Guideline for Design of Common Utility Duct

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Department of Human Settlement
Ministry of Infrastructure and Transport
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Background

A common utility duct is an underground conduit or trench system that houses multiple utility lines (electricity, telecom, water, gas, etc.) together, instead of constructing separate trenches for each service. This approach reduces repeated road cutting, facilitates maintenance, and optimizes space. International experience shows that well-designed utility ducts can accommodate multiple utility lines with minimal additional excavation.

With the initiative from GovTech's Fibre to the Home (FTTH) masterplan, Thimphu Thromde and the Department of Human Settlement, MoIT, developed standard utility duct designs for Thimphu Thromde, taking into account different site conditions. During the 23rd Policy Planning Coordination Meeting (PPCM) of the Ministry of Infrastructure and Transport, the adoption of common utility duct designs and the use of double-wall corrugated (DWC) pipes over the HDPE pipes were endorsed. These designs will serve as a guide for engineers, urban planners, contractors, and officials responsible for urban infrastructure across Bhutan.

Duct Typologies by Settlement Pattern and Right of Way

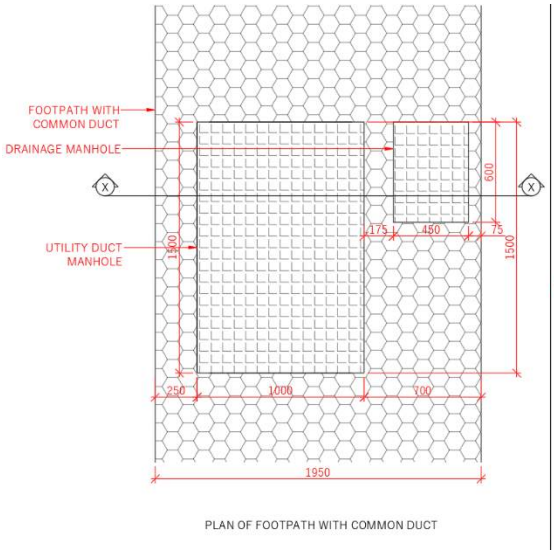
1. Through and Through Duct

The PPCM has formally endorsed four standard duct designs, as proposed by the DHS and Thromde. The adoption of these designs shall be guided by settlement density considerations and the extent of right-of-way available

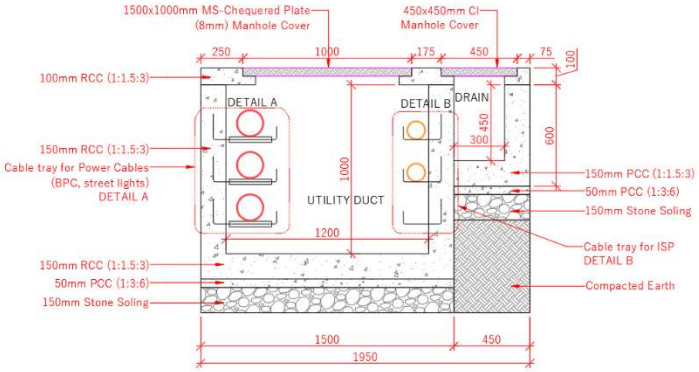
For high-density, mixed-use areas with multiple plot connections and frequent utility interventions, the ***through-and-through duct*** configuration is recommended as shown in the figure. This system shall be designed as a continuous multi-conduit corridor, aligned parallel to the stormwater drainage network to facilitate coordination. The minimum provision of conduits under this typology shall include:

- **BPC Power Supply:**160 mm diameter (DWC) conduit.
- **Telecommunication/ISP Services:**110 mm diameter DWC conduit.

