 9C.1 — Pump station design checklist

No.	Item	Requirement	Clause	Provided (Yes / No / NA)
1	Need for pumping	Gravity drainage cannot meet Chapters 5 and 6; reason stated	9.9.1	
2	Inflow	Inflow hydrograph routed through the catchment and any upstream storage	9.9.2	
3	Design standard	Design AEP of the element served; for underpasses, 2% AEP with a 1% AEP check	9.9.2(a), 6.10.5(a)	
4	Tidal outfall	Storage plus pumps hold the 48 h design volume with the outfall throttled for the tidal-lock duration (default two high tides of 6 h each)	9.9.2(b), Chapter 5	
5	Head range	Pumps selected from the lowest sump level against the lowest tailwater to the highest tailwater (HAT + surge + 0.3 m); pump and system curves submitted	9.9.2(c), 9.14	
6	Wet-well volume	Greatest of: 5 min of minimum inflow (variable speed and automatic control); 10 to 15 min of peak inflow, or the manufacturer's minimum cycle volume; $V = \Theta \cdot q / 4$ for each constant-speed pump	9.9.3	
7	Duty pumps	Same size where practicable	9.9.4(a)	
8	Standby	At least equal to the largest duty pump, and not less than 50% of the number of duty pumps	9.9.4(b)	
9	Alternation	Duty and standby roles alternate automatically	9.9.4(c)	
10	Pump type	Solids-handling (non-clog); axial-flow only behind a screen meeting Clause 9.8.6	9.9.5	
11	Sump and intake	Manufacturer's requirements and ANSI/HI 9.8; clear space 0.6 m (small and medium) or 1.0 m (large units)	9.9.6	
12	Model study	Physical model where any pump exceeds 1 m^3/s or the sump departs from ANSI/HI 9.8 geometry	9.9.6	
13	Silt trap and screen	Upstream of the wet well; screen spacing smaller than the pumps' solids size; removable modules; mechanical raking where inflow exceeds 1 m^3/s	9.9.7, 9.8.6	
14	Screen overflow	Overflow route when the screen is fully blocked	9.8.4	
15	Level control	Primary level sensor (ultrasonic, radar or pressure) with an independent float-switch back-up	9.9.8(a)	
16	Alarms	High-level and pump-fault alarms by telemetry to the local body's control room	9.9.8(b)	
17	Records	Sump levels, pump run hours and power status logged and kept at least 5 years	9.9.8(c)	
18	Power sources	Grid supply plus a standby generator or second independent feeder able to run all duty pumps at once	9.9.9(a)	
19	Fuel	At least 72 h of all duty pumps, stored above the flood level of Clause 9.9.10	9.9.9(b)	
20	Changeover	Automatic changeover to standby power	9.9.9(c)	
21	Flood protection	Electrical and control room floor, generator and transformer at least 0.5 m above the 1% AEP flood level; vehicle access usable in the 1% AEP event	9.9.10	
22	Discharge	Separate rising mains, or a non-return and an isolating valve where mains combine; delivery chamber or outfall with a flap gate or non-return valve; mains sized by a recognised friction formula	9.9.11	

No.	Item	Requirement	Clause	Provided (Yes / No / NA)
23	Gates	Flap or tide gate on outfalls below the 1% AEP still-water level; penstock or stop-log slot upstream for outfalls of 900 mm or more and every pumped outfall; head loss from tested data	9.10.1, 9.10.3, 9.10.4	
24	Sand and debris at the outfall	Gate in a chamber with surface access, or elastomeric check valves, at beach, estuary and creek outfalls	9.10.5	
25	Emergency connection	Hard-standing and quick-coupling connection for mobile pumps into the delivery chamber	9.9.12	
26	Materials	Exposure class of Clause 9.13; stainless steel grade 316, galvanised and coated steel, or non-metallic fixings within 5 km of the coast	9.13	
27	Design life	At least 50 years for civil works and 25 years for mechanical and electrical equipment	9.2.4	
28	Underpass stations	Depth markers and automatic warning or closure signals at 150 mm depth on the carriageway	6.10.5(d)	
29	Certification	Designed by an empanelled professional and checked by an independent empanelled professional	10.6.1(d), 10.6.4	

9C.2 Standard control philosophy

This is the standard control philosophy for a stormwater pump station designed under Clause 9.9. The designer adapts it to the station and submits it with the design report. Items marked "recommended" are good practice that Chapter 9 does not require; all others restate a clause.

Table 9C.2 — Control levels (values to be set in design)

Level	Rule for setting it	Clause
Pump stop	Not below the minimum submergence required by the pump manufacturer and ANSI/HI 9.8	9.9.6
Duty pump 1 start	Above the pump-stop level by at least the effective wet-well volume of Clause 9.9.3	9.9.3
Duty pumps 2, 3 … start	Staged above duty pump 1 start; spacing to be confirmed in design	9.9.2
High-level alarm	Above the highest duty-pump start level; to be confirmed in design	9.9.8(b)
Float back-up high	Independent float; starts the duty pumps	9.9.8(a)
Float back-up low	Independent float; stops the pumps	9.9.8(a)

1. **Normal (automatic) operation.** As the wet-well level rises to the duty pump 1 start level, the lead pump starts. If the level keeps rising, each further duty pump starts at its start level. The pumps stop when the level falls to the pump-stop level. The primary level sensor controls this sequence (Clause 9.9.8(a)).
2. **Duty rotation.** The lead pump changes automatically, after each pump-down cycle or by run hours as set in the design, so that duty and standby roles alternate and wear is shared (Clause 9.9.4(c)).
3. **Pump fault.** A pump that trips or fails to start is locked out. The next available pump, including the standby pump, takes its place, and a pump-fault alarm is sent by telemetry (Clauses 9.9.4(b) and 9.9.8(b)).
4. **Level-sensor failure.** If the primary sensor fails, or disagrees with the float switches, control passes to the independent float back-up: at the float-high level the duty pumps run, and at the float-low level they stop. An alarm is sent (Clause 9.9.8(a), (b)).
5. **Power failure.** Supply changes over automatically to the standby generator or second feeder (Clause 9.9.9(c)). Recommended: pumps restart one at a time after changeover, to limit the starting load on the generator.

6. **High level.** At the high-level alarm level an alarm is sent by telemetry to the local body's control room (Clause 9.9.8(b)). At an underpass, the warning or closure signals operate at 150 mm depth on the carriageway (Clause 6.10.5(d)).
7. **Outfall and gates.** Rising mains discharge to a delivery chamber or outfall fitted with a flap gate or non-return valve (Clause 9.9.11). Flap gates open and close under head difference without control action. The upstream penstock or stop logs are closed only for maintenance, or if the flap gate jams open (Clause 9.10.3). Recommended: penstock position is shown at the control panel and logged.
8. **Tide-locked operation.** Where the outfall is tide-locked, storage and pumping together hold the 48 h design volume for the tidal-lock duration (Clause 9.9.2(b) and Chapter 5). Where the station also has a gravity outfall, gravity discharge resumes through the flap gate when the tide falls.
9. **Screens.** Mechanically raked screens (required where inflow exceeds 1 m³/s, Clause 9.8.6) are run automatically. Recommended: raking is started by a timer and by the level difference across the screen, with an alarm when the difference stays high.
10. **Manual operation.** Recommended: each pump has a hand–off–auto selector at the panel, and the float back-up high-level start remains active in hand mode.
11. **Mobile pumps.** When fixed pumps are out of service or overwhelmed, mobile pumps discharge into the delivery chamber through the quick-coupling connection (Clause 9.9.12).
12. **Records.** Sump levels, pump run hours and power status are logged and kept for at least 5 years (Clause 9.9.8(c)). Recommended: alarms, pump starts and stops, and changeovers are logged as well.
13. **Testing.** The controls, floats, alarms, telemetry, changeover and generator are tested in the pre-monsoon inspection of Chapter 10 (Clause 10.12), and the results reported in the Annual Maintenance Declaration (Form 10-7; Clause 10.10.3).

Form 9-1 — Hydraulic Structures Report checklist

Supports Clause 9.14 of Chapter 9.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Not for statutory use.

Attach this checklist to the front of the Hydraulic Structures Report. For each item, enter Yes, No or Not applicable, and the drawing or page where it is shown.

Section A — Project

Table 9F.1 — Form 9-1, Section A: project

Field	Entry
Project name and location	_____
Local body, and Tier A or Tier B (Chapter 1)	_____
Applicant	_____
Designer (name and registration)	_____
Structures covered (culverts, channels, dissipators, outlets, screens, pumps, gates, inlets, manholes)	_____
Tailwater conditions used: MHWS, HAT + surge, sea-level allowance, joint case (Clause 9.2.1)	_____
Date and revision	_____

Section B — Contents required by Clause 9.14

Table 9F.2 — Form 9-1, Section B: contents required by Clause 9.14

No.	Item	Clause	Provided (Yes / No / NA)	Drawing or page
1	Culvert calculations (HDS-5 or HY-8 output) with HWi, HWo, outlet velocity, tailwater, overtopping and the blockage check	9.4, 6.12		
2	Channel water-surface profiles, velocities, Froude numbers and freeboard	9.5		
3	Outlet protection and dissipator design, with riprap sizing	9.6		
4	Detention outlet stage–discharge tables and the emergency spillway check	9.7		
5	Screen and rack design with the 50% blocked check	9.8		
6	Pump station design report: inflow hydrograph, storage, pump and system curves, wet-well volume, controls, power supply and the Chapter 5 outfall-closed check (with Annex 9C)	9.9		
7	Gate and valve selection with head-loss data	9.10		
8	Inlet, grate and cover load classes	9.11		
9	Exposure class and materials statement	9.13		

Section C — Compliance checks

Table 9F.3 — Form 9-1, Section C: compliance checks

No.	Check	Limit	Clause	Complies (Yes / No / NA)
C1	Climate factor included in design flows	Clause 2.8	9.2.2	
C2	Blocked condition checked where debris can block; safe overflow route	—	9.2.5	
C3	Pipes and box drains: design n (box drains ≥ 0.015); supercritical pipes: jump located in a structure, air venting	—	9.3.1, 9.3.4	
C4	Pipe size does not decrease downstream; joins only at manholes or junction chambers; no change of direction over 90°	—	9.3.5	
C5	Culvert design headwater = greater of HWi and HWo	—	9.4.1	
C6	Culvert headwater at the design AEP	HW/D ≤ 1.2; ≥ 0.3 m below shoulder edge	9.4.5	
C7	Road overtopping weir coefficient	Cd ≤ 1.66	9.4.6	
C8	Culvert inverts match the drain bed; headwalls, wingwalls and cut-off walls	—	9.4.8(c), 9.4.9	
C9	Channel Froude number at the design flow	≤ 0.8; none between 0.8 and 1.2	9.5.2	
C10	Channel velocity	Table 9.2	9.5.3	
C11	Channel slope in engineered channels	≤ 0.4% natural, ≤ 0.2% concrete, or drops / chute	9.5.4	
C12	Side slopes; low-flow channel where bed width ≥ 3 m; uplift or weep holes	—	9.5.6, 9.5.7, 9.5.9	
C13	Outlet protection where outlet velocity exceeds Table 9.2	Table 9.3 apron, or basin	9.6.1, 9.6.3	
C14	Single vertical drop height	≤ 1.5 m	9.6.6(c)	
C15	Detention primary outlet: no moving parts; minimum orifice	≥ 50 mm with screen	9.7.1	
C16	Emergency spillway	1% AEP, outlet blocked, basin full, 0.3 m freeboard; 0.2% AEP for high-hazard basins	9.7.6	
C17	Outlet pipe through embankment; anti-vortex plate where needed	—	9.7.7, 9.7.8	
C18	Conduit-entrance racks	Spacing 75 mm to half the smallest conduit dimension; area ≥ 4×; ≤ 1.0 m/s at 50% blocked	9.8.2	
C19	Detention orifice screens	Openings smaller than the orifice; open area ≥ 10×	9.8.5	
C20	Pump station	Annex 9C checklist complete	9.9	
C21	Gates on outfalls below the 1% AEP still-water level; secondary closure; corrosion-resistant fittings	—	9.10	
C22	Grate load classes, parallel openings ≤ 25 mm, kerb openings ≥ 100 mm × 1.0 m, locked covers	—	9.11	
C23	Manhole sizes (Table 9.4), 600 mm access openings, drops, benching, surcharge covers	—	9.12	

No.	Check	Limit	Clause	Complies (Yes / No / NA)
C24	Exposure class (Table 9.5); chloride and sulphate tests in coastal and delta areas; sulphide protection; metalwork within 5 km of the coast	—	9.13	

Section D — Variances

Table 9F.4 — Form 9-1, Section D: variances

Clause	Requirement not met	Reason and proposed alternative	Approved by and date
_____	_____	_____	_____

Section E — Signatures

The report shall be prepared and signed by a registered professional, and the Professional Design Certificate (Form 10-3) attached (Clauses 10.6.1 and 10.6.3 of Chapter 10). For a facility with an embankment, a high-hazard basin, a pumped facility, a tide gate or a regional facility, the signatory shall be an empanelled Stormwater Design Professional, and a second, independent empanelled professional shall sign as checker (Clauses 10.6.1(c), (d) and 10.6.4).

Table 9F.5 — Form 9-1, Section E: signatures

Role	Name	Registration or empanelment no.	Signature	Date
Designer	_____	_____	_____	_____
Independent checker (Clause 10.6.4, where applicable)	_____	_____	_____	_____

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0.

ANNEXES TO CHAPTER 10

Submittals, Review, Operation & Maintenance and Enforcement

These annexes support Chapter 10. They give the specification and user-guide outline of the compliance calculator, the GIS data specification, the maintenance access dimensions that the Manual sets, model O&M plans for each facility type, model empanelment criteria, and the eight forms that Chapter 10 requires. The Design Rainfall Sheet (Form 2-1) is in the annexes to Chapter 2. The forms are draft forms. The model texts are for consideration by a competent authority and are not in force.

Annex 10A — Compliance calculator and user guide

Supports Clauses 10.4.1(g), 10.5 and 10.9.1(b) of Chapter 10.

> **Status.** The compliance calculator does not exist yet. Clause 10.5.1 requires the State Stormwater Technical Committee to issue and maintain it. This annex is the specification the calculator shall meet and the outline of its user guide. Until the calculator is issued, the designer completes Form 10-2 by hand from the calculations of Chapters 4, 5 and 8, enters "not issued" as the calculator version, and attaches the calculations.

10A.1 General requirements

The calculator shall:

- (a) be a spreadsheet or web tool, published free of charge with its user guide and the source of every table in it (Clause 10.5.4);
- (b) print its version number and release date on every output page and every exported file (Clause 10.5.3);
- (c) keep a public version log. A new version applies to new submittals 6 months after release; a submittal keeps one version from Stage 1 to Stage 4 unless the Applicant elects a later one (Clause 10.5.3);
- (d) work for one site at a time, with one or more drainage areas, each draining to its own outfall (Clause 4.5.1.3);
- (e) never apply a value that the Manual has not published. Where a table it needs has not been issued (for example Table 4.3 of Annex 4B, or the S-2 discharge tables of Annex 1C), the calculator shall show that route as "not available" rather than estimate the value; and
- (f) export its inputs and results as a machine-readable file (CSV or JSON) as well as Form 10-2, so that the Authority can load them into the facility register (Clause 10.17.1(b)).

10A.2 Inputs

Table 10A.1 — Calculator inputs

No.	Input	Unit	Source
I1	Authority, tier (A or B) and file number	—	Clause 1.6

No.	Input	Unit	Source
I2	Site area; land disturbance area	ha	Clause 1.5.2
I3	New impervious area; replaced impervious area; existing impervious area before demolition	m²	Clauses 1.5.2, 1.5.6, 4.5.6.1
I4	Development type: new, redevelopment, linear public work, single dwelling	—	Clauses 1.5.6–1.5.8
I5	Flood-sensitive catchment (yes / no), and basin with an approved BSMP (yes / no)	—	Clauses 4.5.3, 4.13, 11.12
I6	Rainfall zone	—	Annex 2A
I7	Retention depth P_R; 3-month ARI 24-hour depth P_3m	mm	Annexes 2E, 8A
I8	Design rainfall depths by duration (1–72 h) and AEP, with the climate factor, as recorded on Form 2-1	mm	Clauses 2.5, 2.8, 2.13
I9	15-minute intensities i_10 and i_2, with the climate factor (fixed-coefficient route only)	mm/h	Clause 4.14.4
I10	Drainage areas: for each, area, land cover, impervious percentage, HSG and curve number, pre- and post-development	ha, %, —	Clauses 3.3, 3.7, 3.9
I11	Areas preserved under a registered covenant	ha	Clause 4.4.7
I12	Seasonal high groundwater depth below the base of each retention practice	m	Clauses 4.4.3(c), 8.8
I13	Measured infiltration rate at each practice	mm/h	Clause 4.4.3
I14	Retention volume provided, by practice; reuse demand where retention is by reuse	m³, m³/d	Clauses 4.4.3, 4.4.5
I15	Route: full hydrograph method (Clause 4.6); design-aid S-1 (Clause 4.14.2); PSD S-2 (Clause 1.7); fixed-coefficient (Clause 4.14.3); constrained redevelopment (Clause 4.5.6)	—	Clauses 1.7, 4.5.6, 4.6, 4.14
I16	For the full method: model results for each AEP and duration — pre- and post-development peaks, storage used, retention credit found by routing	m³/s, m³	Clauses 4.4.6.2, 4.6
I17	Outlet: low-flow orifice diameter or least slot dimension; drawdown times from routing	mm, h	Clauses 4.7, 4.8.2
I18	Outfall: tidal or non-tidal; outfall-closed check result	—	Chapter 5
I19	Fee-in-lieu unit rate notified for the basin, where the route applies	₹/m³	Clause 4.13.3
I20	Stage of submittal (1, 2 or 4) and, at Stage 4, the as-built values of I14, I16 and I17	—	Clauses 10.5.2, 10.9.1(b)

10A.3 Calculations, by clause

Table 10A.2 — Calculations the calculator shall perform

Step	Calculation	Clause
C1	**Applicability.** Chapters 4 and 5 apply where land disturbance ≥ 0.1 ha or new plus replaced impervious area ≥ 500 m², over the common plan of development. Report exemptions. Flag that the universal provisions apply at every size, and that RWH applies under chapter 10 of UBBL-2021 to every building on a plot of 100 m² or more, whose plans must include a complete rainwater-harvesting proposal (cl. 10.1), with recharge required for buildings and group housing on plots of more than 500 m² (cl. 10.5), storm water captured in public open spaces of more than 500 m² (cl. 10.4) and the structures inspected before the completion certificate (cl. 10.6); the Srinagar Master Plan 2035 makes storage mandatory only from 1,000 m² and for group housing (reg. 1-7-13), and the stricter UBBL threshold applies; recharge is credited only where Clauses 4.11 and 8.8.1 allow it, which is on the Kandi fans and khad beds of the Jammu plains with pre-treatment, never on the alluvium, Gurti clay and Nambal peat of the Kashmir valley floor, nor on the Sirowal, the river terraces or the lake and nambal margins where the seasonal high water table is within 2 m of the surface or wells flow, where rainwater harvesting is storage and reuse, never on a natural slope steeper than 10°, on the Murree and Siwalik clay–sandstone sequences, in a mapped subsidence or sliding zone such as Thathri, Pernote or Duksar, on colluvium or slide debris, or within twice the height of a cut slope or retaining wall upslope of it (unless a geotechnical certificate allows it).	1.5.2–1.5.8
C2	**Process flags.** Stage 0 mandatory (≥ 2 ha, flood-sensitive, variance or regional route, tidal outfall or waterbody); Stages 1 and 2 may be combined (< 1 ha, not flood-sensitive); empanelled signatory required; independent check required.	10.3.2, 10.3.3, 10.6.1, 10.6.4
C3	**Route eligibility.** Tier B simplified method: ≤ 2 ha, or ≤ 0.5 ha in a flood-sensitive catchment, and only once Table 4.3 is published. Fixed-coefficient route: ≤ 1 ha and none of the exclusions of Clause 4.14.3. Constrained redevelopment: existing ≥ 60% impervious and ≤ 1 ha. Regional detention or fee-in-lieu: only in a basin with an approved BSMP.	4.5.6.1, 4.13.1, 4.14.1, 4.14.3, 11.12.1(b)
C4	**Retention volume.** RRV = 10 × Q_R × A, with Q_R the SCS-CN runoff from P_R for each sub-area at AMC II, summed over sub-areas. The larger of the Ia = 0.2S and Ia = 0.05S results governs. The Rv form (RRV = 10 × P_R × Rv × A, Rv = 0.05 + 0.009 × I) is offered only for sites < 0.5 ha and the Tier B method. No climate factor.	4.4.2, 3.8.5(c), 2.8.3
C5	**Preservation credit.** Preserved areas are modelled at their pre-development CN in the post-development condition.	4.4.7
C6	**Retention checks.** Design infiltration rate ≤ half the measured rate; groundwater ≥ 1.0 m below the base; drawdown of the retained volume within 72 h at the design rate (or by the stated reuse demand). A practice that fails any check gets no credit; any shortfall is reported and treated as WQv.	4.4.3–4.4.5, 4.4.6.4
C7	**Water quality volume.** P_wq = max(P_ret, P_3m); WQv = 10 × Q_wq × A by SCS-CN, or (P_wq / 1000) × Rv × A (A in m²) for sites < 0.5 ha and the Tier B method. The retained volume counts toward the WQv in full. No climate factor.	8.4.1–8.4.4, 3.8.5(c)
C8	**Retention credit.** Tier A: the credit found by routing is entered (I16); the calculator does not compute it. Tier B: V_credit = C_R × RRV provided, with C_R = 0 until Annex 4B is published.	4.4.6
C9	**Design-aid route (S-1).** V = SSR × A − V_credit; Q_PSD,T = PSD_T × A for the 2-yr and 100-yr stages, from Table 4.3. Shown as "not available" until Table 4.3 is published.	1.7.2, 4.14.2
C10	**Permissible site discharge (S-2).** Q = PSD (m³/s/ha) × A for each AEP, from the S-2 tables. Shown as "not available" until they are issued.	1.7.2, 1.7.3(e)
C11	**Fixed-coefficient route.** Q_cap,10 = 2.78 × C_10 × i_10 × A and Q_cap,2 = 2.78 × C_2 × i_2 × A (L/s); V_100 and V_2 = max over d of [10 × C_v × P(d) × A − 1.8 × Q_cap × d] for d = 1 to 72 h, with pervious C ≥ 0.50 for d ≥ 12 h; V = max(V_100, V_2); retention added without credit. Coefficients from Table 4.3A (provisional).	4.14.4–4.14.7
C12	**Release-rate screen (full method).** For each AEP and duration: Q_post ≤ 0.9 × Q_pre (standard), or the two mixed-frequency caps (flood-sensitive). Report the governing duration and margin.	4.5.2, 4.5.3
C13	**Constrained redevelopment.** Q_post ≤ 0.5 × Q_existing for 2-, 10- and 100-yr at each duration; shortfall volume = greenfield storage − storage provided; fee = shortfall × unit rate.	4.5.6.2, 4.5.6.3
C14	**Minimum orifice.** Flag any orifice < 50 mm. Where a cap is below the discharge of a 50 mm orifice at the corresponding stage, report "50 mm orifice deemed to comply".	4.5.5.1, 4.8.2
C15	**Drawdown.** Report the detention drawdown (90% of the 10-yr stored volume within 48 h), the WQv release time (24–48 h) and the retention emptying time (≤ 72 h).	4.7

Step	Calculation	Clause
C16	**Fee-in-lieu.** Fee = detention volume required on site × notified unit rate.	4.13.3
C17	**Model screen.** Where the full method is used, compare the model results (I16) with the calculator's screen values (C9 to C11, where available) and flag a difference above the tolerance stated in the user guide.	10.5.2(c)
C18	**As-built re-run.** At Stage 4, repeat C4 to C17 with the as-built values and report each change from Stage 2.	10.9.1(b), 10.9.2

10A.4 Outputs

The calculator produces:

- (a) **Form 10-2**, filled in, with the calculator version and release date on every page;
- (b) a machine-readable export of every input and result of Tables 10A.1 and 10A.2; and
- (c) a list of the flags raised (C1 to C3, C6, C14, C17), each with the clause on which it is based (Clause 10.7.7).

10A.5 Testing before release

Before each release the State Stormwater Technical Committee shall check that the calculator reproduces, within rounding, the worked examples of the Manual that use the same method, including the illustrative examples of Clauses 4.6.7 and 4.14, and the benchmark problems of Annex 3C where they apply. The test results shall be published with the version log.

10A.6 Outline of the user guide

The user guide shall contain at least:

1. Purpose, status and limits of the calculator: a summary and screening check outside the design-aid route (Clause 10.5.2(c)).
2. How to obtain the current version, and the version rule of Clause 10.5.3.
3. Each input of Table 10A.1, with where to find it in the Manual and its annexes.
4. Each calculation of Table 10A.2, with its equation and clause.
5. The tolerance used in step C17, and what the drainage report must explain where it is exceeded (Clause 10.5.2(c)).
6. How to read and sign Form 10-2, and what to attach.
7. At least one worked example for each route, labelled "Illustrative — not design values".
8. The sources of every table in the calculator (Clause 10.5.4), and the version log.

Annex 10B — GIS data specification and attribute schema

Supports Clauses 10.4.4, 10.14.1(d), 10.14.3 and 10.17 of Chapter 10.

10B.1 Format and reference systems

- (a) **Format.** One OGC GeoPackage (.gpkg) per submittal is preferred. Shapefiles are accepted, one per layer, zipped with all component files. Field names shall be as in Tables 10B.2 to 10B.6; shapefile names are limited to 10 characters, and the names below meet that limit.
- (b) **Horizontal reference.** WGS 84 geographic (EPSG:4326), or WGS 84 / UTM zone 43N (EPSG:32643), which covers the whole Union Territory with no exception, whichever contains the site (Clause 10.4.4(c)). One system shall be used for all layers.

- (c) **Vertical reference.** All levels shall be in metres relative to a named vertical datum, stated in the metadata. The metadata shall also state the relationship between that datum and the river datums of the CWC gauges on the Jhelum, the Chenab, the Tawi and the Lidder, the zeros of the I&FC staff gauges read in feet (stated once I&FC publishes them, and never assumed), the lake and reservoir levels of LCMA, WUCMA, I&FC, JKSPDC, NHPC and the other operators, and the flood marks surveyed on ungauged khads and nallahs used in Chapter 5 (Clause 10.4.4(d)).
- (d) **Accuracy.** Positions shall come from the site survey or the approved drawings. At Stage 4 and at handover, positions and levels shall come from the as-built survey (Clause 10.9.1(a)).
- (e) **File name.** `<Authority file number>_<stage>_<yyyymmdd>.gpkg`, for example `SMC–BP–2026–0123_S2_20261015.gpkg`.
- (f) **Identifiers.** Every feature has an identifier unique within the submittal (FAC_ID, OUT_ID, CAT_ID, FLP_ID). The Authority replaces them with register identifiers on acceptance and returns the mapping to the Applicant.

10B.2 Layers

Table 10B.1 — Layers

Layer	Geometry	Content	Required at
SW_SITE	Polygon	Site boundary	Stages 1, 2, 4
SW_CATCH	Polygon	Catchment boundaries draining to and through the site, pre- and post-development (Clause 10.4.1(b))	Stages 1, 2, 4
SW_FAC	Polygon (point for buried items smaller than 5 m across)	Every stormwater facility: retention, detention, water quality, pumping, gate, conveyance element designed under this Manual	Stages 2, 4; handover
SW_OUTF	Point	Every outfall from the site, and every public outfall	Stages 1, 2, 4; handover
SW_FLOW	Line	Major-system flow paths through and from the site, and natural drainage paths (Clause 10.15.1(g))	Stages 1, 2, 4
SW_CONV	Line	Drains and pipes designed under Chapter 6	Stage 4 for public works; handover
SW_META	Table (no geometry)	Metadata of Table 10B.6	Every stage

10B.3 Attribute schema

Types: T = text, I = integer, R = real, D = date (ISO 8601, yyyy-mm-dd). "Req." marks fields that shall not be empty; other fields are filled where they apply.

Table 10B.2 — Attributes of SW_FAC (facilities)

Field	Type	Unit	Req.	Content	Source
FAC_ID	T	—	Yes	Facility identifier	10B.1(f)
FAC_TYPE	T	—	Yes	Code from Table 10B.7	Clause 4.10, Table 10.3
FAC_NAME	T	—		Name on the drawings	—
OWNER_TYP	T	—	Yes	PRIVATE / ASSOC / DEVELOPER / ULB / DEPT	Clauses 10.10, 10.14
OWNER_NM	T	—	Yes	Name of a corporate owner or association only; for an individual, "private individual" (Clause 10.17.3)	Clause 10.17.3

Field	Type	Unit	Req.	Content	Source
CTRL_AREA	R	ha	Yes	Area draining to the facility	Clause 4.5.1.3
V_RET	R	m³		Retention volume provided	Clause 4.4
V_WQ	R	m³		Water quality volume provided	Clause 8.4
V_DET	R	m³		Detention volume at the top design level	Clause 4.6
Q_2	R	L/s		Release at the 50% AEP (2-yr) design level	Clause 4.5
Q_10	R	L/s		Release at the 10% AEP (10-yr) design level	Clause 4.5
Q_100	R	L/s		Release at the 1% AEP (100-yr) design level	Clause 4.5
ORIF_MM	R	mm		Low-flow orifice diameter or least slot dimension	Clause 4.8.2
INV_OUT	R	m		Outlet invert level	Clause 10.9.1(a)
TWL_DES	R	m		Top design water level	Clause 10.9.2(a)
SPILL_LV	R	m		Spillway or overflow crest level	Clause 4.9
PUMPED	T	—	Yes	Y / N	Clause 10.10.3
REGIONAL	T	—	Yes	Y / N	Clause 4.13
EMPANEL	T	—	Yes	Y / N: facility under Clause 10.6.1(c) or (d)	Clause 10.6.1
STATUS	T	—	Yes	Code from Table 10B.8	Clause 10.17.1(a)
APPR_DATE	D	—		Date of Stage 2 approval	Clause 10.3
ASB_DATE	D	—		Date the as-built certificate was accepted	Clause 10.9
DECL_REF	T	—		Registration reference of the Maintenance Declaration (Form 10-6)	Clause 10.10.1(e)
HAND_DATE	D	—		Date of the Asset Handover Certificate (Form 10-8)	Clause 10.14
LAST_INSP	D	—		Date of the latest inspection	Clause 10.12
INSP_RES	T	—		Code from Table 10B.9	Clause 10.17.1(a)
OUT_ID	T	—	Yes	Outfall to which the facility discharges	—

Table 10B.3 — Attributes of SW_OUTF (outfalls)

Field	Type	Unit	Req.	Content	Source
OUT_ID	T	—	Yes	Outfall identifier	10B.1(f)
RECEIVER	T	—	Yes	Receiving drain, channel, waterbody or sea, by name	Clause 4.5.1.3
RECV_TYPE	T	—	Yes	PUBLIC_DRAIN / CANAL / RIVER / TANK / SEA / OTHER	Chapter 5
INV_LEVEL	R	m	Yes	Outfall invert level	Clause 10.9.1(a)
SIZE_MM	R	mm	Yes	Diameter, or width × height written in the drawing	Chapter 6
TIDAL	T	—	Yes	Y / N	Chapter 5
GATE_TYPE	T	—		NONE / FLAP / TIDE / DUCKBILL / PENSTOCK / NRV	Clauses 5.11, 9.10
GATE_REQ	T	—	Yes	Y / N: invert below the 1% AEP still-water level	Clause 5.11.1
GPT	T	—		Y / N: gross pollutant trap fitted	Clause 8.10.1

Field	Type	Unit	Req.	Content	Source
Q_100	R	L/s		Design 1% AEP discharge	Chapter 5

Table 10B.4 — Attributes of SW_CATCH (catchments)

Field	Type	Unit	Req.	Content	Source
CAT_ID	T	—	Yes	Catchment identifier	10B.1(f)
CONDITION	T	—	Yes	PRE / POST / EXTERNAL (land outside the site draining through it)	Clause 10.4.1(b)
AREA_HA	R	ha	Yes	Area	—
IMPERV_PC	R	%	Yes	Impervious percentage	Clause 3.9
HSG	T	—	Yes	A / B / C / D, or mixed with area shares in NOTES	Clause 3.7
CN	R	—		Curve number, AMC II	Chapter 3
OUT_ID	T	—	Yes	Outfall to which it drains	Clause 4.5.1.3
FLOODSENS	T	—	Yes	Y / N	Clause 4.5.3
NOTES	T	—		Free text	—

Table 10B.5 — Attributes of SW_FLOW and SW_CONV (flow paths and conveyance)

Field	Type	Unit	Req.	Content	Source
FLP_ID	T	—	Yes	Line identifier	10B.1(f)
LINE_TYPE	T	—	Yes	OVERLAND / NATURAL / OPEN_DRAIN / COVERED_DRAIN / PIPE / CULVERT	Chapter 6
US_LEVEL	R	m		Upstream invert or ground level	Chapter 6
DS_LEVEL	R	m		Downstream invert or ground level	Chapter 6
SIZE_MM	R	mm		Pipe diameter, or drain width (depth in NOTES)	Clause 6.7.6
Q_DES	R	L/s		Design discharge	Chapter 6
AEP_DES	T	—		Design AEP, for example "10%" or "1%"	Clause 6.4
RESERVE_M	R	m		Drainage reserve width, where one applies	Clause 6.9.7
NOTES	T	—		Free text	—

Table 10B.6 — Metadata (SW_META)

Field	Content
FILE_NO	Authority file number
STAGE	1, 2, 4 or HANDOVER
H_CRS	EPSG code of the horizontal reference system
V_DATUM	Name of the vertical datum
TIDE_REL	Relationship of the vertical datum to the Chapter 5 river datums of the CWC gauges on the Jhelum, the Chenab, the Tawi and the Lidder, the zeros of the I&FC staff gauges read in feet (stated once I&FC publishes them, and never assumed), the lake and reservoir levels of LCMA, WUCMA, I&FC, JKSPDC, NHPC and the other operators, and the flood marks surveyed on ungauged khads and nallahs (for example, MSL = x.xx m on the site datum)

Field	Content
SURVEYOR	Name and licence number of the surveyor
SURV_DATE	Date of the survey
PREP_BY	Name and registration number of the certifying professional
CALC_VER	Compliance calculator version (Annex 10A), or "not issued"
DATE	Date the file was prepared

10B.4 Code lists

Table 10B.7 — Facility type codes (FAC_TYPE)

Code	Facility	Inspection row of Table 10.3
RET_SOAK	Soakaway, recharge pit or shaft	Retention / infiltration
RET_TRENCH	Infiltration trench or basin	Retention / infiltration
RET_BIO	Bioretention or rain garden	Retention / infiltration
RET_PERM	Permeable pavement	Retention / infiltration
RET_REUSE	Retention by reuse (tank with demand)	Underground or podium detention tank, gravity outlet
DET_BASIN	Surface detention basin	Surface detention basin or multi-use open space area
DET_OSR	Multi-use detention in open space, park or playfield	Surface detention basin or multi-use open space area
DET_ROOF	Rooftop detention	Underground or podium detention tank, gravity outlet
DET_PODIUM	Podium or landscape-deck detention	Underground or podium detention tank, gravity outlet
DET_PARK	Parking-lot detention	Surface detention basin or multi-use open space area
DET_TANK	Underground tank or vault, gravity outlet	Underground or podium detention tank, gravity outlet
DET_PUMP	Pumped detention or pump station	Pumped detention, pumps and controls
WQ_POND	Wet pond or constructed wetland	Surface detention basin or multi-use open space area
WQ_SWALE	Swale or filter strip	Private drains and inlets
WQ_GPT	Gross pollutant trap, first-flush device or oil-grit separator	Gross pollutant trap / first-flush device
GATE	Flap or tide gate, non-return valve	Flap / tide gate, non-return valve
CONV	Private drain, inlet or culvert	Private drains and inlets

Table 10B.8 — Status codes (STATUS)

Code	Meaning
PROPOSED	In a Stage 1 or Stage 2 submittal
APPROVED	Stage 2 approved; not yet built
ASBUILT	As-built certificate accepted (Clause 10.9)
HANDEDOVER	Accepted by the ULB (Clause 10.14)
ALTERED	Changed with the Authority's approval (Clause 10.3.5)

Code	Meaning
REMOVED	Removed with the Authority's approval

Table 10B.9 — Inspection result codes (INSP_RES)

Code	Meaning
OK	Working as designed; no defect
MINOR	Defect found and corrected; date in the inspection record
MAJOR	Defect affecting storage, outlet or safety; notice issued (Clause 10.15.2, step 1)
NOACCESS	Inspection could not be made
NOTFOUND	Facility missing, filled, covered or changed in use (Clause 10.15.1(c))

10B.5 Facility register extract

The public facility register of Clause 10.17.1(a) is an extract of SW_FAC: FAC_ID, FAC_TYPE, location (centroid), V_DET (and V_RET, V_WQ), Q_100 (and Q_2, Q_10), OWNER_NM, ASB_DATE, LAST_INSP and INSP_RES. It is published as CSV and GeoPackage under the licence of Clause 10.17.4. Personal data are not published (Clause 10.17.3).

Annex 10C — Maintenance access dimensions

Supports Clause 10.13 of Chapter 10.

Clause 10.13 sets access by function. This annex collects the access dimensions that the Manual already sets in other chapters, and lists the dimensions that it does not set. Where a dimension is not set by the Manual, the designer shall state it on the drawings, show that it suits the plant and equipment named in the O&M plan (Clause 10.11.1(h)), and mark it "to be confirmed in design".