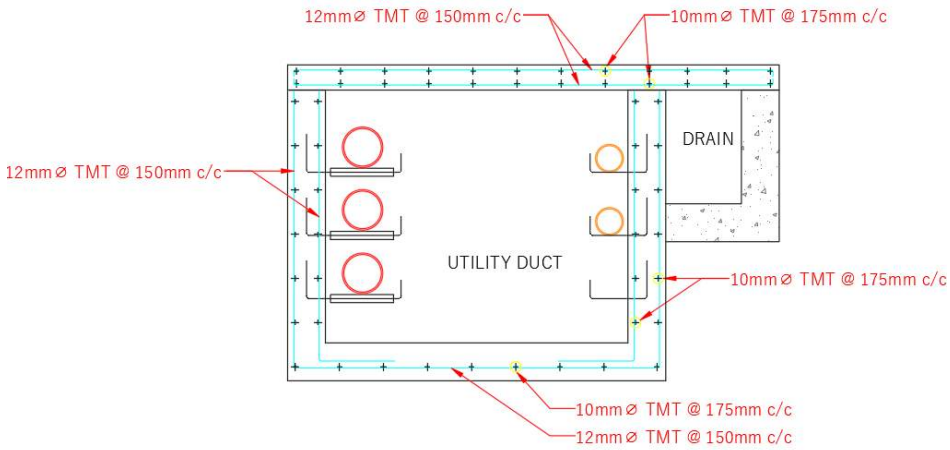
Additional conduits may be incorporated based on projected demand and site-specific requirements.



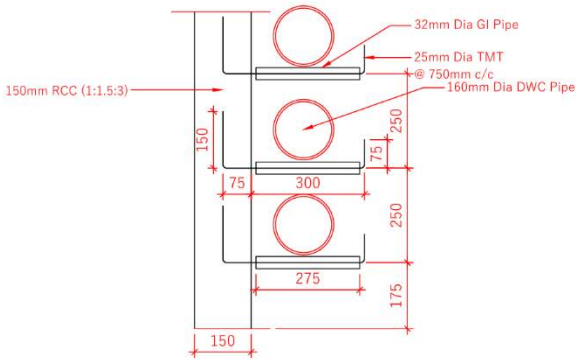
PLAN OF FOOTPATH WITH COMMON DUCT



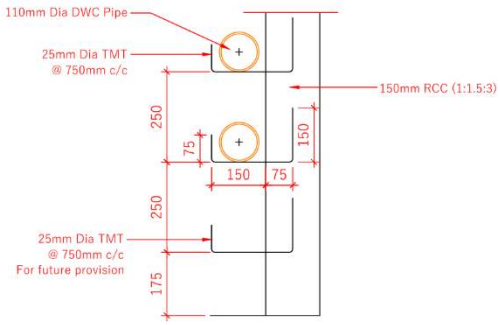
TYPICAL SECTION OF COMMON DUCT (X-X)



TYPICAL REINFORCEMENT DETAILS



DETAIL A



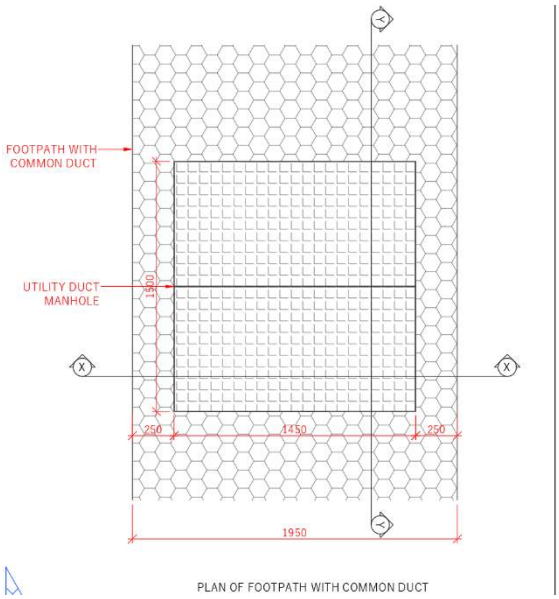
DETAIL B

2. Inspection-Chambered Conduit System

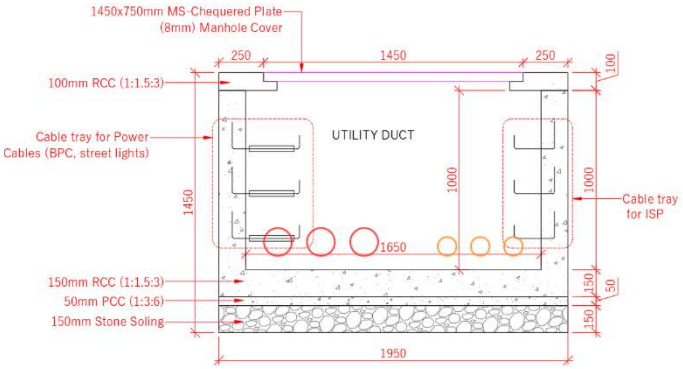
For ***low-density settlements*** with limited-service connections and minimal intervention requirements, the ***inspection-chambered conduit system*** is the recommended duct design. This configuration consists of DWC conduits laid with inspection chambers provided at fixed intervals to enable ease of access for operation and maintenance. The minimum provision of conduits under this typology shall include:

- **BPC power:** 160 mm DWC pipe.
- **ISP/telecom:** 110 mm DWC pipe.