Table 10C.1 — Access dimensions set by the Manual

Element	Requirement	Clause
Open drains with a top width of 2 m or more	Maintenance access strip at least 3.5 m wide along one bank, connected to a public road at intervals of not more than 500 m	6.9.4
Drainage reserves	Width not less than Table 6.9, based on the required drain size; where the access strip of Clause 6.9.4 is wider, the wider governs	6.9.7
Covered drains, minimum section	0.6 m × 0.6 m clear	6.7.6
Covered drains, removable covers	Panels at not more than 10 m centres, each at least 0.6 m long and spanning the full clear width, liftable by two workers or a hand-operated device	6.13.2(a)
Covered drains, access chambers	Clear opening at least 0.6 m × 0.6 m at every junction, bend and change of section, and at not more than 30 m centres on straight runs	6.13.2(b)
Manholes and access chambers on public drains	Clear access opening at least 600 mm	9.12.3
Inlet chambers on public roads	Silt sump at least 300 mm deep below the outlet pipe invert, cleanable from the surface	6.6.7

Element	Requirement	Clause
Underground tanks and vaults	Access openings over the outlet chamber and over every inlet; in tanks over 500 m², not more than 30 m apart; floor falling at least 1% to a sump at the outlet	4.10.2(b), (c)
Detention outlets serving more than 1 ha	A means of isolating the outlet (stop-log slot or penstock)	4.8.6
Outfall gates	Stop-log slot or penstock upstream on outfalls larger than 600 mm (Chapter 5) and on outfalls of 900 mm or more or serving a pumped or storage system (Chapter 9); the gate chamber accessible at all tides, with its access above HAT + surge + sea-level allowance	5.11.3(d), (e); 9.10.3
Pump stations	Maintenance vehicle access usable in the 1% AEP event; hard standing and a quick-coupling connection for mobile pumps; clear space between adjacent pumps or motors of 0.6 m (small and medium units) or 1.0 m (large units)	9.9.6, 9.9.10, 9.9.12
Pretreatment devices	Cleanable without entering or disturbing the main BMP	8.5.4
Screens at outfalls, culvert inlets and pump sumps	Cleanable from a safe platform, with vehicle access	8.10.3(d)
Infiltration trenches	Observation well to the base of each trench	8.7.6(c)
Publicly accessible storage	Side slopes no steeper than 4H:1V, with at least a quarter of the perimeter at 6H:1V or flatter	4.15.1(c)
Wet basins	Safety bench at least 3 m wide, no more than 0.3 m below normal water level	4.15.2
Fencing	At least 1.2 m high, non-climbable, with a lockable gate, where Clause 4.15.3 requires it	4.15.3

Table 10C.2 — Access dimensions not set by the Manual (to be confirmed in design)

Element	What the designer shall state	Clause setting the function
Vehicle access route to the inlet, outlet and base of a basin, pond or open channel	Width, gradient, turning space and design load for the plant in the O&M plan	10.13.2
Maintenance strip beside a basin or pond	Width along at least one side	10.13.2
Ramp into a basin	Width, gradient and surface for the sediment-removal plant	10.13.2
Access openings of private tanks	Clear size of each opening over the inlet, outlet and each chamber	10.13.3(a)
Ladders and steps	Type and spacing; ventilation for confined-space entry	10.13.3(b)
Headroom in underground tanks	Clear height for manual cleaning	10.13.3(d)
Reach to orifices and screens	How the outlet is cleaned without entering a full facility	10.13.4

Commentary. APWA 5600 (2006, §5608) required a maintenance access strip of 15 ft (about 4.5 m) for detention facilities. The Manual did not adopt a fixed width for private sites, because plot sizes in Srinagar, Jammu and the other cities and towns of Jammu and Kashmir vary widely (Clause 10.13, Commentary). The State Stormwater Technical Committee may add standard values to Table 10C.2 when it issues the standard drawings of Annexes 6C and 9B.

Annex 10D — Model O&M plans by facility type

Supports Clauses 10.11, 10.12 and 10.13 of Chapter 10.

The model plans below are starting points. The designer adapts them to each facility and completes the items marked "_____". Inspection frequencies are the minimum frequencies of Table 10.3; a plan may set more frequent inspection, never less. Where this annex leaves a value to the designer, the Manual does not set it.

10D.1 Contents of every O&M plan

Every plan shall contain the items of Clause 10.11.1:

Table 10D.1 — Contents of an O&M plan

Item	Content	Clause
1	Inventory and plan drawing of each facility, with design levels, volumes and outlet details (from SW_FAC, Annex 10B)	10.11.1(a)
2	Routine tasks and their frequency (Tables 10D.2 to 10D.8)	10.11.1(b)
3	Trigger for sediment removal, as a depth (mm) or a percentage of design volume: _____	10.11.1(c)
4	Inspection checklist matching Form 10-7	10.11.1(d)
5	For pumps, gates and valves: operating rules, test schedule, standby power, and actions on a cyclone or heavy-rainfall warning	10.11.1(e)
6	Actions against standing water and mosquito breeding, consistent with the drawdown times of Clause 4.7	10.11.1(f)
7	Safety: confined spaces, deep water, public access	10.11.1(g)
8	Access routes and equipment (Annex 10C)	10.11.1(h)
9	Annual cost estimate (₹ _____ per year) and who pays it	10.11.1(i)
10	Records to be kept, and for how long: _____ years (pump records at least 5 years, Clause 9.9.8(c))	10.11.1(j)

10D.2 Model plans

Table 10D.2 — Retention and infiltration (soakaways, trenches, bioretention, permeable paving)

Task	Frequency	Standard or trigger	Clause
Inspect surface, inlets, pretreatment and overflow	Every 6 months; before 31 May; after each heavy-rainfall day	No blockage; overflow clear	Table 10.3
Check drawdown at the observation well or surface	At each inspection after rain	Empties within 72 h of the end of rain; if not, investigate clogging	4.4.5, 8.7.6(c)
Clean pretreatment (forebay, filter strip, silt trap)	When the sediment trigger (item 3) is reached	Pretreatment cleaned without disturbing the main BMP	8.5.3, 8.5.4
Bioretention: mulch, plants, ponding	Every 6 months	Ponding drains within 48 h; dead plants replaced; mulch 50–75 mm	8.7.2
Permeable paving: surface	Every 6 months	Sweep or vacuum; no resurfacing with impermeable material	8.7.5(e)
Keep the contributing area stable	Each inspection	Bare soil stabilised; no sediment washing in	10.8.3(b)
Keep the facility in place and in use	Each inspection	Not filled, covered, paved or built over without approval	10.10.1(d)

Table 10D.3 — Surface detention basin or multi-use open space area

Task	Frequency	Standard or trigger	Clause
Inspect inlets, outlet, orifice, trash rack and spillway	Every 6 months; before 31 May; after each heavy-rainfall day	Orifice and rack clear; spillway unobstructed	Table 10.3, 4.8, 4.9
Remove debris and sediment	When the sediment trigger is reached, and after events	Design volume restored	10.11.1(c)
Check that the basin drains	After rain	No low point ponds for more than 72 h	4.15.7
Vegetation	As set in the plan	Grass cut; no woody growth on embankments or in the outlet zone	10.11.1(b)
Safety features	Every 6 months	Signs in Urdu and English and a depth marker in place; fences and gates sound where required	4.15.3, 4.15.5
Embankment (if any)	Every 6 months and after events	No cracks, slips, seepage or animal burrows	4.9.6

Table 10D.4 — Underground or podium detention tank, gravity outlet

Task	Frequency	Standard or trigger	Clause
Inspect from the access openings: inlets, outlet, orifice, screen, sump, vents	Every 6 months; before 31 May; after each heavy-rainfall day	Clear; vents open	Table 10.3, 4.10.2
Clean the sump and floor	When the sediment trigger is reached	Floor falls freely to the sump	4.10.2(c)
Inlet silt trap or GPT	Every 3 months (Table 10.3 row for GPTs)	Cleaned	4.10.2(e)
Overflow route	Each inspection	Operates when the outlet is blocked; route to the overland path unobstructed	4.9.5
Confined-space entry	Each entry	Entry procedure stated in the maintenance declaration followed; covers locked after	4.15.6
Use of the space	Each inspection	Not used for parking or storage; volume not reduced	10.10.1(d)

Table 10D.5 — Pumped detention, pumps and controls

Task	Frequency	Standard or trigger	Clause
Test run of each pump, duty and standby	Monthly	Each pump starts on level control; roles alternate	Table 10.3, 9.9.4(c)
Full duty test	Before 31 May	Station meets its design duty point	Table 10.3, 10.9.3
Standby power	Monthly with the test run; full test before 31 May	Automatic changeover works; fuel for at least 72 h of all duty pumps on site	9.9.9
Level sensors, float back-up, alarms, telemetry	Monthly	High-level and fault alarms reach the control room	9.9.8
Screens and silt trap	Every 3 months and after events	Clean	9.9.7
Records	Continuous	Sump levels, run hours and power status logged; kept at least 5 years	9.9.8(c)

Task	Frequency	Standard or trigger	Clause
Warning actions	On an IMD heavy-rainfall or cyclone warning	Actions written in the plan: _____ (for example staff on site, fuel topped up, mobile pump connection checked)	10.11.1(e), 9.9.12

Table 10D.6 — Flap or tide gate, non-return valve

Task	Frequency	Standard or trigger	Clause
Inspect and operate	Every 3 months; after each heavy-rainfall day	Opens at a small head; no debris, sand or growth holding it	Table 10.3, 9.10.4
Seal test	Before 31 May	Seals against the receiving water	Table 10.3, 10.9.3
Beach, estuary and creek outfalls	After every high-tide or surge event in the monsoon season	Sand and debris cleared	9.10.5(b)
Isolation	Before 31 May	Stop-log slot or penstock operable	9.10.3
Hinges, pins and fixings	Before 31 May	No corrosion that would stop the gate working	9.10.6
Property non-return valves	Every 3 months	Cleaning eye accessible; valve seals	5.11.4

Table 10D.7 — Gross pollutant trap or first-flush device

Task	Frequency	Standard or trigger	Clause
Inspect and empty	Every 3 months; before 31 May; after each heavy-rainfall day	Emptied before the capture chamber is full; bypass clear	Table 10.3, 8.4.6
Screens	Each inspection	Clean; overflow path clear	8.10.3(b)
Disposal	Each cleaning	Material taken to an authorised solid-waste facility	—

Table 10D.8 — Private drains and inlets

Task	Frequency	Standard or trigger	Clause
Inspect and clean drains, inlets and silt sumps	Every 6 months; before 31 May	Free of silt and debris	Table 10.3
Check for sewage connections	Each inspection	None; any cross-connection removed	1.5.4, 8.9
Overland flow paths	Each inspection	Not obstructed by walls, fill or stored material	6.9.2, 10.15.1(g)

Annex 10E — Empanelment criteria for Stormwater Design Professionals and reviewers

Supports Clauses 10.6, 10.7.4 and 11.4.3 of Chapter 10.

> *Model text for consideration by a competent authority. Not in force.* Clause 10.6.2 assigns the issue of empanelment criteria to H&UDD. The text below is a model. Values shown as "[ ]" are for the competent authority to set; the Manual does not set them.

10E.1 Model criteria

1. **Lists.** The competent authority shall keep three public lists:
    - (a) **Stormwater Design Professionals**, who may sign designs under Clause 10.6.1 and act as independent checkers under Clause 10.6.4;
    - (b) **Empanelled Reviewers**, who may review submittals for an Authority under Clause 10.7.4; and
    - (c) a **basin modelling endorsement**, held by a Stormwater Design Professional who may prepare or direct a BSMP under Clause 11.4.3.
2. **Eligibility for list (a).** An applicant shall:
    - (a) hold a degree in civil engineering, or an equivalent qualification recognised by the competent authority (Clause 10.6.2);
    - (b) be registered as a professional under the Jammu and Kashmir Unified Building Bye-Laws 2021 (Clause 1.4);
    - (c) have at least [ ] years of experience in drainage design after graduation, shown by a list of at least [ ] projects with the applicant's role in each (Clause 10.6.2); and
    - (d) have completed a training course on this Manual, with an assessment, within the [ ] years before application (Clause 10.6.2).
3. **Eligibility for list (b).** As for list (a), with at least [ ] years of experience, of which at least [ ] years in the design or review of drainage under this Manual or an equivalent standard.
4. **Basin modelling endorsement (c).** A Stormwater Design Professional who shows experience in basin-scale 1D–2D modelling, including calibration, on at least [ ] studies (Clause 11.4.3).
5. **Independence of a checker.** A checker under Clause 10.6.4 shall not be employed by, or a partner of, the designer's firm or the Applicant, and shall not have worked on the design.
6. **Conflict of interest of a reviewer.** An Empanelled Reviewer shall not review a site on which the reviewer, or the reviewer's firm, has worked in any capacity (Clause 10.7.4), and shall declare any other interest before accepting a review. The Authority remains the decision-maker (Clause 10.7.4).
7. **Application.** The application shall include proof of degree and registration, the project list with references, the training certificate, and a signed declaration that the information is true.
8. **Term and renewal.** Empanelment is valid for [ ] years. Renewal requires evidence of continuing practice and of any refresher training issued after a revision of the Manual (Clause 1.12).
9. **Suspension and removal.** The competent authority may suspend or remove an empanelled person after a false or negligent certificate (Clause 10.6.5), on a report under step 6 of Table 10.4, or on loss of registration. The person shall be given notice and an opportunity to be heard. Every suspension and removal shall be published on the list.
10. **Publication.** The lists shall be published and kept current, with each person's name, registration number, list, endorsement and validity date.

Form 10-1 — Drainage Report Checklist

Supports Clauses 10.4.1 to 10.4.4 and 10.7.1 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Lodge with every Stage 1 and Stage 2 submittal. For each item give the page or sheet where it is addressed, or the reason it does not apply. The Authority does not start technical review without a completed Form 10-1 (Clause 10.4.3).

Table 10F.1 — Form 10-1, Section A: Submittal

No.	Field	Entry
A1	Authority and file number	_____
A2	Site name and address; survey numbers	_____
A3	Stage: 1 / 2 / combined 1 and 2 (Clause 10.3.3) / public work DPR or tender (Clause 10.3.4)	_____
A4	Applicant	_____
A5	Certifying professional (name, registration and empanelment number)	_____

Table 10F.2 — Form 10-1, Section B: Stage 1 contents (Clause 10.4.1)

No.	Item	Clause	Page / sheet	Not applicable: reason
B1	Form 1-1; Form 1-2 where a variance or waiver is sought	10.4.1(a)	_____	_____
B2	Site plan: existing and proposed levels, impervious areas, catchment boundaries to and through the site	10.4.1(b)	_____	_____
B3	Soils (HSG), seasonal high groundwater, infiltration tests or test plan	10.4.1(c)	_____	_____
B4	Design Rainfall Sheet (Form 2-1)	10.4.1(d)	_____	_____
B5	Pre-development condition and hydrologic method	10.4.1(e)	_____	_____
B6	Order of measures: areas preserved, retention method, detention concept, conveyance	10.4.1(f)	_____	_____
B7	Preliminary retention, WQ and detention volumes and release rates, with Form 10-2	10.4.1(g)	_____	_____
B8	Downstream extent and tailwater case	10.4.1(h)	_____	_____
B9	Waterbodies, setbacks and the 1% AEP level	10.4.1(i)	_____	_____
B10	Land reserved for facilities and maintenance access	10.4.1(j)	_____	_____
B11	Professional Design Certificate (Form 10-3)	10.4.5	_____	_____

Table 10F.3 — Form 10-1, Section C: Stage 2 contents (Clause 10.4.2)

No.	Item	Clause	Page / sheet	Not applicable: reason
C1	Updated Stage 1 contents (Section B)	10.4.2	_____	_____
C2	Final calculations for every storage duration and AEP, with the outfall-closed check	10.4.2(a)	_____	_____

No.	Item	Clause	Page / sheet	Not applicable: reason
C3	Stage–storage–discharge tables; emergency spillway design	10.4.2(b)	_____	_____
C4	Hydraulic design of conveyance, inlets and structures	10.4.2(c)	_____	_____
C5	Water quality design; first-flush device or GPT where required	10.4.2(d)	_____	_____
C6	Construction drawings, details and specifications of every facility	10.4.2(e)	_____	_____
C7	Construction sequence, with protection of retention and infiltration areas	10.4.2(f)	_____	_____
C8	Hold-point schedule (Form 10-4, Section A)	10.4.2(g)	_____	_____
C9	Draft O&M plan and draft Maintenance Declaration (Form 10-6)	10.4.2(h)	_____	_____
C10	Model input files and GIS data	10.4.2(i)	_____	_____
C11	Certificates (Form 10-3, signed by designer and, where required, checker)	10.4.2(j)	_____	_____

Table 10F.4 — Form 10-1, Section D: Digital submittal (Clause 10.4.4)

No.	Item	Clause	Provided (yes / no)	Detail
D1	Reports and drawings as searchable PDF	10.4.4(a)	_____	_____
D2	Models in native, runnable format; software name and version	10.4.4(b)	_____	_____
D3	GIS data to Annex 10B; horizontal reference system (EPSG code)	10.4.4(c)	_____	_____
D4	Vertical datum named; relationship to the Chapter 5 river datums of the CWC gauges on the Jhelum, the Chenab, the Tawi and the Lidder, the zeros of the I&FC staff gauges read in feet (stated once I&FC publishes them, and never assumed), the lake and reservoir levels of LCMA, WUCMA, I&FC, JKSPDC, NHPC and the other operators, and the flood marks surveyed on ungauged khads and nallahs	10.4.4(d)	_____	_____

Table 10F.5 — Form 10-1, Section E: Declaration and completeness check

Field	Entry
I confirm that this checklist is complete and correct. Certifying professional: name, signature, date	_____
For the Authority: date received	_____
Date of completeness check (within 5 working days, Clause 10.7.1)	_____
Result: accepted for review / returned	_____
Missing items, if returned	_____
Officer: name, designation, signature	_____

Form 10-2 — Compliance Calculator Summary

Supports Clauses 10.4.1(g), 10.5 and 10.9.1(b) of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Produced by the compliance calculator (Annex 10A) with Stage 1, 2 and 4 submittals. Until the calculator is issued, complete it by hand and enter "not issued" in A3. One column per drainage area where the site has more than one outfall.

Table 10F.6 — Form 10-2, Section A: Site and route

No.	Field	Entry	Clause
A1	Authority, file number, stage (1 / 2 / 4)	_____	10.5.2(a)
A2	Site area, ha; land disturbance, ha; new + replaced impervious area, m²	_____	1.5.2
A3	Calculator version and release date	_____	10.5.3
A4	Tier (A / B); flood-sensitive (yes / no); approved BSMP for the basin (yes / no)	_____	1.6, 4.5.3, 11.12
A5	Route: full method / S-1 / S-2 / fixed-coefficient / constrained redevelopment / regional or fee-in-lieu	_____	1.7, 4.5.6, 4.13, 4.14
A6	Flags raised by the calculator (list)	_____	Annex 10A.4

Table 10F.7 — Form 10-2, Section B: Rainfall and soils

No.	Field	Entry	Clause
B1	Rainfall zone; Form 2-1 reference	_____	2.13
B2	Retention depth P_R, mm; 3-month ARI depth P_3m, mm	_____	2.10, 8.4.1
B3	Climate factor applied (≤ 6 h; > 6–72 h)	_____	2.8
B4	HSG by sub-area; seasonal high groundwater, m below base	_____	3.7, 4.4.3
B5	Measured and design infiltration rates, mm/h	_____	4.4.3

Table 10F.8 — Form 10-2, Section C: Volumes

No.	Quantity	Required (m³)	Provided (m³)	Clause
C1	Retention volume (RRV)	_____	_____	4.4.2
C2	Water quality volume (WQv)	_____	_____	8.4.2
C3	Retention credit against detention	_____	—	4.4.6
C4	Detention volume	_____	_____	4.6, 4.14
C5	Fee-in-lieu or regional volume, and fee (₹)	_____	_____	4.5.6.3, 4.13.3

Table 10F.9 — Form 10-2, Section D: Release rates (each outfall)

AEP	Q_pre or cap (L/s)	Q_post (L/s)	Governing duration (h)	Meets criterion (yes / no)	Clause
50% (2-yr)	_____	_____	_____	_____	4.5
10% (10-yr)	_____	_____	_____	_____	4.5

AEP	Q_pre or cap (L/s)	Q_post (L/s)	Governing duration (h)	Meets criterion (yes / no)	Clause
1% (100-yr)	_____	_____	_____	_____	4.5

Table 10F.10 — Form 10-2, Section E: Outlets, drawdown and stage comparison

No.	Field	Entry	Clause
E1	Low-flow orifice, mm (minimum 50 mm)	_____	4.8.2
E2	Detention: time to release 90% of the 10-yr stored volume, h (≤ 48 h)	_____	4.7.1
E3	WQv release time, h (24–48 h)	_____	4.7.2
E4	Retention emptying time, h (≤ 72 h)	_____	4.7.3
E5	Model result differs from the calculator screen by more than the guide tolerance? If yes, report section that explains it	_____	10.5.2(c)
E6	Stage 4 only: changes from the Stage 2 values (list), and whether every criterion is still met	_____	10.9.2
E7	Prepared by (name, registration number), signature, date	_____	10.6.3(b)

Form 10-3 — Professional Design Certificate

Supports Clauses 10.6.1 to 10.6.5 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Signed by the designer with every Stage 1 and Stage 2 submittal, and by an independent checker for facilities under Clause 10.6.1(c) and (d).

Table 10F.11 — Form 10-3, Section A: Project and signatory

No.	Field	Entry	Clause
A1	Authority, file number, stage	_____	—
A2	Site and facilities covered by this certificate	_____	—
A3	Designer: name, qualification, UBBL-2021 registration number	_____	10.6.1
A4	Empanelment number, where required, and the reason: Tier A ≥ 1 ha / flood-sensitive / embankment or high-hazard basin / pumped, tide gate or regional facility	_____	10.6.1(a)–(d)
A5	Variances or waivers approved (Form 1-2 references), or "none"	_____	10.6.3(a)

Table 10F.12 — Form 10-3, Section B: Certificate of the designer

No.	I certify that:	Initials
B1	the design complies with the Jammu and Kashmir Stormwater Design Manual, except for the variances listed at A5, which have been approved	_____
B2	the rainfall, soils and tailwater inputs are as recorded on Form 2-1 and Form 10-2	_____
B3	the models submitted reproduce the results reported	_____
B4	I understand that a false or negligent certificate is a contravention under Clause 10.15	_____

Table 10F.13 — Form 10-3, Section C: Certificate of the independent checker (Clause 10.6.4)

No.	Field or statement	Entry
C1	Checker: name, registration and empanelment number	_____
C2	I am independent of the designer and the Applicant and have not worked on this design	_____
C3	I have checked the facilities listed: _____, and agree with the certificate in Section B	_____
C4	Matters on which I do not agree, if any	_____

Table 10F.14 — Form 10-3, Section D: Signatures

Role	Name	Signature	Date
Designer	_____	_____	_____
Independent checker (where required)	_____	_____	_____

Form 10-4 — Hold-Point Inspection Record

Supports Clauses 10.4.2(g), 10.8 and 10.9.3 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Section A is the hold-point schedule, approved at Stage 2. Section B is completed at each hold point, with dated, geotagged photographs (Clause 10.8.2). Work shall not proceed past a hold point until Section B is signed. See Figure 10.2.

Table 10F.15 — Form 10-4, Section A: Hold-point schedule

Hold point	Facility (FAC_ID)	Stage of work	Planned date	Notice to Authority sent (date)*	Authority attended (yes / no)
(a) Excavated base, before media, liner or structure	_____	_____	_____	_____	_____
(b) Outlet structure, orifice and trash screen, before backfill or first filling	_____	_____	_____	_____	_____
(c) Infiltration and verification tests (Clause 10.9.3)	_____	_____	_____	–	_____
(d) Outfall, flap or tide gate and non-return valve, before downstream connection	_____	_____	_____	–	_____
(e) Pumps and controls, at commissioning	_____	_____	_____	–	_____
Other hold points added by the Authority	_____	_____	_____	_____	_____

* For sites under Clause 10.6.1, at least 3 working days' notice of hold points (a) and (b) (Clause 10.8.2).

Table 10F.16 — Form 10-4, Section B: Inspection record (one per hold point)

No.	Field	Entry
B1	Hold point and facility	_____
B2	Date and time of inspection; weather	_____
B3	Inspected by (certifying professional); others present	_____
B4	Approved drawing and revision checked against	_____
B5	Levels, dimensions and materials found, against approved values	_____
B6	For (a): retention and infiltration areas protected from traffic and stockpiles (Clause 10.8.3(a))	_____
B7	For (b): orifice size and invert; screen in place	_____
B8	For (c): infiltration test result and emptying time (≤ 72 h); pump duty point; gate opening and sealing	_____
B9	For (d) and (e): gate type, seating and test; pump commissioning record	_____
B10	Photograph references (dated, geotagged)	_____
B11	Result: released / not released; corrective work required	_____
B12	Corrective work checked (date, by)	_____
B13	Signature of the certifying professional, date	_____

Form 10-5 — As-built Certificate

Supports Clauses 10.9 and 10.3.5 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Lodged before the completion certificate. The Authority shall not issue the completion certificate until this form is accepted (Clause 10.9.4).

Table 10F.17 — Form 10-5, Section A: Project and survey

No.	Field	Entry	Clause
A1	Authority, file number; Stage 2 approval reference and date	_____	—
A2	Licensed surveyor: name, licence number, date of survey	_____	10.9.1(a)
A3	Vertical datum	_____	10.4.4(d)
A4	GIS data to Annex 10B, as built (file name)	_____	10.4.4(c)

Table 10F.18 — Form 10-5, Section B: Approved against as built (one block per facility)

Item	Approved	As built	Accepted (yes / no)	Clause
Storage volume at each design level, m³	_____	_____	_____	10.9.2(a)
Outlet dimensions (orifice, weir), mm	_____	_____	_____	10.9.2(b)
Outlet and outfall inverts, m	_____	_____	_____	10.9.2(b)
Spillway or overflow level, m	_____	_____	_____	4.9
Retention volume, m³	_____	_____	_____	4.4

Table 10F.19 — Form 10-5, Section C: Re-run and tests

No.	Field	Entry	Clause
C1	Compliance calculator re-run with as-built values: version, and Form 10-2 (Stage 4) attached	_____	10.9.1(b)
C2	Model re-run with as-built values (where a model was used): file name	_____	10.9.1(b)
C3	Every criterion of Chapters 4 and 5 met on re-run (yes / no; list any not met)	_____	10.9.2(c)
C4	Infiltration retention: measured emptying time, h (≤ 72 h)	_____	10.9.3
C5	Pumps: duty point achieved (flow at head)	_____	10.9.3
C6	Tide gates and non-return valves: shown to open and seal	_____	10.9.3
C7	Deviations, and how corrected or re-certified under Clause 10.3.5	_____	10.9.2

Table 10F.20 — Form 10-5, Section D: Attachments and certificate

No.	Field	Entry
D1	Completed hold-point records (Form 10-4)	_____
D2	Final O&M plan	_____
D3	Executed Maintenance Declaration (Form 10-6) or handover documents (Form 10-8)	_____

No.	Field	Entry
D4	I certify that the facilities listed were built as approved, except as stated at C7, and perform as designed. Certifying professional: name, registration number, signature, date	_____
D5	For the Authority: accepted / returned; officer, date	_____

Form 10-6 — Maintenance Declaration

Supports Clauses 10.10.1, 10.10.2, 10.10.4 and 10.13.1 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Model text for consideration by a competent authority. Not in force. Executed by the owner of every private stormwater facility before the completion certificate is issued, and registered so that it runs with the land.

> **Drafting note D10A.1.** The instrument under which this declaration is registered, and the Act that gives the Authority its right of entry and its power to carry out works in default, are to be confirmed by the competent authority. This form does not cite statute sections.

Table 10F.21 — Form 10-6, Section A: Parties and land

No.	Field	Entry
A1	Owner (the declarant): name and address; for a company or association, its registration number	_____
A2	Authority	_____
A3	Land: survey numbers, village, tehsil, district; extent	_____
A4	Approval reference (file number, Stage 2 approval date)	_____
A5	For multi-owner developments: the association or body that takes over after the developer (Clause 10.10.2)	_____

Table 10F.22 — Form 10-6, Section B: Schedule of facilities

Facility (FAC_ID)	Type	Location on the attached plan	Design volume (m³)	Outlet	O&M plan reference
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Model declaration. I/We, the owner named in Section A, declare and undertake, for myself/ourselves and for every successor in title to the land:

1. to operate, inspect and maintain each facility in Section B under the approved O&M plan, and to make the inspections of Clause 10.12 (Clause 10.10.1(b));
2. to give the Authority, its officers and its contractors a right of entry to inspect each facility and the access route shown on the plan, and to carry out works in default under Clause 10.15, with the cost recoverable from the owner (Clause 10.10.1(c));
3. not to remove, fill, cover, reduce or change the use of any facility, or obstruct its access route, without the Authority's written approval (Clauses 10.10.1(d), 10.13.5);
4. where Clause 10.10.3 applies, to lodge an Annual Maintenance Declaration and Inspection Report (Form 10-7) by 31 May each year;
5. for underground tanks, to follow the confined-space entry procedure stated here: _____ (Clause 4.15.6);
6. on sale or transfer of the land or any part of it, to disclose this declaration and the latest Form 10-7 to the purchaser, who takes on these obligations from the date of transfer (Clause 10.10.4); and
7. for a multi-owner development, that the developer remains responsible until the body named at A5 is legally constituted and has accepted this declaration in writing (Clause 10.10.2).

Table 10F.23 — Form 10-6, Section C: Execution and registration

Field	Entry
Owner: signature, name, date	_____
Witness 1: signature, name, address	_____
Witness 2: signature, name, address	_____
Acceptance by the association or body at A5 (when constituted): signature, date	_____
Registration: office, document number, date	_____
For the Authority: received and recorded in the facility register; officer, date	_____

Form 10-7 — Annual Maintenance Declaration and Inspection Report

Supports Clauses 10.10.3, 10.11.1(d) and 10.12 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Due by **31 May** each year from every owner of a facility in a Tier A area, and from every owner of a pumped facility, tide gate or regional facility anywhere (Clause 10.10.3). See Figure 10.3.

Table 10F.24 — Form 10-7, Section A: Owner and facilities

No.	Field	Entry
A1	Reporting year (1 June to 31 May)	_____
A2	Owner or association; Maintenance Declaration registration reference	_____
A3	Facilities covered (FAC_ID and type)	_____
A4	Any facility under Clause 10.6.1(c) or (d) (yes / no). If yes, Section E is required	_____

Table 10F.25 — Form 10-7, Section B: Inspections made during the year (Table 10.3)

Facility	Routine inspections (dates)	Pre-monsoon inspection (date)	After heavy-rainfall events (dates)	Monthly pump test runs (number)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Table 10F.26 — Form 10-7, Section C: Pre-monsoon checklist (one per facility)

No.	Item	Condition (OK / defect)	Defect and date corrected
C1	Inlets, pretreatment and silt traps clear	_____	_____
C2	Orifice, trash screen and outlet clear; orifice size unchanged	_____	_____
C3	Sediment below the trigger in the O&M plan	_____	_____
C4	Storage volume not reduced; no filling, covering or change of use	_____	_____
C5	Overflow and spillway route clear	_____	_____
C6	Retention drains within 72 h (observation well or surface)	_____	_____
C7	Pumps: full duty test; standby pump and standby power tested; fuel for 72 h on site	_____	_____
C8	Alarms and telemetry tested	_____	_____
C9	Flap or tide gates and non-return valves: operated and seal tested	_____	_____
C10	Safety: covers locked, fences, signs and depth markers in place	_____	_____
C11	Access routes clear and not used for parking	_____	_____

Table 10F.27 — Form 10-7, Section D: Declaration of the owner

Field	Entry
I/We declare that the pre-monsoon inspection of Clause 10.12 has been made, that the defects found have been corrected as listed in Section C, and that the facilities are maintained under the approved O&M plan. Owner: name, signature, date	_____

Table 10F.28 — Form 10-7, Section E: Empanelled professional (facilities under Clause 10.6.1(c) and (d))

Field	Entry
I have inspected the facilities listed and confirm Section C. Name, empanelment number, signature, date	_____

Table 10F.29 — Form 10-7, Section F: For the Authority

Field	Entry
Date received; on time (by 31 May) yes / no	_____
Entered in the facility register (Clause 10.17), date	_____
Follow-up action, if any (Clause 10.15)	_____

Form 10-8 — Asset Handover Certificate

Supports Clause 10.14 of Chapter 10.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Signed by the developer and the ULB when drains, open space facilities, regional facilities or other stormwater assets built by a developer are handed over.

Table 10F.30 — Form 10-8, Section A: Asset and parties

No.	Field	Entry
A1	Developer: name and address	_____
A2	ULB	_____
A3	Layout or project, approval reference	_____
A4	Assets handed over (FAC_ID, type, length or volume), with a plan	_____

Table 10F.31 — Form 10-8, Section B: Conditions of handover (Clause 10.14.1)

No.	Condition	Met (yes / no)	Reference or date
B1	As-built certificate (Form 10-5) accepted	_____	_____
B2	Facility cleaned; pipes and culverts inspected internally (CCTV or manual entry), record handed over	_____	_____
B3	Land, or an easement over it, transferred to the ULB	_____	_____
B4	O&M plan, drawings, GIS data (Annex 10B) and warranties handed over	_____	_____

Table 10F.32 — Form 10-8, Section C: Defects liability and register

No.	Field	Entry	Clause
C1	Defects liability period: from _____ to _____ (includes at least one full monsoon season, from 15 June to 31 October, after handover)	_____	10.14.2
C2	Developer responsible during the period for defects and routine maintenance	_____	10.14.2
C3	Security deposit held by the ULB, ₹, and release date	_____	10.14.2
C4	Entered in the ULB GIS drainage asset register and the facility register: date	_____	10.14.3

Table 10F.33 — Form 10-8, Section D: Signatures

Party	Name and designation	Signature	Date
Developer	_____	_____	_____
Certifying professional	_____	_____	_____
ULB	_____	_____	_____

ANNEXES TO CHAPTER 11

Basin and City Stormwater Master Plans

These annexes support Chapter 11. They give a terms of reference template for a Basin Stormwater Master Plan (BSMP), the layout of the basin list and boundary layer, the layout and method for depth–damage curves, the standard for publishing BSMP data and models, and the annual implementation report form. Annexes 11B and 11C need data that are not yet available; they say so and give the rule to use in the meantime. The template and the form are a model and a draft form for consideration by a competent authority, and are not in force.

Annex 11A — BSMP terms of reference template

Supports Clauses 11.1 to 11.12 of Chapter 11.

> *Model text for consideration by a competent authority. Not in force.* The Lead Authority adapts this template for each basin. Items in "[ ]" are for the Lead Authority to complete. Clause references are to this Manual, which the consultant shall follow in full.

11A.1 Background and purpose

1. The [Lead Authority] intends to prepare a Basin Stormwater Master Plan for the [name] basin under Chapter 11 of the Jammu and Kashmir Stormwater Design Manual.
2. The BSMP shall (Clause 11.1.2):
    - (a) map flood hazard for the basin under existing and future conditions;
    - (b) set the level of service for each part of the drainage system;
    - (c) identify, cost and rank the works, storage and land needed to reach that level of service;
    - (d) identify land to be reserved in the statutory land-use plan for regional storage, talab and tank restoration and major flow paths;
    - (e) set the basin inputs for site design: regional facilities, the fee-in-lieu unit rate, and any basin release rate stricter than Chapter 4; and
    - (f) recommend catchments for notification as flood-sensitive.
3. The BSMP may make the site criteria of Chapters 4 to 8 stricter for the basin. It shall not relax them, except through the regional detention and fee-in-lieu routes of Clauses 4.13 and 4.5.6 (Clause 11.1.3).

11A.2 Client, partners and study area

1. **Client:** [Lead Authority] (Clause 11.4.1).
2. **Partners:** I&FC, wherever the basin includes a river, canal or tank under its control, and [other local bodies, a Development Authority or H&UDD, J&K SDMA] (Clause 11.4.1).
3. **Study area:** the whole of the [name] basin, draining to [outfall], as delineated under Clause 11.3, including the parts outside the client's limits (Clause 11.3.1). The provisional boundary is in [Annex 11B / attached map]. The consultant shall confirm it in Task 2.

4. **Links to other basins:** [for example the receiving river, khad, nallah, lake, nambal, flood spill channel or canal corridor]. Diversions between basins by canal, drain or surplus course shall be mapped and represented in the model (Clause 11.3.2).

11A.3 Team

1. The study shall be led by an engineer empanelled as a Stormwater Design Professional with the basin modelling endorsement of Annex 10E (Clause 11.4.3).
2. The team shall include at least: [a hydrologist; a hydraulic modeller; a coastal or tidal specialist where the basin has a tidal outfall; a GIS and survey lead; a planner; a cost engineer; a community engagement lead]. The client sets the minimum qualifications and experience of each.

11A.4 Tasks

Task 1 — Inception. Review existing studies, data and projects in the basin. Prepare a data inventory against Table 11.1, a gap list, a survey plan, a consultation plan, and the work programme. Deliver the inception report.

Task 2 — Data and surveys. Assemble, survey where missing, and quality-check every item of Table 11.1 (Clause 11.5.1):

- (a) terrain: DEM from LiDAR or photogrammetry with vertical accuracy of 0.15 m RMSE or better in urban areas, tied to the Survey of India datum, with the accuracy test reported;
- (b) drain network: every public drain, culvert and outfall, with invert levels, sizes, condition and silt depth; private drains above 600 mm;
- (c) waterbodies: every tank, talab, pond and marsh under Chapter 7: FTL, MWL, bund level, stage–storage, sluices, surplus weirs, supply channels and encroachment, in the fields of Annex 7A;
- (d) rivers and canals: cross-sections at no more than 200 m spacing and at every structure;
- (e) outfalls, rivers, khads, lakes and reservoirs: outfall invert levels, on a named datum, against the danger and high flood levels of the receiving river at the nearest CWC site (on the Jhelum, Khanabal, Sangam, Ram Munshi Bagh or Safapora; on the Tawi, Sidhra; on the Chenab, Akhnoor) and its recorded peaks, with the I&FC readings in feet kept as a separate series and any conflict between published values stated; the stage at which each gravity outfall closes, and the duty points, sump levels and standby power of each pumping station; for ungauged rivers, khads and nallahs, surveyed flood marks and the 1% AEP level with its sediment and debris; for outfalls to lakes, nambals and reservoirs, outlet levels, gate rules, maximum water level, full reservoir level and spillway data from LCMA, WUCMA, I&FC or the dam operator; the release records of the dams and barrages that set the receiving levels; the debris-flow fans, landslide and subsidence zones and glacial lakes above the basin; and flap gates, penstocks, debris racks, sediment traps and pumping stations on the outfalls, with their capacities and operating rules;
- (f) rainfall and water levels: all available records (IMD, including its observatories and stations at Srinagar, Jammu and Jammu Airport, Udhampur IAF, Katra, Qazigund, Banihal, Batote, Bhaderwah, Kokernag, Pahalgam, Gulmarg and Kupwara, the automatic weather stations reported by the Meteorological Centre Srinagar, among them Kawa (Udhampur), Rambagh and Srinagar, and its gauges at Kathua, Samba, Rajouri, Poonch, Anantnag, Baramulla, Doda and Kishtwar; the self-recording gauges at Srinagar and Gulmarg used for the CWC Flood Estimation Report for zone 7; the river gauges of CWC and the staff gauges of I&FC; the rain and reservoir records of JKSPDC at Baglihar and of NHPC at Salal and Dul Hasti; and any gauges kept by SMC, JMC, the Smart City companies, J&K SDMA and the Jal Shakti Department), including the 3–10 September 2014 (599.8 mm at Qazigund in the four days to 6 September and 698.6 mm at Katra in 72 hours, Ray et al., 2015; the Jhelum at Ram Munshi Bagh at its high flood level on 8 September, 1,588.99 m or 1,589.65 m in CWC's lists of 2022 and 2018, as transcribed by SANDRP; 262 km², 34% of the Srinagar planning area, flooded), 26–27 August 2025 (380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30 IST on 27 August, IMD, with the Tawi at Sidhra at a new high flood level of 321.1 m, as reported), 1 August 2019 (Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar waterlogged after 26.4 mm, as reported), 7–10 September 1992 (the

Chenab at Akhnoor at its high flood level of 324.29 m on 10 September, CWC as transcribed by SANDRP, and 61 ft on the I&FC gauge, as reported) and 25 September 1988 (316.2 mm at Batote, 292.4 mm at Katra and 270.4 mm at Jammu, IMD) events;

- (g) flood evidence: surveyed flood marks and mapped extents of past events, including public reports, photographs and residents' records;
- (h) land use: existing land use and imperviousness; future land use from the statutory master plan;
- (i) soils and groundwater: HSG map (Annex 3A or Clause 3.7.2), seasonal high groundwater, aquifer and recharge zones; and
- (j) sewer interaction: known cross-connections, dry-weather flow in drains, solid-waste hotspots.