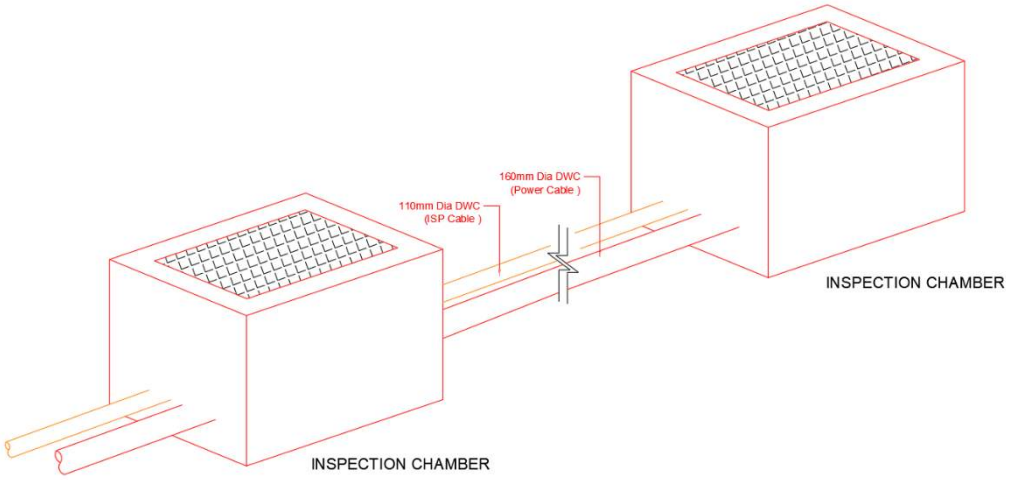
Inspection chambers shall be installed at intervals not exceeding 12 meters. The design shall also include provisions for plot connections to allow easy integration of future service connections when required.



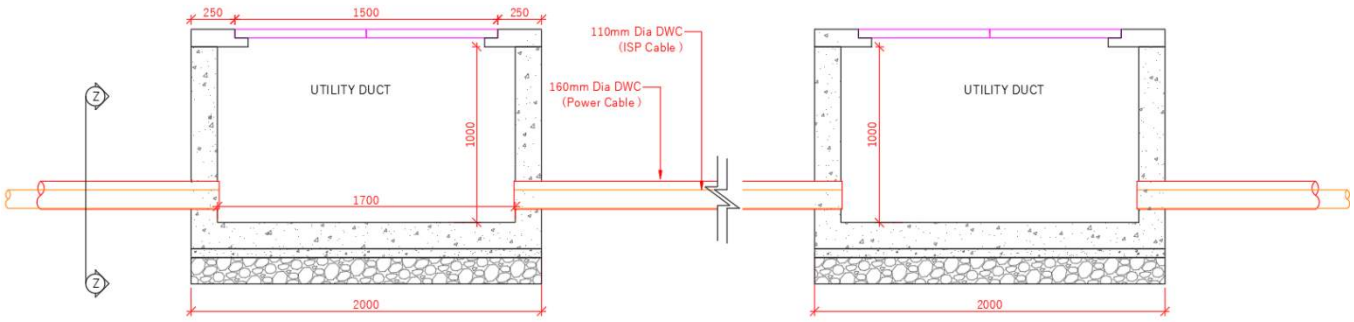
PLAN OF FOOTPATH WITH COMMON DUCT



SERVICE DUCT (SECTION X-X)

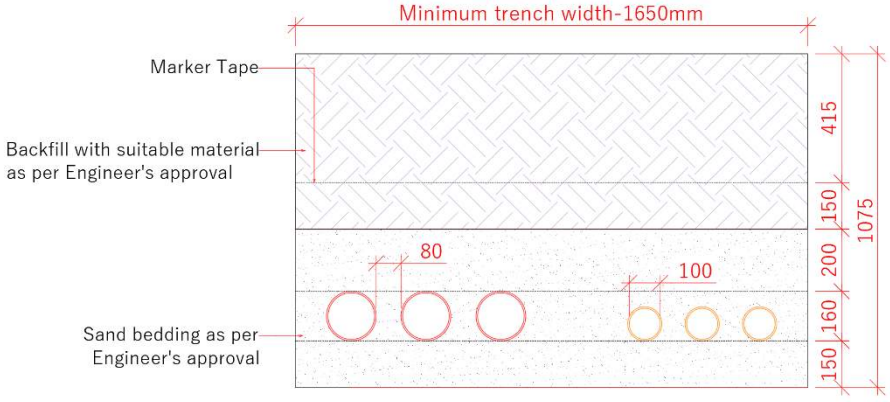


Isometric view of the utility duct

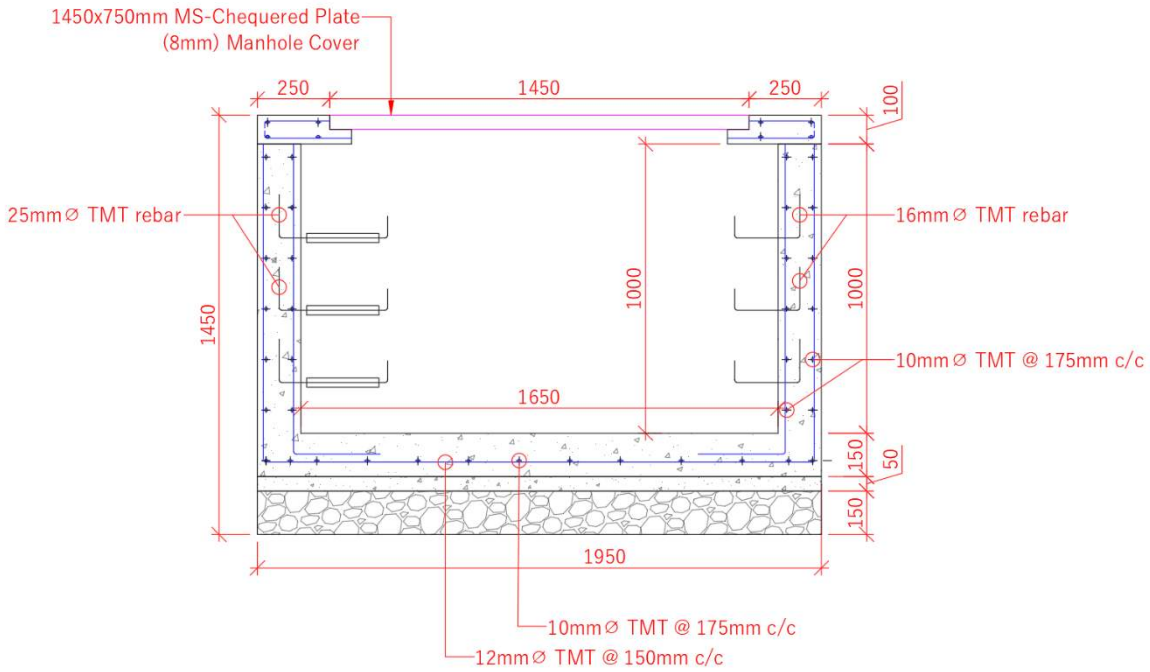


SERVICE DUCT (SECTION Y-Y)