Confirm the basin boundary and the inter-basin diversions (Clause 11.3.2). Deliver the data report and the data in the formats of Annex 11D.

Task 3 — Model build. Build a coupled 1D–2D hydraulic model of the minor system, the major (overland) system, rivers, canals and tanks, and the outfalls (Clause 11.7.1; Figure 11.2). Use the methods of Chapter 3 and the tidal and river boundaries of Chapter 5. Run the design storms of Chapter 2, including the 24-, 48- and 72-hour storms, for at least the 50%, 10%, 1% and 0.2% AEPs, with areal reduction under Clause 2.7.3 (Clause 11.7.2). Where the basin has tank cascades, run continuous simulation under Clause 3.13 with the full IMD gridded daily record where available, and at least 30 years, disaggregated by the temporal patterns of Annex 2D. The two-step approach of Clause 3.13.5 may be used: starting tank levels and antecedent conditions from the continuous run are passed to the design-storm runs (Clause 11.7.3).

Task 4 — Calibration and validation. Calibrate and validate the model under Clause 3.15, using at least two of the 3–10 September 2014 (599.8 mm at Qazigund in the four days to 6 September and 698.6 mm at Katra in 72 hours, Ray et al., 2015; the Jhelum at Ram Munshi Bagh at its high flood level on 8 September, 1,588.99 m or 1,589.65 m in CWC's lists of 2022 and 2018, as transcribed by SANDRP; 262 km², 34% of the Srinagar planning area, flooded), 26–27 August 2025 (380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30 IST on 27 August, IMD, with the Tawi at Sidhra at a new high flood level of 321.1 m, as reported), 1 August 2019 (Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar waterlogged after 26.4 mm, as reported), 7–10 September 1992 (the Chenab at Akhnoor at its high flood level of 324.29 m on 10 September, CWC as transcribed by SANDRP, and 61 ft on the I&FC gauge, as reported) and 25 September 1988 (316.2 mm at Batote, 292.4 mm at Katra and 270.4 mm at Jammu, IMD) events where data exist (Clause 11.7.5). Report the performance measures of Clause 3.15.4 and the reasonableness check of Clause 3.15.6.

Task 5 — Scenarios and hazard maps. Model the scenarios of Clause 11.7.4: (a) existing; (b) future, uncontrolled; (c) future, controlled; (d) future, with plan; and (e) climate, applied to (a) and (d). Produce flood hazard maps of extent, depth, velocity and hazard class (H1–H6, Chapter 6) for the 10%, 1% and 0.2% AEPs, existing and future-with-plan (Clause 11.8.4(a)).

Task 6 — Level-of-service assessment. Compare scenarios (a), (c) and (d) with the levels of service of Table 11.2 and any stricter levels the client adopts (Clause 11.6.1). Map every shortfall.

Task 7 — Options. Develop options in the order of Clause 11.8.1: protect and restore storage; regional retention and detention, sited by modelling; conveyance; outfall works; property-level protection; non-structural measures. Assess each option for the criteria of Clause 11.8.2: reduction in flood risk (buildings and people flooded, and expected annual damage using Annex 11C); capital and 30-year maintenance cost; land required; effect on groundwater recharge on the Kandi fans of Jammu, Samba and Kathua, the preferred recharge zone, from whose groundwater Jammu is supplied (the three districts were Safe in every assessment from 2017 to 2024, CGWB), the waterlogging of the Sirowal and of the Kashmir valley floor, where the water table stands 0–2 m below the ground and wells flow on both sides of the Jhelum, so that recharge there adds to flooding (in Srinagar "there is no scope for artificial recharge", CGWB), the stability of hill slopes, where water put into the ground raises the pore pressure, as at Pernote in 2024 and Thathri in 2023, the springs that feed the lakes and towns and the ponds of the Kandi, the zamindari khuls that carry hill runoff,

and the quality of the groundwater, in which nitrate exceeded 45 mg/L in 9.2% of the samples of 2024 (CGWB), and of the lakes, nambals and rivers that the runoff reaches; effect on downstream basins and the receiving river, khad, nallah, lake, nambal, flood spill channel or canal; and who benefits.

Task 8 — Basin inputs for site design. Where scenario (c) does not meet the level of service, propose basin release rates (m³/s/ha) by AEP and sub-catchment (Clause 11.8.3). Recommend catchments for notification as flood-sensitive, with the evidence of Clause 4.5.4.1. Identify regional facility sites, with storage volumes, land needs and the sites they serve, and compute the fee-in-lieu unit rate, including land, construction and 10 years of maintenance (Clauses 4.13.3, 11.8.4(c), (d)).

Task 9 — Capital Improvement Programme. Rank the works by risk reduction per rupee, with cost, phasing and responsible agency (Clause 11.8.4(e)).

Task 10 — Maintenance and monitoring. Prepare the pre-monsoon maintenance programme: desilting, gate and pump testing, and tank operating rules (Clause 11.8.4(f); Chapters 7 and 10). Specify monitoring needs: new rain gauges, level sensors and flood-mark survey points (Clause 11.8.4(g); Clause 10.16.1).

Task 11 — Land-use integration. Prepare the material for the statutory land-use plan required by Clause 11.9.1: sites to be reserved; the 1% AEP hazard map with the Chapter 7 setbacks; land in hazard classes H5–H6 in the 1% AEP event; and open space locations that can form part of flow paths or regional storage.

Task 12 — Consultation. Publish the draft BSMP for public comment for at least 60 days, with public meetings in each affected local body (Clause 11.10.1). Keep a log of comments and responses.

Task 13 — Final BSMP and publication. Revise the BSMP after consultation. Prepare the package for approval by the State Stormwater Technical Committee, including the model for review (Clause 11.11.1). Publish the data, models, maps and CIP under Annex 11D (Clause 11.10.2).

11A.5 Deliverables

Table 11A.1 — Deliverables

No.	Deliverable	Task	Due (months from start)
D1	Inception report, data inventory and survey plan	1	[ ]
D2	Data report and data sets (Annex 11D)	2	[ ]
D3	Model build report and model files	3	[ ]
D4	Calibration and validation report	4	[ ]
D5	Scenario results, hazard maps and level-of-service assessment	5, 6	[ ]
D6	Options report, with basin inputs for site design	7, 8	[ ]
D7	Draft BSMP with draft CIP, for consultation	9–12	[ ]
D8	Final BSMP, consultation log, approval package and open-data release	13	[ ]

11A.6 Ownership and publication

All data, models, maps and reports produced under these terms are owned by the Lead Authority and shall be published under Annex 11D. The consultant shall not use any software licence, data licence or format that prevents publication, or that prevents a third party from re-running the model with the stated software version.

Annex 11B — Basin lists and boundaries for Tier A bodies

Supports Clauses 11.3 and 11.4 of Chapter 11.

To be prepared. This annex will contain the list of basins for every Tier A body, with a GIS layer of basin boundaries delineated under Clause 11.3.2. It needs the list of Tier A bodies (Annex 1A), a DEM of the accuracy of Clause 11.5.1, flown again over the valley floor, the Kandi fans and the khad terraces after any large flood, the drain network of every drain-owning body (UEED, the Town Drainage wings of SMC and of the Directorate of Urban Local Bodies Kashmir, JMC, the Municipal Councils and Committees, the Smart City companies, SDA, JDA, PW (R&B) and NHAI), the dewatering stations of Srinagar and the other embanked towns with their duty points, sump levels and the river stages at which their gates shut, the rivers, nallahs, khads, embankments, flood spill channel, city channels and khuls of I&FC with their works, the lakes, nambals and talabs with their outlets and gate rules (LCMA, WUCMA, the Wildlife Department), the reservoirs of JKSPDC, NHPC and the other operators with their levels, spillways, gates and operating rules on a stated datum, the records of the CWC gauges and of the I&FC feet gauges with their zeros, the land recorded as Gair Mumkin Khad set against the functional khads, the springs and the ponds of the Kandi, the subsidence and sliding zones (Pernote, Duksar, Thathri) and the landslide, cloudburst, debris-flow and glacial-lake hazards mapped by J&K SDMA (other likely sources: Survey of India, CWC, CGWB, the Geological Survey of India, NIH and the district land records). No basin map of any town in Jammu and Kashmir was found. Until the annex is published, the basins of Srinagar (the Dal catchment and Telbal, the city behind the Jhelum embankments, the flood-basin chain, the Doodhganga and the Sindh–Anchar), Anantnag–Bijbehara–Pampore, Sopore–Baramulla–Sumbal–Bandipora, Jammu (the Tawi, the Devak, the Basantar and the Balol, Thather and Bhalwal khads), Kathua–Hiranagar and Samba, R.S. Pura–Bishnah–Arnia, Akhnoor, Udhampur and Katra, and the hill towns of the Chenab valley named in Clause 11.3.3 are at least those named there; other bodies define their basins in their first BSMP (Clause 11.3.3); in sub-area JK-D the hazard screening of Clause 11.3.3 comes first; and the interim arrangements of Clause 11.12 apply in every basin without an approved BSMP.

Table 11B.1 — Basins named in Clause 11.3.3 (provisional)

Tier A body or area	Basin	Note from Chapter 11
Srinagar (SMC, UEED, SDA; LCMA)	Catchments draining to Dal and Nigeen, including the Telbal Nallah	Dal Gate and Nallah Amir Khan as controlled outlets; lake at its gate-shut level as boundary [TBC]; Telbal and Lal Bazar sewage inflows shown
Srinagar (SMC, UEED, SDA)	The three drainage zones behind the Jhelum embankments	Every scheme, gravity outfall and dewatering station modelled; Jhelum at Ram Munshi Bagh as boundary (Clause 5.8.5(a)); outfall-closed case a design case
Srinagar (SMC, SDA; I&FC, Wildlife Department)	Catchments draining to the flood spill channel and the flood-basin chain, the Doodhganga and the Sindh–Anchar	Hokersar, Narkara, Shallabugh, Rakh-e-Arth and Anchar as storage; Lelhar–Lasjan floodplain mapped (proposed, not notified)
Anantnag–Bijbehara–Pampore	Catchments of the towns and of the Jhelum tributaries of the master plan's watershed list	Jhelum at Khanabal and Sangam as boundary
Sopore–Baramulla–Sumbal–Bandipora	Catchments draining to the lower Jhelum and Wular	Safapora and the Wular level as boundary; Ningli outlet a control
Jammu (JMC, UEED, JDA)	Catchments draining to the Tawi, the Devak and the Basantar and through the Balol, Thather and Bhalwal khads	Gair Mumkin Khad land mapped against the functional khad; Tawi at Sidhra and the Tawi barrage [TBC] as boundary
Kathua–Hiranagar and Samba	Catchments draining to the Ujh, the Ravi and the Basantar	Ranjit Sagar level as the Ravi boundary; flood marks elsewhere

Tier A body or area	Basin	Note from Chapter 11
R.S. Pura–Bishnah–Arnia	Sirowal catchments	Waterlogged, flat; level beyond the border unknown, flood-mark profile as boundary
Akhnoor	Catchments of the town on the Chenab	Akhnoor high flood level and Salal releases as boundary
Udhampur and Katra	Catchments on the Tawi and the Devak, and the nallahs of Katra	Debris racks and basins at the foot of the hills; 1% AEP level with debris as boundary
Hill towns of the Chenab valley (Ramban–Batote–Banihal, Doda–Thathri–Kishtwar)	Catchments of each town and of each nallah crossing it	Pernote, Duksar and Thathri zones mapped; flood marks as boundary; dam levels and releases where they set the river
Other bodies, and sub-area JK-D	To be defined in the first BSMP	Clause 11.3.3; in JK-D, hazard screening first

Table 11B.2 — Attributes of the basin boundary layer (layout)

Field	Type	Content
BASIN_ID	Text	Basin identifier
NAME_EN, NAME_UR	Text	Basin name in English and Urdu
TIER_A	Text	Tier A body or bodies in the basin
OUTFALL	Text	Outfall to the sea, river or major waterbody (Clause 11.2)
AREA_KM2	Real	Basin area, km²
LEAD_AUTH	Text	Lead Authority (Clause 11.4.1)
PARTNERS	Text	Partners, including I&FC where it applies
LINKS	Text	Diversions to and from other basins (Clause 11.3.2)
BSMP_STAT	Text	None / in preparation / draft published / approved
BSMP_DATE	Date	Date of approval of the current BSMP
REVIEW_DUE	Date	Date of the next review (Clause 11.11.2)

Annex 11C — Depth–damage curves for Jammu and Kashmir building types

Supports Clause 11.8.2 of Chapter 11.

To be prepared. This annex will contain depth–damage curves for the main building types of Srinagar, Jammu and the other cities and towns of Jammu and Kashmir, for structure and contents, for use in computing expected annual damage under Clause 11.8.2. It needs a building-type classification and building stock data (Census housing tables, property-tax records, Lead Authority GIS), damage surveys and claims from the 3–10 September 2014 (599.8 mm at Qazigund in the four days to 6 September and 698.6 mm at Katra in 72 hours, Ray et al., 2015; the Jhelum at Ram Munshi Bagh at its high flood level on 8 September, 1,588.99 m or 1,589.65 m in CWC's lists of 2022 and 2018, as transcribed by SANDRP; 262 km², 34% of the Srinagar planning area, flooded), 26–27 August 2025 (380 mm at Jammu and 630 mm at Udhampur IAF in the 24 hours to 08:30 IST on 27 August, IMD, with the Tawi at Sidhra at a new high flood level of 321.1 m, as reported), 1 August 2019 (Lal Chowk, Budshah Chowk, Residence Road, M A Road and the Exhibition Grounds in Srinagar waterlogged after 26.4 mm, as reported), 7–10 September 1992 (the Chenab at Akhnoor at its high flood level of 324.29 m on 10 September, CWC as transcribed by SANDRP, and 61 ft on the I&FC gauge, as reported) and 25 September 1988 (316.2 mm at Batote, 292.4 mm at Katra and 270.4 mm at Jammu, IMD) floods (Revenue Department and J&K SDMA damage assessments, insurers), and replacement costs (Public Works (R&B) Department schedules of rates). Until it is published, each BSMP shall state the depth–damage relations it uses and their source, and shall report the reduction in buildings and people flooded for every option (Clause 11.8.2), which does not depend on the curves.

Table 11C.1 — Depth–damage curve (layout, one table per building type)

Depth of water above floor level (m)	0	0.25	0.5	1.0	1.5	2.0	3.0
Structure damage (% of replacement cost)	_____	_____	_____	_____	_____	_____	_____
Contents damage (% of contents value)	_____	_____	_____	_____	_____	_____	_____
Building type, source and year of costs	_____						

11C.1 Use in option assessment

Expected annual damage (EAD) is computed for each scenario from the damages at the modelled AEPs. With damages D_1, D_2, … at annual exceedance probabilities P_1 > P_2 > …, using at least the 50%, 10%, 1% and 0.2% AEP results of Clause 11.7.2:

> $$EAD \approx \sum \tfrac{1}{2} \times (D_i + D_{(i+1)}) \times (P_i - P_{(i+1)})$$

The reduction in EAD between scenario (c) and scenario (d), or between options, is the risk-reduction benefit used to rank works per rupee (Clause 11.8.4(e)). The BSMP shall state how damages beyond the 0.2% AEP and below the 50% AEP were treated.

Annex 11D — BSMP data and model publication standard

Supports Clauses 11.5.1 and 11.10 of Chapter 11, and Clause 10.17 of Chapter 10.

11D.1 What is published, and when

Table 11D.1 — Items to be published

Item	Format	At draft (Clause 11.10.1)	At approval (Clause 11.10.2)
BSMP report, with the level-of-service assessment and options	Searchable PDF	Yes	Yes, final
Flood hazard maps: extent, depth, velocity, hazard class, for each AEP and scenario of Clause 11.8.4(a)	GeoTIFF rasters; extents also as GeoPackage polygons	Yes	Yes
Capital Improvement Programme	CSV and PDF	Draft	Yes
Basin release rates, recommended flood-sensitive catchments, regional facility sites, fee-in-lieu unit rate	GeoPackage and CSV	Yes	Yes
Data of Table 11.1 (terrain, drains, waterbodies, cross-sections, river, lake and reservoir levels, pumping stations, debris hazards and outfall structures, rainfall and levels, flood evidence, land use, soils and groundwater, sewer interaction)	GeoTIFF (terrain); GeoPackage (features); CSV (tables and time series)	Summary	Yes, except security-sensitive asset details
Model files: native, runnable, with all boundary-condition, rainfall and control files, the software name and version, and a run log	Native format, zipped	No	Yes
Calibration and validation report	Searchable PDF	Yes	Yes
Consultation log of comments and responses	PDF or CSV	—	Yes

11D.2 Formats and references

- (a) Raster data shall be GeoTIFF, preferably cloud-optimised, with the cell size stated. Vector data shall be GeoPackage. Tables and time series shall be CSV in UTF-8, with a header row and units in the column names.
- (b) Horizontal and vertical references shall be as in Annex 10B.1(b) and (c). The vertical datum and its relationship to the Chapter 5 river datums of the CWC gauges on the Jhelum, the Chenab, the Tawi and the Lidder, the zeros of the I&FC staff gauges read in feet (stated once I&FC publishes them, and never assumed), the lake and reservoir levels of LCMA, WUCMA, I&FC, JKSPDC, NHPC and the other operators, and the flood marks surveyed on ungauged khads and nallahs shall be stated in every data set that carries levels.
- (c) Times shall be in Indian Standard Time, written as ISO 8601 (yyyy-mm-ddThh:mm+05:30). Units shall be SI.
- (d) Hazard map files shall be named `<basin>_<scenario>_<AEP>_<variable>.tif`, where scenario is a to e of Clause 11.7.4, AEP is written as 50, 10, 1 or 0p2, and variable is depth, velocity, hazard or extent; for example `telbal_d_1_depth.tif`.
- (e) Waterbody data shall use the fields of Annex 7A. Facility and outfall data shall use the fields of Annex 10B.

11D.3 Metadata

Every published data set shall carry: title; description; Lead Authority; source and method; date of capture; accuracy (for the DEM, the measured vertical RMSE); horizontal and vertical reference; scenario and AEP, where relevant; BSMP version; licence; and a contact.

11D.4 Withholding and personal data

- (a) Security-sensitive details of critical assets may be withheld, with the reason recorded and published (Clauses 10.17.3, 11.10.2). The flood hazard maps and the model shall still be published; only the sensitive attributes are removed.
- (b) Personal data shall not be published (Clause 10.17.3). Flood evidence collected from residents shall be published without names or contact details unless the person consents.

11D.5 Licence, viewer and versions

- (a) Published data and models shall be released under the Government Open Data Licence – India or an equivalent open licence (Clause 10.17.4).
- (b) The hazard maps, regional facility sites and CIP shall also be shown on a public map viewer (Clause 11.10.2).
- (c) Each approved BSMP shall carry a version number and date. Superseded versions shall stay available, marked as superseded, so that designs approved under them can be checked.
- (d) The published model package shall allow a third party with the stated software version to reproduce the published results. Designers may use its boundary conditions for site designs in the basin (Clause 11.10, Commentary).

Form 11-1 — Annual implementation report

Supports Clause 11.11.3 of Chapter 11, with Clauses 4.5.6.3 and 4.13.4 of Chapter 4.

Draft form — Jammu and Kashmir Stormwater Design Manual, Draft v1.0. Published by the Lead Authority for each basin with an approved BSMP before each south-west monsoon, by **31 May** (Clause 11.11.3).