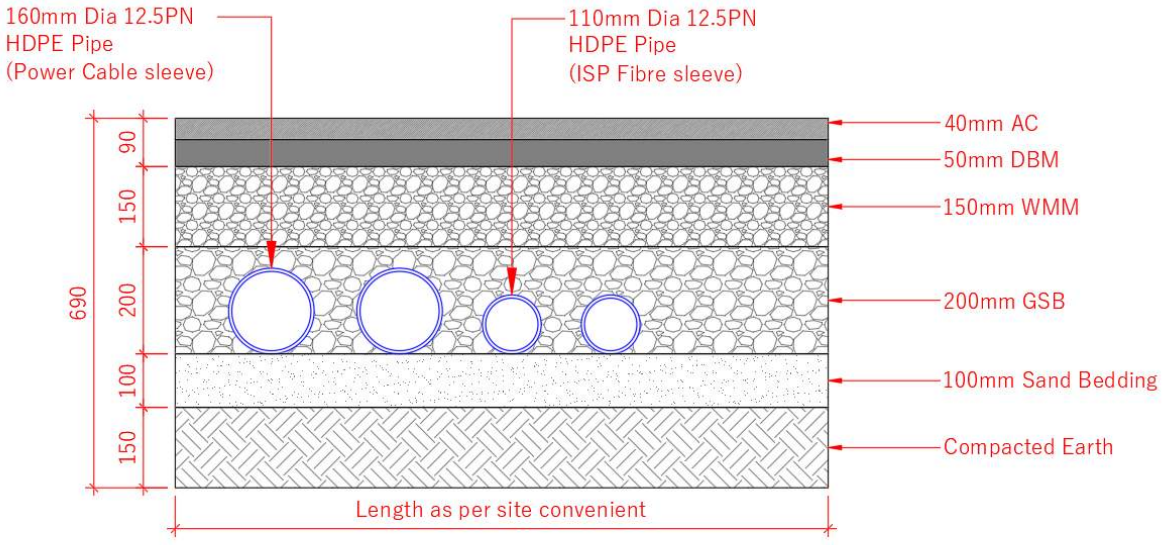
Note: minimum center to center distance between chambers-12meters



Trench backfill and bedding details(section Z-Z)



Reinforcement Details

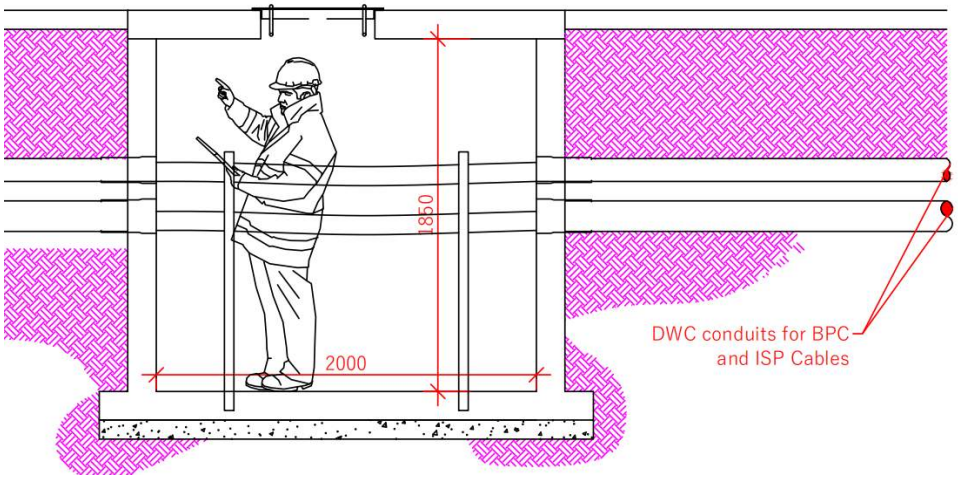


SECTION AT ROAD CROSSING

3. Accessible (Walk-in) Service Duct

This walk-in duct system is an enhanced version of the inspection-chambered design and shall be adopted where a greater number of connections must be accommodated and where direct in-person access for maintenance is essential.

The duct shall be constructed with internal dimensions adequate to permit walk-in access, enabling maintenance personnel to enter and carry out inspection, repair, and installation works safely and efficiently.