Table 11F.1 — Form 11-1, Section A: Basin and plan

No.	Field	Entry
A1	Basin; Lead Authority; partners	_____
A2	BSMP version and date of approval	_____
A3	Reporting year (1 June to 31 May)	_____
A4	Date of publication (by 31 May) and web address	_____

Table 11F.2 — Form 11-1, Section B: CIP progress

CIP rank	Work	Agency	Cost in CIP (₹)	Spent this year (₹)	Spent to date (₹)	Status	Expected completion
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____

Table 11F.3 — Form 11-1, Section C: Fee-in-lieu ledger (Clauses 4.5.6.3(c) and 4.13.4)

Regional facility or tank	Volume credited to sites (m³)	Volume delivered (m³)	Fees received (₹)	Fees spent (₹)	Fees held, with year received
_____	_____	_____	_____	_____	_____
Basin total: volume owed and delivered	_____	_____	_____	_____	_____

Table 11F.4 — Form 11-1, Section D: Maintenance completed (Clause 11.8.4(f))

No.	Item	Planned	Done	Date completed
D1	Desilting of drains and canals (length, km; volume, m³)	_____	_____	_____
D2	Tank and talab desilting and restoration (tanks, number; storage restored, m³)	_____	_____	_____
D3	Gate tests (number of gates)	_____	_____	_____
D4	Pump station duty tests (number of stations)	_____	_____	_____
D5	Tank operating rules reviewed with the custodian (number)	_____	_____	_____
D6	Monitoring added: rain gauges, level sensors, flood-mark points (Clause 11.8.4(g))	_____	_____	_____

Table 11F.5 — Form 11-1, Section E: Flooding against the levels of service

Event (dates)	Rainfall compared with the design depths (Clause 10.16.2(a))	Level-of-service element (Table 11.2)	Location	Met (yes / no)	Event report reference (Clause 10.16.2)
_____	_____	_____	_____	_____	_____

Table 11F.6 — Form 11-1, Section F: Review triggers and sign-off

No.	Field	Entry
F1	Event exceeding the 1% AEP design depth in the basin this year (yes / no). If yes, review due within 2 years (Clause 11.11.2)	_____
F2	Statutory land-use plan revised this year (yes / no) (Clause 11.11.2)	_____
F3	Next 10-year review due (date)	_____
F4	Officer of the Lead Authority: name, designation, signature, date	_____

SUPPLEMENT

Ladakh

Status. This Supplement is part of Draft v1.0 of the Manual. Neer prepared it as a proposal for applying the Manual in the Union Territory of Ladakh, which adjoins Jammu and Kashmir and was part of the former State of Jammu and Kashmir until 31 October 2019. Ladakh is a Union Territory without a legislature. It is administered by the President through an Administrator, the Lieutenant Governor, appointed under Article 239 of the Constitution, and its laws are regulations made by the President under Article 240 read with section 58(2) of the Jammu and Kashmir Reorganisation Act, 2019. The authority that could adopt this Supplement is therefore the Administration of the Union Territory of Ladakh. No law of the Union Territory of Jammu and Kashmir, and no body of its Government, has any part in that decision.

Not adopted. This Supplement has not been adopted, notified or endorsed by the Administration of the Union Territory of Ladakh, the Lieutenant Governor, the Ladakh Autonomous Hill Development Councils of Leh and Kargil or any new Council constituted for another district, the Municipal Committees of Leh and Kargil, the Deputy Commissioners, the Housing and Urban Development Department, the Irrigation and Flood Control Department, the Public Health Engineering (Jal Shakti) Department, the Rural Development and Panchayati Raj Department, the Ladakh Disaster Management Authority, the Ladakh Pollution Control Committee, the Wetland Authority of the Union Territory of Ladakh, or any other department or agency of the Administration, nor by the Government of the Union Territory of Jammu and Kashmir or any of its departments. Where it names a body, it describes the role that body would have if the Manual and this Supplement were adopted. It does not say the body has agreed to that role. Until the Administration adopts it, the Ladakh Building Bye-Laws, the building bye-laws for rural areas and the approval conditions in force in the Union Territory continue to apply.

S1.1 Scope

S1.1.1 This Supplement applies to the whole of the Union Territory of Ladakh, in its seven districts:

- (a) **Leh**, including the area of the **Municipal Committee, Leh**;
- (b) **Sham** (headquarters Khaltse), **Nubra** (Diskit) and **Changthang** (Nyoma), formed from Leh district;
- (c) **Kargil**, including the area of the **Municipal Committee, Kargil**; and
- (d) **Zanskar** (Padum) and **Drass** (Drass-Ranbirpura), formed from Kargil district.

It applies in the municipal areas of Leh and Kargil, in Halqa Panchayat areas, and to works of the departments of the Administration, subject to Clause S1.1.5 for works of Central agencies.

S1.1.2 **How this Supplement works.** In Ladakh, the chapters and annexes of the Manual apply as written, except as modified by Table S1.1 and Clauses S1.3 to S1.8. In particular:

- (a) where the Manual says "the State", it means the Union Territory of Ladakh; "the State Government" and "the Government" mean the Administration of the Union Territory of Ladakh, acting through the Lieutenant Governor as Administrator; this usage is one of convenience and does not change who holds any power;
- (b) where the Manual names a body, statute or rule of the Union Territory of Jammu and Kashmir, the Ladakh instrument or body of Table S1.1 or Table S1.2 is read in its place;

- (c) the instruments of the Union Territory of Jammu and Kashmir that the Manual names, among them UBBL-2021, the Srinagar and Jammu master plans and the orders of its departments, do not apply in Ladakh, and neither do the rainfall zones JK-Z1 to JK-Z4 and the hydrologic sub-areas JK-A to JK-D of Annex 2A, the rules the Manual sets for them, or its river levels, gauges and pumped outfalls; and
- (d) clause, table, annex and form numbers do not change.

S1.1.3 Values marked **[TBC]** are to be confirmed from the primary source before adoption. Until they are confirmed, the clause concerned states the rule that applies in the meantime.

S1.1.4 Clauses S1.3 (design rainfall), S1.4 (debris flows and outbursts) and S1.6 (groundwater) take precedence over any clause of the Manual that they contradict.

S1.1.5 **Central agencies and defence land.** Works of the Border Roads Organisation, the National Highways and Infrastructure Development Corporation (NHIDCL), the armed forces and other Central agencies are covered only as Clause 1.5.1(c) provides, to the extent that the Administration's approval or no-objection is required. The Ladakh Autonomous Hill Development Councils (Amendment) Regulation, 2026 protects land allotted to the Administration and to the Central Government, "including defence establishments", from the Councils' land powers (proviso to section 42(1)).

> **Commentary.** Ladakh is the series' first cold desert. Leh receives on average 15.4 mm of rain in August, its wettest month, and its highest 24-hour fall on record is 51.3 mm (IMD). Its towns stand on fans of loose sediment at the mouths of side valleys, beside the Indus, the Shyok, the Suru and the Zanskar. Their floods come from convective cloudbursts that the gauges miss, from the debris flows those bursts set off, and from outbursts of glacial and landslide-dammed lakes; they do not come from the long storms of the plains and the outer hills on which the design rainfall of Chapter 2 rests. Most of Leh drinks shallow groundwater from the same fans into which its soak pits drain. The ground is frozen for months. The nearest analogue in the series is the hazard-first sub-area of the high and trans-Himalaya in the Himachal Pradesh edition (Kinnaur, Lahaul and Spiti), where the zone-7 relations of the CWC Flood Estimation Report are not used for snow-fed catchments, design starts with an outburst and debris-flow screening, and no work is sized to carry a debris flow or an outburst. In Ladakh every settlement is in that position, and this Supplement makes that approach the rule for the whole Union Territory.
>
> The Lieutenant Governor approved the issue of the notification creating the five new districts on 27 April 2026 (Administration of Ladakh); the number of the notification was not found, and whether the districts are fully operational is **[TBC]**. The Ladakh Autonomous Hill Development Councils (Amendment) Regulation, 2026 (No. 16 of 2026, Gazette of India Extraordinary, Part II, Section 1, No. 441, 16 October 2026) defines "district" as the seven districts and gives each Council the "allotment, use and occupation of land vested in the Council" (section 23(1)(i)), "all the powers of the Panchayat at the district level" (section 23(2)), the development plan (section 32) and bye-laws made "with the approval of the Administration" (section 61). It comes into force on a date that the Administrator appoints by notification; that date, and whether Councils have been constituted for the five new districts, are **[TBC]**. Section 61A transfers land, staff and bye-laws from an existing Council to a new Council on the new Council's appointed day; until that day, this Supplement reads the Councils of Leh and Kargil as acting for the districts formed from them (NEER reading). Ladakh has no legislature, so no "Ladakh Act" is cited in this Supplement: its law is the law of the former State continued for it, as amended by the President's regulations, and the bye-laws and rules made under that law.

S1.2 How the Manual applies: clause-by-clause modifications

S1.2.1 The clauses of the Manual listed in Table S1.1 apply in Ladakh with the changes shown. Clauses not listed apply unchanged.

Table S1.1 — Modifications to the Manual for Ladakh

Manual clause	What changes in Ladakh
1.3.1 Notification	Statutory effect would be given (a) in the municipal areas of Leh and Kargil, by an amendment to the Ladakh Building Bye-Laws, 2025, made by the Administration under section 218 of the Jammu and Kashmir Municipal Act, 2000 with the publication required by section 219; and (b) in Halqa Panchayat areas, by an amendment to the building bye-laws for rural areas made under rule 155 of the Jammu and Kashmir Panchayati Raj Rules, 1996. The Councils could add bye-laws for their districts under section 61 of the Ladakh Autonomous Hill Development Councils Act, 1997, with the approval of the Administration, once the Regulation of 2026 is in force. The instruments of the Union Territory of Jammu and Kashmir do not apply.
Building rules ("UBBL-2021" throughout)	Read as (a) the **Ladakh Building Bye-Laws, 2025** within the notified municipal limits; the draft of 16 October 2025, which supersedes the Unified Ladakh Building Bye-Laws, 2024 (S.O. 123 of 04-11-2024), was read for this Supplement, and the final bye-laws are reported to have been notified as S.O. 121 on 20 February 2026 (as reported); their text was not read **[TBC]**, so the clause numbers in this Supplement are those of the draft; and (b) the **Ladakh Unified Building Bye-Laws Rural, 2025** in Halqa Panchayat areas, of which the draft of 9 October 2025 was read; whether they have been made final is **[TBC]**.
1.3.2 State Stormwater Technical Committee	The committee would be constituted by the Administrator, for example under the Housing and Urban Development Department, with the Irrigation and Flood Control Department, the Public Health Engineering (Jal Shakti) Department, the Ladakh Disaster Management Authority and the Councils of Leh and Kargil represented (set by this Supplement).
1.4.1 Approving Authority ("the Authority")	In the municipal areas, the **Municipal Committee, Leh** and the **Municipal Committee, Kargil**: under the 2025 draft "Municipal area" is the area of the Municipal Committee (cl. 3.87), and committees of municipal and other officials may be constituted (cl. 4.5). In Halqa Panchayat areas, the Competent Authority of cl. 6 of the rural bye-laws: for an individual house (Category I), a committee chaired by the Sarpanch with the Secretary Panchayat as Member Secretary, and for other buildings (Categories II and III), a committee chaired by the Sub-Divisional Magistrate with the Block Development Officer as Member Secretary. There is no Development Authority in Ladakh (as reported, July 2026). A department of the Administration is the Authority for its own works.
1.5.3 RWH	Chapter 9 of the 2025 draft, "Climate Change and Sustainable Measures in Cold Desert", provides for rainwater and snow-melt harvesting by the owner of a plot of more than 200 m² (cl. 9.1), prefers recharge for all buildings, including group housing on plots of more than 250 m² (cl. 9.1(i)), and sends the water of melting snow to the recharge system (cl. 9.1(iii)). In Ladakh these provisions are read with Clause S1.6: storage for use comes first, and only clean roof water is recharged.
1.5.4(b), 1.5.4(d) Provisions at every size	Apply, with Clause S1.4: no building, wall or fill in a debris-flow corridor or active fan channel, at any size.
1.6 Tiers	The Municipal Committees of Leh and Kargil, and the Competent Authorities of Halqa Panchayat areas, are **Tier B** authorities (set by this Supplement). The Municipal Committee, Leh may opt into Tier A under Clause 1.6.4. The Councils are not Approving Authorities; their land allotment and development plans are governed by Clauses S1.4.2 and S1.8 and Chapter 11.
1.8, 1.9 Other instruments and roles	Instruments in force in Ladakh and relevant to the Manual: the Jammu and Kashmir Municipal Act, 2000; the Jammu and Kashmir Development Act, 1970 (cited in the definitions of the 2025 draft, though no Development Authority is constituted under it in Ladakh); the Jammu and Kashmir Panchayati Raj Act, 1989 and Rules, 1996; and the Ladakh Autonomous Hill Development Councils Act, 1997, as amended by Jammu and Kashmir Act No. 19 of 2018 and by Regulation No. 16 of 2026. An interim land-use framework for the municipal areas was approved on 8 July 2026 (as reported). Whether the water-resources and flood-plain statutes that the Manual cites for Jammu and Kashmir apply in Ladakh, and in what form, is **[TBC]**; until it is confirmed, the consents of the Irrigation and Flood Control Department required by Clause S1.5.5 are conditions set by this Supplement. Roles are as in Table S1.2.
Chapter 1 flood history and evidence	The events of the Union Territory of Jammu and Kashmir are not evidence for Ladakh. Ladakh's events are in Clause S1.9.
2.3 to 2.12, Annex 2A, Annex 2B, Annex 2E Design rainfall	Replaced by Clause S1.3. Ladakh is outside Annex 2A and forms the single rainfall zone **L-Z1 Trans-Himalayan cold desert** (set by this Supplement). The interim source of Clause 2.3.6, its ratios, plate readings and record check, NIH-DHAARA and the zone-7 synthetic unit hydrograph are not used.

Manual clause	What changes in Ladakh
2.11.4 Antecedent moisture	AMC III for every design storm (Clause S1.3.7).
3.7, 3.8 Soils and CN	Clause S1.3.8.
3.10 Groundwater and high water table	Clause S1.6.6.
4.4, 4.11, 8.8, 8.11 Retention, infiltration and recharge	Modified by Clause S1.6. The hill infiltration rule of Clause 4.11 applies in Ladakh as written, to slopes, colluvium, slide debris and moraine and above cuts and retaining walls; the valley-floor rule and the Kandi recharge rule of Clause 4.11 do not apply.
4.5.3 Flood-sensitive catchments	The Jammu and Kashmir catchments do not apply. In Ladakh, the catchments of Clause S1.4.3 are flood-sensitive (set by this Supplement).
4.6, Annex 4B, Table 4.3 Detention sizing	L-Z1 is not tabulated; Clause 4.6 applies, with the design storm of Clause S1.3.5.
5.6, 5.8, 5.9 Tailwater and river backwater	Clause S1.5. The river levels, gauges and outfall rules of Clause 5.8.5 for the rivers of Jammu and Kashmir do not apply.
5.10, 5.12 Outfall-closed check; pumped outfalls	The outfall-closed check applies where the river level of Clause S1.5.2 or S1.5.3 stands above an outfall invert. No drainage in Ladakh is pumped; Clause 5.12 applies only where a pump is proposed.
6.3.6 Debris, bulking and blockage	Applies in full to every drain, culvert and channel in Ladakh, with Clause S1.4.
6.4, Table 6.1 Design AEPs	Every minor-system and road-drainage element of Table 6.1 is designed for the nominal storm of Clause S1.3.3, whatever its AEP, and every check event is made as Clause S1.3.4 provides.
6.9 Major system	The major system in Ladakh is the **tokpo corridor**, kept open as a debris-flow path under Clause S1.4; no flow is computed for a debris flow.
6.11 Floor levels	The 2025 draft requires a plinth not less than 450 mm and not more than 1.5 m above the surrounding ground (cl. 8.5(1)) and a courtyard at least 150 mm above the street (cl. 8.5(2)). Clause 6.11 applies with the levels of Clause S1.5, and the higher level governs. No habitable floor shall be built in a debris-flow corridor or active fan channel mapped under Clause S1.4, whatever its plinth: a raised plinth does not protect against a debris flow (set by this Supplement).
7.4 Setbacks	No statutory setback from a nallah or tokpo was found in Ladakh. The 2025 draft keeps boundary and compound walls "at least 10 m away from the bank of the river" (cl. 8.7(7)), and the rural draft says "Natural drainage not to be obstructed" (Annexure-III). Zones 1 and 2 of Clause 7.4 apply to every tokpo and fan channel, measured as Clause S1.4.4 provides (set by this Supplement).
7.10 Supply channels	Yuras (irrigation channels) are protected as Clause S1.8.4 provides.
7.12 Wetlands	Clause S1.8.
8.9 Sewage cross-connections	Applies, with Clause S1.6.4. The 2025 draft forbids any outlet from an absorption pit to a storm or surface drain (cl. 12.5(2)) and requires absorption-pit walls at least 0.5 m above ground "to ensure that storm water does not enter" (cl. 12.5(3)).

Manual clause	What changes in Ladakh
Chapter 9 Culverts and structures	Clause S1.4.6 for crossings of fans and tokpos, and Clause S1.7 for frost and ice. Clauses 9.9 and 9.10 apply only where a pump or gate is proposed.
10.4.4(c) GIS data	Sites west of 78° E, including Leh, Kargil, Drass, Padum and Diskit, are in UTM zone **43N (EPSG:32643)**; sites east of 78° E, in much of Changthang district, are in zone **44N (EPSG:32644)**. A project that crosses 78° E states the zone it uses (NEER reading of the meridian; to be confirmed against Survey of India).
10.12, Figure 10.3 Maintenance calendar	Apply, with Clause S1.7.6.
10.16 Post-event review	Led by the **Ladakh Disaster Management Authority**, in place of J&K SDMA, with the Deputy Commissioner of the district. Every cloudburst, debris flow and outburst flood that damages a building or a road is mapped and recorded, as the 2010 event was in the District Disaster Management Plan of Leh, and the corridor maps of Clause S1.4.2 are revised.
Chapter 11 Basin plans	The planning unit is each **tokpo catchment and its fan**. The basin plan begins with the hazard screening of Clause S1.4.5 and adopts the corridor map of Clause S1.4.2 before any drain is planned. The GIS master plans of Leh and Kargil are not notified (as reported, July 2026).

Commentary. The 2025 draft already contains the hooks this Supplement uses. It defines "natural hazard prone areas" as areas of significant "flood flow or inundation or landslides/mud flows … declared so by the competent authority" (cl. 3.85), which is the power Clause S1.4.2 relies on. It asks that hazard profiling of construction zones be "mandatorily carried out" under the National Disaster Management Plan, 2019, with IS codes "for Cloud bursts, Floods/Flashfloods, Avalanches" (chapter 4). It sends snowmelt drains "away from pathways in order to prevent hazards due to freeze-thaw cycles" (cl. 9.2(xi)), keeps recharge wells 10 m from any structure handling sewage (cl. 9.2(v)), forbids absorption pits where "domestic supply is taken from sub soil water" (cl. 12.3(1)), and keeps stormwater out of absorption pits (cl. 12.5). What it lacks is a design storm, any peak-flow or detention rule, any setback from a tokpo, and a map of the corridors to which its hazard power could be applied; that is the gap this Supplement fills. The interim land-use framework of July 2026 is reported to allow land of up to 2 kanals in a municipal area to be used for residential, commercial, industrial or mixed use, and to bar refusal of a proposal "solely on the ground of the non-availability of the Master Plan" (as reported). With no master plan notified, the check at building permission is the only point at which a house on a fan channel can be stopped, which is why Table S1.1 sets the corridor rule at every size. Every authority is Tier B because the two Municipal Committees are small; Leh, the larger, may opt up.

Table S1.2 — Roles in Ladakh

Body	Role under the Manual and this Supplement
Lieutenant Governor (Administrator, Article 239); Chief Secretary; Administration of the Union Territory of Ladakh	Would amend the bye-laws (Table S1.1, 1.3.1), constitute the committee of Clause 1.3.2 and declare the corridors of Clause S1.4.2 as natural-hazard-prone areas through the competent authority; the Lieutenant Governor chairs the Ladakh Disaster Management Authority (as reported).
Housing and Urban Development Department; Director, Urban Local Bodies; Urban Planning	Would prepare the bye-law amendments under section 218 of the Jammu and Kashmir Municipal Act, 2000; would add the checks of this Supplement to the Online Building Permission System; master plans of Leh and Kargil.
Municipal Committees, Leh and Kargil	Approving Authority in the municipal areas; town drains, subject to the [TBC] on drain ownership in Clause S1.4.7; anti-encroachment along tokpos, as in the Skamlung Nallah drive of 27 July 2023; compliance of septic tanks and soak pits (Clause S1.6).

Body	Role under the Manual and this Supplement
Ladakh Autonomous Hill Development Councils, Leh and Kargil, and the Councils of the five new districts once constituted	Allotment, use and occupation of land vested in the Council (section 23(1)(i)), district-level Panchayat powers (section 23(2)) and the development plan (section 32), once the Regulation of 2026 is in force: would keep allotments and the development plan off the corridors of Clause S1.4.2 and would be consulted on basin plans. Whether the Councils hold any power over building permission is not explicit in the Act as amended (NEER reading).
Deputy Commissioners of the seven districts (also Chief Executive Officers of the Councils); Sub-Divisional Magistrates; Block Development Officers	District disaster management, warnings and evacuation; chair or serve on the rural approving committees (Table S1.1, 1.4.1); post-event mapping (Table S1.1, 10.16).
Rural Development and Panchayati Raj Department; Halqa Panchayats	Rural building permission under rule 155 of the Jammu and Kashmir Panchayati Raj Rules, 1996; consent for works on yuras with the Irrigation and Flood Control Department (Clause S1.8.4).
Irrigation and Flood Control Department	Custodian of nallah training, check dams and flood-protection works (as reported); yuras; consent for outfalls and works on rivers and tokpos (Clause S1.5.5); a flood-zone master plan reported to have been commissioned from a consultant, PDCOR, whose status is **[TBC]**.
Public Health Engineering (Jal Shakti) Department, Leh and Kargil	Water supply from groundwater and springs; registration of borewells under the notification of 18 April 2022; sewerage, STPs and faecal sludge treatment plants (FSTPs); water testing; frost-depth practice for buried pipes (Clause S1.7.3).
Public Works Department (Roads and Buildings)	Road drains and culverts on Union Territory roads (Clause S1.4.6).
Border Roads Organisation; NHIDCL	Culverts and causeways on strategic roads and national highways that cross fans; covered only as Clause S1.1.5 provides; their role under the Manual is **[TBC]**.
Ladakh Disaster Management Authority (LDMA)	Hazard maps; cloudburst and outburst warning with IMD; post-event review (Table S1.1, 10.16). Its first meeting was held on 10 February 2021 (as reported).
Ladakh Pollution Control Committee (LPCC)	Consents under the Water Act for effluent and septage; enforcement of Clause S1.6.4. It was constituted on 25 March 2021 (as reported).
Wetland Authority of the Union Territory of Ladakh; Wildlife and Forest Departments	Tso Moriri, Tso Kar and the other lakes of Clause S1.8; wetland notifications under the Wetlands (Conservation and Management) Rules, 2017.
IMD, Meteorological Centre Leh	Rainfall records for Leh, Kargil, Drass and other stations; nowcasts and warnings; the data requests of Clause S1.3.2.
CWC	No flood-forecasting site in Ladakh at last report (Clause S1.5); glacial-lake monitoring, whose coverage of Ladakh is **[TBC]**.
CGWB	Aquifer mapping and groundwater assessments of Leh and Kargil (Clause S1.6).
NHPC	Operation of the Nimoo Bazgo (Indus) and Chutak (Suru) projects and their levels (Clause S1.5.3).
NDMA; the Army	Response to landslide dams and outbursts, as at Phuktal in 2015 and in the rescue of 2010 (as reported).

S1.3 Design rainfall and season: replacing the design-storm approach

S1.3.1 **Zone L-Z1.** Ladakh is outside Annex 2A. The whole Union Territory is one rainfall zone, **L-Z1 Trans-Himalayan cold desert** (set by this Supplement). In L-Z1:

- (a) no rainfall-intensity table, IDF relationship, FER plate, NIH-DHAARA value or zone-7 synthetic unit hydrograph is used to design any drain, storage or structure;
- (b) the minor system and site storage are sized for the nominal storm of Clauses S1.3.3 to S1.3.5; and
- (c) cloudbursts, debris flows and outburst floods are treated as siting and corridor problems under Clause S1.4, never as pipe-sizing problems. No drain, culvert, storage or other work is sized to carry a debris flow or an outburst.

The hazard-first approach that Clause 2.3.6(i) takes in sub-area JK-D (High mountains and snow-fed catchments) thus applies to the whole of Ladakh; the 1-hour floor of Clause 2.3.6(g) and the record check of Clause 2.3.6(h) do not, because they rest on gauges in Jammu and Kashmir.

S1.3.2 **Data request.** The first data request of this Supplement is for the IMD annual-maximum series of 24-hour rainfall, and any hourly or automatic-weather-station records, at **Leh, Kargil and Drass**, and at any other IMD station or automatic rain gauge in the Union Territory, with the years of record of each **[TBC]**. When the series for a station has been analysed and published, the Administration may set the nominal storm for the district of that station from it under Clause 1.12.

S1.3.3 **Nominal storm for minor drains.** Until the analysis of Clause S1.3.2 is published, every element of the minor system and every road drain and crossing listed in Table 6.1, whatever its AEP, shall be designed for a **nominal storm of 51.3 mm falling uniformly in 1 hour** (51.3 mm/h), with the Rational Method of Clause 3.5 within its limits (Clause 3.4.2) and a hydrograph method above them (set by this Supplement). For a time of concentration longer than 1 hour, the intensity is 51.3 mm divided by the time of concentration in hours; for a shorter one, it is 51.3 mm/h. The nominal storm applies throughout L-Z1, at Leh, Kargil and Drass alike. Where an IMD table confirms a 24-hour fall at a station in the Union Territory larger than 51.3 mm, that fall, assumed to fall in 1 hour, replaces 51.3 mm within the district of that station until the analysis of Clause S1.3.2 is published (set by this Supplement).

S1.3.4 **Check events.** The check events of Table 6.1, and the 1% AEP overland-path requirement of Clauses 6.3.2 and 6.4.2, are met:

- (a) on a tokpo or fan channel, by keeping the corridor of Clause S1.4 open; no flow is computed for it; and
- (b) on any other overland flow path, by showing that the path carries the flow of the nominal storm computed with a runoff coefficient of 0.9 for every surface, pervious or not, and with every inlet and culvert on it 50% blocked, without water entering a building (set by this Supplement; the case is that of frozen ground with drains choked by ice or debris, the condition in which Ladakh's drains are most likely to fail).

S1.3.5 **Storage and the climate factor.** For Chapter 4, the nominal storm is the design storm for every AEP: it is applied as a 1-hour event and as a 24-hour event of the same depth, and the criteria of Clauses 2.11.2 and 2.11.3 are checked with it (so that, in a flood-sensitive catchment, the post-development peak shall not exceed the pre-development peak for the nominal storm). The retention design depth of Clause 2.10 is **20 mm** until a percentile depth is computed from the IMD daily record of Leh or Kargil **[TBC]** (set by this Supplement; it is more than the mean August rainfall at Leh, 15.4 mm, so a site that retains it retains almost every ordinary rain day). The climate factor of Clause 2.8 is not applied to the nominal storm (set by this Supplement), because the nominal storm already places the whole of the highest 24-hour fall recorded at Leh in a single hour; it is applied to any design rainfall set later under Clause S1.3.2.

S1.3.6 **Never from the 2010 gauge value.** No design depth, intensity or ratio shall be derived from the rainfall recorded at the Leh gauge on 5–6 August 2010, or from any gauge reading taken during a cloudburst (Clause S1.3.9).

S1.3.7 **Season and antecedent moisture.** The cloudburst season in Ladakh is **June to September** (LDMA; IMD). The **snowmelt season, April to June [TBC]** from IMD and Irrigation and Flood Control records, is a separate design case on frozen or saturated ground (Clause S1.7.5). AMC III applies to every design storm in L-Z1, in every month (set by this

Supplement): in summer the bare slopes shed nearly all of a burst, and in winter and spring the ground is frozen or saturated.

S1.3.8 **Soils.** No hydrologic soil group mapping of Ladakh was found. Until a field test is made, every soil in L-Z1 shall be taken as **HSG D** (set by this Supplement). A field test made in the thawed season may place a fan gravel or valley fill in a lower-runoff group for the summer case, but the frozen-ground case of Clause S1.7.5 is always made with HSG D, and no infiltration credit is taken except as Clause S1.6 allows. Default CN values of Chapter 3 are used only with a tested group.

> Commentary. IMD's note on the cloudburst of 6 August 2010 gives the August normal at Leh as 15.4 mm and "the highest rainfall ever recorded over Leh during 24 hours period" as **51.3 mm on 22 August 1933**, and describes Ladakh as a cold desert "not known to be frequently affected" by cloudbursts. The annual normal is given as less than 100 mm in the CWC zone-7 report and as 40–70 mm in the District Disaster Management Plan of Leh (2011-12); the two are not reconciled **[TBC]**. The zone-7 report's study area, longitudes 73° to 81° E and latitudes 29° to 37°30' N, takes in Ladakh, and it notes the low rainfall of Leh, but its gauged catchments lie in the outer Himalaya far to the south, its synthetic unit hydrograph is "not to be utilised" in the snow-fed area, and whether its plates cover the Indus, the Shyok and the Zanskar has not been checked against the report's plates **[TBC]**. That is why Clause S1.3.1 does not use it. The nominal storm of Clause S1.3.3 is a deliberate overstatement of the record, not a frequency estimate: it takes the largest day in about ninety years at Leh and assumes it all falls in one hour. Even so it sizes nuisance drainage only. The rain that caused the 2010 disaster was not measured: the Indian Air Force observatory at Leh recorded **12.8 mm** in the 24 hours to 05:30 IST on 6 August 2010 (IMD), while the burst was reconstructed at **at least 150 mm/h** over Leh (Hobley, Sinclair and Mudd, 2012, as reported in a secondary source; the paper was not read). NCMRWF's high-resolution simulation of the event produced only about 4 cm in three hours at its wettest point (NCMRWF, 2010, paraphrased). Neither the gauge nor the model saw the design event, which is why Clause S1.3.6 forbids using the gauge value and Clause S1.4 handles the event by siting. Later falls are of the same order as the nominal storm or below it: in August 2025 Leh recorded 80.2 mm for the month, the highest in 52 years, with a wettest day of 37 mm, and Kargil 33 mm in 24 hours (as reported); on 8–9 July 2023 Ladakh received 19.1 mm against a normal of 0.1 mm (as reported). The 46.4 mm (1995) and 45.2 mm (2006) "highs" quoted in the press for Leh may be daily or monthly totals and are not used **[TBC]**. The retention depth of 20 mm and the roof store of Clause S1.6.3 are set together, so that the store holds the retention depth from its roof.
>
> S1.3.9 **Cloudbursts.** IMD's note on the Leh event describes a cloudburst as a fall at a rate that "may be of the order of 100mm per hour" over a localised area. No design rule is drawn from the term, and no design depth is set to match a cloudburst. A burst over a side valley in Ladakh does its damage through the debris flow it sets off on bare slopes of loose sediment, which Clause S1.4 keeps out of buildings by siting; a drain cannot carry it.

S1.4 Debris flows, tokpos and outburst floods

S1.4.1 **Tokpos are the major system.** A tokpo (side-valley stream or nallah, Clause S1.8.5) that crosses or borders a settlement shall be kept open along its whole course through the settlement (set by this Supplement):

- (a) it shall not be culverted, covered, built over or narrowed, except at a road crossing designed under Clause S1.4.6;
- (b) no plantation shall be made in the bed of a tokpo or on land next to it within the corridor of Clause S1.4.2, following the District Disaster Management Plan of Leh ("Not allowing plantations in the nallah bed, near nallah"); trees already standing in the bed may be removed by the Authority, as in the Skamlung Nallah drive of 2023; and
- (c) no solid waste, construction debris or excavated material shall be placed in it or on its banks.

S1.4.2 **Corridor map.** The Authority, with the LDMA and the Irrigation and Flood Control Department, should map for every settlement the **active debris-flow paths, active fan channels and flash-flood paths**, including every channel that carried a flow in 2010 or since, and should have them declared as natural-hazard-prone areas under cl. 3.85 of the 2025 draft (as the competent authority's declaration it provides for). One candidate method is the susceptibility mapping of the Leh valley by Sharma et al. (2022), which combines connectivity, flow-routing and weights-of-evidence models. Until a map is adopted for a settlement, the designer shall map the corridor for the site and its surroundings from the field, from the imagery of the events of Clause S1.9 and from the records of the Authority and the LDMA, and show it in the drainage report (set by this Supplement).

S1.4.3 **Flood-sensitive catchments.** The following are flood-sensitive catchments for Clause 4.5.3 and Chapter 11 in Ladakh (set by this Supplement):

- (a) the catchments of the nallahs that the District Disaster Management Plan of Leh lists as most vulnerable to cloudburst and flash flood, among them the Leh Nallah from Gabglies to Spituk, and the Saboo, Igoo, Phyang, Taru, Nimoo, Ney–Basgo, Tia–Temisgam, Shila–Wanla, Kungam, Anlay, Tingang, Trishi, Chamshen, Tyakshi, Bogdang, Diskit, Turtuk, Hunder, Lungdo and Taksha nallahs and the Murgi nallah at Nungstate (the first five items of the list are not legible in the copy read **[TBC]**);
- (b) the Skamlung Nallah in Leh, which flooded in July 2023, and the Leh Nallah and the Shenam nallah, which the status report of Clause S1.6 names as the main drains of Leh town;
- (c) every other catchment with a corridor mapped under Clause S1.4.2 through a settlement; and
- (d) the catchments of Kargil and the other towns of the Kargil, Zanskar and Drass districts that the Authority lists once their events are dated (Clause S1.9; **[TBC]**).

S1.4.4 **Setbacks on tokpos and fans.** Clause 7.4 applies to every tokpo and fan channel, with these changes (set by this Supplement):

- (a) Zone 1 is measured from the outer edge of the corridor mapped under Clause S1.4.2, not from the low-flow channel or the top of its bank, and extends not less than the minimum of Clause 7.4.7 (15 m) beyond it;
- (b) the whole of the mapped corridor is in Zone 1, which is a **no-build zone**: no building, compound wall, fill, storage facility or stormwater facility other than a crossing under Clause S1.4.6 or a training work of the Irrigation and Flood Control Department is placed in it;
- (c) where no corridor has been mapped, Table 7.1 applies with the "channel draining more than 20 km², and rivers" row (50 m, of which 20 m is Zone 1) for every tokpo whose fan holds a settlement, measured from the edge of the active fan channel; and
- (d) on a river, the 10 m boundary-wall setback of cl. 8.7(7) of the 2025 draft is the statutory minimum, and Zone 1 governs where it is wider (Clause 7.4.5).

S1.4.5 **Outburst screening.** No basin plan, and no drainage report for a site with a glacier, a glacial lake, a moraine- or landslide-dammed lake or a landslide-prone gorge in the catchment above it, is complete without a screening for glacial-lake outbursts, landslide-dam breaches, ice-dam floods and debris flows recorded in the report. It identifies the lakes, dams and fans upstream from the glacial-lake inventories, the LDMA's hazard maps and CWC's glacial-lake monitoring where they cover the site **[TBC]**, and states whether the site lies on their flow path. Where it does, the siting, setback and floor-level rules of this Supplement and of Chapters 6 and 7 govern, and the outburst sets the tailwater case of Clause S1.5.4; it never sets a pipe size (set by this Supplement).

S1.4.6 **Crossings of fans and tokpos.** A road or path that crosses an active fan or a tokpo shall cross it by a vented causeway, a ford or a culvert or bridge sized under Clause 6.3.6 for debris and blockage, and debris racks or basins, where provided, shall be placed upstream of the crossing and not at the inlet (set by this Supplement). Crossings by the Border Roads Organisation and NHIDCL are covered as Clause S1.1.5 provides; their design practice on fans is **[TBC]**.

S1.4.7 **Drain ownership.** Who owns and maintains the town drains of Leh and Kargil, as between the Municipal Committee, the Public Works Department and the Irrigation and Flood Control Department, is **[TBC]**. Until it is confirmed, the Municipal Committee is taken as owner of drains within its area that are not part of a tokpo, and the

Irrigation and Flood Control Department as custodian of the tokpos and their training works, and the Authority shall record the response of both to every drainage report that affects a tokpo.

> Commentary. In 2010 the destruction in Leh district came from "the rapid movement of huge volumes of water charged with mud, boulders, trees, building debris and other objects" off slopes "covered in loose, unconsolidated deposits". At Choglamsar the debris flow travelled about 10 km from near Saboo and spread up to 2 km wide; in Leh it travelled about 3 km, from 3,800 m to 3,410 m, down the catchment of the Shakshaling stream, destroying settlements and the bus stand (District Disaster Management Plan, Leh). Sharma et al. (2022) find the Leh valley "affected almost annually by debris flows", with rare, extensive flows formed where drainage networks integrate "in an open fan area". A drain or a culvert does not survive such a flow, and a raised plinth does not protect a house in its path. The only protection is to keep buildings, walls and fill out of the paths the flows take and to keep those paths open, which is what Clauses S1.4.1 to S1.4.4 require. The DDMP's own measures were "Construction of Checkdams", "Nallah training" and "Not allowing plantations in the nallah bed, near nallah". In July 2023, after "flash floods from the overflowing nallah", the Council, the District Administration and the Municipal Committee cleared the Skamlung Nallah in Leh of encroachments and removed "over 200 trees" that hindered its flow (Administration of Ladakh); no distance rule was stated, which Clause S1.4.4 supplies. The 15 m minimum of Zone 1 is the Manual's; the 50 m fixed width for a tokpo with a settlement on its fan, until a corridor is mapped, is set by this Supplement because the 2010 flows spread far beyond the channels.
>
> Outburst floods are not driven by rain at any gauge. The **Gya** glacial lake, at about 5,300 m, grew from about 0.03 to 0.08 km² between 1969 and 2014 and burst in 2014, destroying terraces, a new bridge and two houses (as quoted in a conference abstract, EGU 2016); a hydraulic model of the event gave a peak of about 470 m³/s (as reported, source not identified) **[TBC]**; Schmidt et al. (2020) note that the lake had been "overlooked in inventories". On the Phuktal river in Zanskar a landslide dammed the valley at about the end of 2014 and the lake breached on **7 May 2015**, damaging bridges and a school downstream; its volume is reported variously as about 24 to more than 30 million m³, and the Army and NDMA cut a channel through the dam in April 2015 (as reported). On the Shyok, ice dams of the Chong Kumdan glacier burst in 1926, 1929 and 1932 (as quoted in the *Himalayan Journal*), and sixteen outbursts from the Kumdan glacier group since 1835 are counted in a recent abstract (as quoted, EGU 2026). An inventory of 2018 counted 192 glacial lakes in Ladakh, 127 of them proglacial, and a Kargil inventory 85 proglacial lakes in contact with a glacier (as quoted in conference abstracts, EGU 2023 and 2024) **[TBC]**. These events set where not to build and the river levels of Clause S1.5; they set no pipe size.

S1.5 Rivers and tailwater

S1.5.1 **Receiving waters.** The receiving waters of Ladakh's towns are the **Indus** (Leh, Choglamsar, Nimoo–Basgo, Khaltse), the **Shyok** and the **Nubra** (Diskit, Hunder, Turtuk), the **Suru** (Kargil), the **Zanskar** and its tributaries (Padum), and the **Drass** and the **Shingo** (Drass). CWC has no flood-forecasting site in Ladakh: "Presently there is no site functioning in Ladakh" (as reported, SANDRP, 2022). No danger level, warning level or high flood level is published for any river in the Union Territory.

S1.5.2 **Design river level.** Until a level is published **[TBC]**, the river level used for Clauses 5.6, 5.8 and 6.11.2 at an outfall shall be the highest of (set by this Supplement):

- (a) the highest flood mark surveyed at or near the outfall from the events of 2010, 2015, 2023 and 2025 and any later event, with the source of each mark stated on Form 5-1;
- (b) the level of the river at its **snowmelt peak** in July and August, the months of the cloudbursts, from surveyed marks or the records of the Irrigation and Flood Control Department or NHPC, because a burst over a side valley meets a river already high with melt (NEER reading); and
- (c) a level from a hydraulic model of the reach under Clause 5.8.2(b), where one is made.

Where none of (a) to (c) is available for a plot below the Chapter 1 thresholds, Clause 6.11.3 applies.

S1.5.3 **Projects.** On the Indus near Alchi and on the Suru, the operating levels and spillway records of NHPC's **Nimoo Bazgo** (45 MW, on the Indus at Alchi) and **Chutak** (44 MW, on the Suru) projects (as reported) shall be included under Clause 5.8.3 where the reach is affected; the levels are **[TBC]**, and until they are known the reach is analysed under Clause S1.5.2.

S1.5.4 **Outburst tailwater.** Where the screening of Clause S1.4.5 finds a lake or dam whose outburst would reach the river at the outfall, the outfall shall be checked against the river level of that outburst, estimated by a method agreed with the Authority and the Irrigation and Flood Control Department, with a non-return valve or a raised outfall where the check fails (set by this Supplement). No drain is enlarged for it.

S1.5.5 **Consent.** Every outfall to a river or a tokpo, and every wall, embankment or training work in or on one, shall be referred to the Irrigation and Flood Control Department, whose consent shall be recorded before approval (set by this Supplement; its statutory basis in Ladakh is **[TBC]**, Table S1.1, 1.8).

> Commentary. The Indus is high with snowmelt in July and August, the same months in which cloudbursts occur (NEER reading), so an outfall checked only against the river's low autumn level will be drowned when it is needed. No river level is published because CWC had no functioning site in Ladakh at last report (as reported, 2022); whether one has been added since, and the high flood level of the Indus at Leh (Choglamsar and Spituk), are **[TBC]**. Surveyed marks of the known events are therefore the only levels available. During the Phuktal crisis of 2015 a risk to the Nimoo Bazgo project downstream was reported (as reported), which is why outbursts are part of the tailwater check.

S1.6 Groundwater, infiltration and rainwater harvesting: roof water only over the Leh aquifer

S1.6.1 **Roof water only.** Where groundwater or a spring is drawn for drinking within 500 m of the site, which includes the whole of the municipal area of Leh, only **clean roof water** shall be led into a recharge well, soakaway, infiltration trench or other infiltration facility (set by this Supplement; the distance is the Supplement's, pending the aquifer maps of Clause S1.6.6). Runoff from roads, parking, yards, animal pens and fuel areas shall not be infiltrated there: it shall be conveyed at the surface, through a sediment trap, to a tokpo or river under Clause S1.5.5.

S1.6.2 **Separations.** In addition to Clause 8.8 (set by this Supplement, except as stated):

- (a) a recharge well shall be at least **10 m** from any structure handling sewage or industrial wastewater, such as a septic tank or effluent treatment plant (2025 draft, cl. 9.2(v));
- (b) no absorption pit shall be allowed where domestic supply is taken from sub-soil water (2025 draft, cl. 12.3(1)); in Ladakh this Supplement reads every settlement whose drinking supply comes from wells, borewells or springs, including Leh town, as such an area (NEER reading);
- (c) a septic tank or absorption pit shall be at least **60 m** from any percolation well, watercourse or stream used or likely to be used for drinking or domestic purposes, unless a hydrogeological report accepted by the Authority shows that a smaller distance protects the source, and then not less than 16 m; and
- (d) no recharge well or soakaway shall be placed within the corridor of Clause S1.4.2.

S1.6.3 **Storage for use first.** The rainwater and snow-melt harvesting of cl. 9.1 of the 2025 draft shall be provided first as **roof-water storage for use**, with a store of not less than **20 L per m² of roof** (set by this Supplement), protected from frost under Clause S1.7.2. Only the overflow of the store may go to a recharge well, and only under Clauses S1.6.1 and S1.6.2. Clauses 4.11 and 8.11.5 apply: the store is assumed full at the start of every design storm and is not counted as detention.

S1.6.4 **Sewage and stormwater.** Clause 8.9 applies. Where no sewer is available, the on-site system shall meet Clause S1.6.2 and cl. 12.5(2) and (3) of the 2025 draft, and no overflow or effluent from it shall be led to a storm drain, a tokpo, a yura or a recharge structure.

S1.6.5 **Snow-melt.** The draft's direction that "the water of melting snow should flow to the ground water recharge system" (cl. 9.1(iii)) applies only to melt from roofs and from clean open space, and only under Clause S1.6.1; melt from roads and yards is surface runoff under Clause S1.7.5.

S1.6.6 **Water table.** For Clause 3.10, the seasonal high water table shall be taken as the highest level recorded from May to September, when the rivers are high, and on valley floors and terraces within 100 m of a river or a spring (chumik) as ground level unless measured (set by this Supplement). The aquifer maps of CGWB for Leh are **[TBC]**.

> Commentary. Leh drinks groundwater. The status report of the Deputy Commissioner and Chief Executive Officer of the Council, Leh to the National Green Tribunal (O.A. 206 of 2023, 28 March 2023) records 927 borewells in Leh town, including those of the defence establishments, at 31 December 2022, and the registration of borewell users under the Union Territory's notification of 18 April 2022. It records that the 48 km sewer network is "just 30% of total required sewer network", that 2,884 of 6,820 households are connected to the 3 MLD plant at Agling, that the rest use septic tanks and soak pits, whose septage goes by suction truck to a 12 KLD FSTP, and that "Disposal of untreated waste (sewage) directly into Ground (through soak pit) could be the reason for ground water contamination which needs further investigation". Kargil has no sewer and a 10 KLD FSTP (the same report). Nitrate in Leh's wells is reported as 60 mg/L in one account and as "approaching the WHO limit of 50 mg/L in some cases" in another (both as reported); the two conflict and neither is a primary measurement. CGWB is reported, in material seen only in summary, to find the groundwater unconfined in valley fill, at depths from very shallow to 45 m "related to river water level" (as quoted in a CGWB presentation of 2020) **[TBC]**. The plains rule of putting as much water into the ground as possible is unsafe here: road and yard runoff carries fuel, dung and silt into the same fan gravels from which the town drinks, and every soak pit is a source of the contamination the Tribunal is examining. Clause S1.6.1 therefore keeps infiltration to clean roof water. The 2023 draft bye-laws kept septic tanks 60 m from a drinking-water well or watercourse; the 2025 draft reduces this to 16 m (cl. 12.4(1)(iii), checked on the page image). Whether the final bye-laws keep 16 m is **[TBC]**, and the draft gives no reason for the change. With most of Leh on soak pits over its drinking aquifer, this Supplement keeps the larger distance unless a hydrogeological check supports less. Rainwater harvesting yields little: at 40–100 mm a year, a 100 m² roof collects about 4–10 m³ a year before losses (NEER arithmetic), so the store of Clause S1.6.3 is a small seasonal supply and a snow-melt store, not a source of recharge.

S1.7 Freeze–thaw and snowmelt

S1.7.1 **No permanent wet pools.** No wet pond, permanent pool or wetland treatment cell shall be designed in Ladakh. Detention basins shall be **dry**, with outlets that drain them completely before the first freeze, and shall be empty through the winter (set by this Supplement).

S1.7.2 **Ice.** Inlets, outlets, orifices and gratings shall be protected from ice, by placement out of drifting snow, by covers or by heating where power is available, and shall be shown on the O&M plan of Clause 10.11 with their winter checks. Open channels shall be designed with an allowance for ice in the freeboard, stated in the drainage report **[TBC]** (set by this Supplement).

S1.7.3 **Frost depth.** Buried stormwater pipes shall be laid with their crown below the frost depth. The frost depth for each town is **[TBC]** from the practice of the Public Health Engineering Department and the Public Works Department and the relevant IS code. Until it is confirmed, the cover shall be not less than that to which the Public Health Engineering Department lays water mains in the same town, stated on the drawings; where that is not known, open or covered channels designed under Clause S1.7.2 shall be used in place of buried pipes (set by this Supplement).

S1.7.4 **Snowmelt drains.** Snowmelt drains shall be led away from pathways, as cl. 9.2(xi) of the 2025 draft requires "in order to prevent hazards due to freeze-thaw cycles", and no roof, terrace or yard outlet shall discharge onto a footpath, road or neighbouring plot. Snow cleared from roads and roofs shall be stored where its melt drains to a drain or tokpo and not across a path or into a building.

S1.7.5 **Snowmelt-on-frozen-ground check.** Every drainage report shall show that melt and rain in the snowmelt season of Clause S1.3.7, running off frozen ground with every inlet and culvert 50% blocked by ice, reaches a drain, tokpo or river without crossing a pathway or entering a building (set by this Supplement). The melt rate for the check is **[TBC]**; until it is set, the check is made as a flow-path check, with the nominal storm of Clause S1.3.3 on frozen ground (runoff coefficient 0.9) where a flow is needed.

S1.7.6 **Maintenance calendar.** Clause 10.12 and Figure 10.3 apply, with the pre-monsoon date of 31 May, readiness by 15 June and standby to 31 October. In addition, inlets, culverts and fan channels in settlements shall be cleared of ice, snow and debris by **30 April**, before the snowmelt season, and every channel and crossing affected by a debris flow shall be cleared within the time set by the Authority after the event (set by this Supplement).

S1.7.7 **Structures.** Retaining walls, embankments and other structures of a stormwater facility shall be designed for the snow loads of Annexure-II of the rural draft (2.0, 3.0 and 4.5 kN/m² for altitudes of 3,000–3,500, 3,501–4,000 and more than 4,000 m) where they carry snow. The rural draft (Annexure-I) puts all buildings in IS 1893 **Zone V**, while the District Disaster Management Plan of Leh (2011-12) places Leh district in **Zone IV**. Until the zone is confirmed **[TBC]**, structures of a stormwater facility shall be designed for Zone V (set by this Supplement, the stricter of the two).

> Commentary. Minimum temperatures in Leh district fall to about −40 °C (District Disaster Management Plan, Leh). A pool or basin that holds water into winter freezes solid, splits its lining and outlet, and stays blocked into the snowmelt season, when it is needed; that is why Clause S1.7.1 forbids permanent pools. The snowmelt season of April to June is the Supplement's working assumption from the climate of the region and is to be confirmed **[TBC]**. No frost-depth value for Ladakh was found for this draft, which is why Clause S1.7.3 relies on local practice for water mains.

S1.8 Waterbodies and local terms

S1.8.1 **Ramsar sites. Tso Moriri** (Ramsar site No. 1213, designated 19 August 2002, 12,000 ha) and the **Tso Kar Wetland Complex** (No. 2443, designated 17 November 2020, 9,577 ha, of which the hypersaline lake is about 1,800 ha, in the Changthang Cold Desert Wildlife Sanctuary) are Wetlands of International Importance (as listed by the Ramsar Sites Information Service, seen only in summary; areas **[TBC]** against the Ramsar list). Pangong Tso is not a Ramsar site; no listing was found. Clause 7.12 applies to all three lakes and to Tso-Rul and the other lakes the District Disaster Management Plan of Leh lists, and no drain from a road, camp or settlement shall discharge to them without the treatment of Chapter 8 and the consent of the Wetland Authority of the Union Territory of Ladakh (set by this Supplement).

S1.8.2 **Wetland Authority.** The Wetland Authority of the Union Territory of Ladakh, under the Wetlands (Conservation and Management) Rules, 2017, held its first meeting in September 2021 (as reported). Its constitution notification, and any wetland notified under the Rules in Ladakh, are **[TBC]**.

S1.8.3 **Village waterbodies.** Zings (village ponds) are waterbodies under Clause 7.3 and receive the setbacks of Clause 7.4. Whether a zing in Ladakh is a holding pond on the yura system is **[TBC]**; where it is, Clause S1.8.4 applies to it as well.

S1.8.4 **Yuras.** A yura (irrigation channel) is a supply channel under Clause 7.10. No storm drain shall discharge into a yura, and no yura shall be used as a storm drain, without the consent of the Irrigation and Flood Control Department and of the Halqa Panchayat concerned (set by this Supplement), because a yura carries water for irrigation and, in many

villages, for domestic use.

S1.8.5 **Local terms.** The terms below are used in this Supplement. The meanings are those of Jäschke's *Tibetan-English Dictionary* (1881), which gives the classical spellings; the romanised Ladakhi forms are the customary ones and were not checked in a Ladakhi dictionary, and the Tibetan script is written from the classical spelling. A Ladakhi-speaking reviewer should confirm both **[TBC]**.

Table S1.3 — Local terms

Term (Ladakhi, as commonly romanised)	Tibetan script; classical spelling	Meaning (Jäschke, 1881)	Use in this Supplement
tokpo	གྲོག་པོ; *grog po*	"a deep dell, ravine, lateral valley"	the stream or nallah of a side valley; the regulated watercourse of Clause S1.4
yura	ཡུར་བ; *yur ba*	"aqueduct, conduit, water-course, ditch"	an irrigation channel, protected under Clause S1.8.4
zing	རྫིང; *rdzing*	"pond"	a village pond, a waterbody under Clause S1.8.3
chumik	ཆུ་མིག; *chu mig*	"spring, fountain"	a spring; ground level is the water table near it (Clause S1.6.6)
tso	མཚོ; *mtsho*	lake	a lake, as in Tso Moriri and Tso Kar

> Commentary. The village water official who times the delivery of water and maintains the channels, the *churpon*, is described in secondary sources (as reported); his consent is not made a condition because his role is customary and varies from village to village.

S1.9 Event evidence

> Commentary. **August 2010.** Cloudbursts struck on the night of 4–5 August at Ney, Nimoo and Basgo, and on the night of 5–6 August at Leh, Choglamsar, Saboo and Phyang (District Disaster Management Plan, Leh). IMD placed the Leh burst around 01:30–02:00 IST on 6 August, from "an intense convective cloud clusture" that formed east of Leh by 21:30 IST on 5 August. Seventy-one villages and about 9,000 people were affected; the DDMP records about 233 lives lost, 424 people injured and about 79 still missing, while other accounts give "at least 255" dead and estimates of more than 600 (as reported). The toll is therefore given as a range: 233 recorded dead, about 312 if the 79 missing are counted (NEER arithmetic), and higher in some estimates. The debris flows are described in Clause S1.4 and the rainfall in Clause S1.3. **Other cloudbursts.** The LDMA lists similar events causing "low-intensity flooding and mudslides" in 2006, 2012, 2016 and 2018 (as quoted on its website) **[TBC]**. **2014–2015.** The Gya outburst (2014) and the Phuktal landslide-dam breach (7 May 2015) are described in Clause S1.4. **July 2023.** Heavy rain on 8–9 July (Clause S1.3) was followed in Leh by flash floods from the Skamlung Nallah and the clearance of 27 July 2023 (Clause S1.4). **August 2025.** Leh recorded its wettest August in 52 years and Kargil 33 mm in a day (as reported), and the Council, Kargil assessed areas affected by cloudbursts in a notice of 18 August 2025 (as reported). **Kargil.** Flash floods at Sangra and Khangral, Drass and Holiyal, and Pashkum and Khawos are reported without dates **[TBC]**. These records are evidence only and are not design values (Clause 2.3.4(c)).

To be confirmed

The following are needed before this Supplement could be adopted. Each is followed by the rule that applies until it is confirmed.

1. **Final Ladakh Building Bye-Laws, 2025** (reported as S.O. 121 of 20 February 2026): whether cl. 3.85, 8.5, 8.7(7), 9.1, 9.2, 12.3, 12.4 (16 m) and 12.5 of the draft survive. Until then, the clause numbers of the draft are used, and the 60 m distance of Clause S1.6.2(c) applies.
2. **Rural bye-laws**: whether the draft of 9 October 2025 was made final after its comment period (10 October to 10 November 2025). Until then, the Competent Authority of the draft is read as the Approving Authority in Halqa Panchayat areas (Table S1.1, 1.4.1), under the rural rules in force.
3. **Regulation No. 16 of 2026**: the date of commencement, whether Councils have been constituted for the five new districts, and whether building permission is delegated to the Councils. Until then, the Councils of Leh and Kargil act for the districts formed from them, and the Councils are not Approving Authorities (Table S1.2).
4. **District notification** of 27 April 2026: its number and the operational status of the new districts. Until then, Clause S1.1.1 lists the seven districts as approved, and every rule of this Supplement applies in the same way in each.
5. **Nallah setbacks**: any order of a Council or a Deputy Commissioner after 2010 or 2023 fixing a distance from a nallah. Until one is found, Clause S1.4.4 applies; a wider order, if found, governs under Clause 7.4.5.
6. **IMD records**: annual-maximum series and normals for Leh, Kargil and Drass; whether the annual normal at Leh is about 100 mm or 40–70 mm; whether the 46.4 mm (1995) and 45.2 mm (2006) "highs" are daily or monthly. Until then, the nominal storm of Clause S1.3.3 and the retention depth of Clause S1.3.5 apply.
7. **Rainfall of 2010**: the papers of Hobley et al. (2012) and Thayyen et al. (2013), and the "250 mm" and "356 mm in two hours" figures quoted in the press and in a snippet. Until they are read, no figure for the 2010 burst is used for design (Clause S1.3.6).
8. **CWC zone-7 coverage**: whether the plates of the zone-7 report extend over the Indus, the Shyok and the Zanskar in Ladakh (Plate 1). Until then, the zone-7 report is not used (Clause S1.3.1).
9. **CWC sites**: whether a flood-forecasting site has been added in Ladakh since 2022, and whether CWC's glacial-lake monitoring covers Ladakh's lakes. Until then, Clause S1.5.2 applies.
10. **CGWB**: the aquifer mapping of 2022 for Leh and the district brochure. Until they are read, Clause S1.6.1 applies within 500 m of every drinking source, and Clause S1.6.6 sets the water table.
11. **Kargil events**: the dates of the flash floods of Sangra and Khangral, Drass and Holiyal, and Pashkum and Khawos. Until they are dated, Clause S1.4.3(c) applies to the corridors mapped in those valleys.
12. **Frost depth, pipe cover and snow storage** practice of the Public Health Engineering and Public Works Departments in Leh and Kargil, and the melt rate for Clause S1.7.5. Until then, Clauses S1.7.3 and S1.7.5 apply.
13. **Ladakhi terms**: the pronunciation and usage of tokpo, yura, zing and chumik, from a Ladakhi dictionary or a Ladakhi-speaking reviewer. Until then, the meanings of Table S1.3 are used.
14. **Seismic zone**: Zone V (rural draft) or Zone IV (DDMP, 2011-12). Until then, Zone V applies to stormwater structures (Clause S1.7.7).
15. **Irrigation and Flood Control Department**: the status of the flood-zone master plan reported to have been commissioned from PDCOR, and of its flood-management schemes for Leh and Kargil. Until then, Clause S1.4.2 sets the corridors.
16. **Drain ownership** in Leh and Kargil, as between the Municipal Committees, the Public Works Department and the Irrigation and Flood Control Department. Until then, Clause S1.4.7 applies.

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