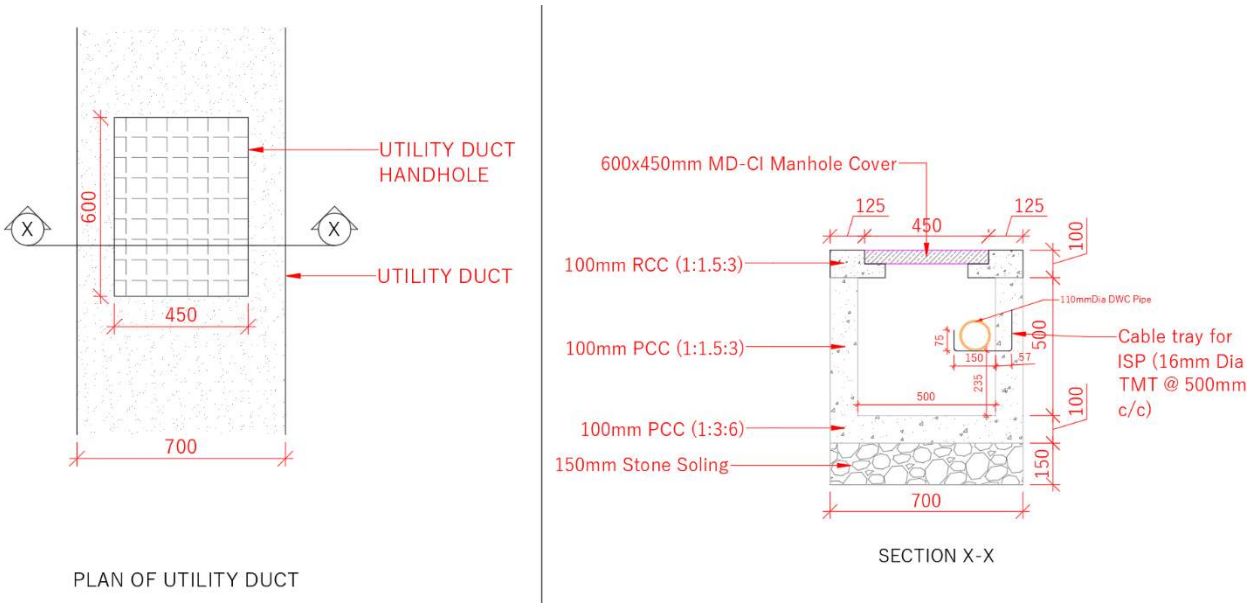


4. Small Connection Duct with Inspection Chambers

This design shall be adopted in locations where space constraints do not permit the installation of abovementioned duct designs. It ensures service continuity while minimizing the land requirement.

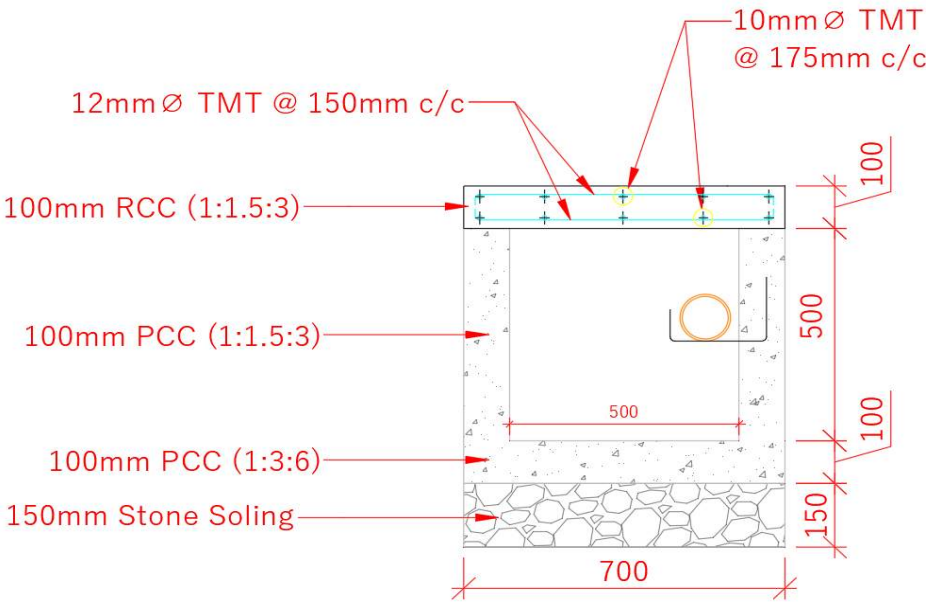
Conduits (minimum):

- **BPC power:** 160 mm DWC.
- **ISP/telecom:** 110 mm DWC.



PLAN OF UTILITY DUCT

SECTION X-X



REINFORCEMENT DETAILS

Technical Standards and Materials

Materials and Diameters

The primary material to be adopted for conduits within the common utility duct shall be ***Double Wall Corrugated (DWC) pipes*** equipped with elastomeric push-fit or coupler joints. DWC pipes are preferred over High-Density Polyethylene (HDPE) pipes due to several technical and economic advantages, as outlined below:

- **Flexibility**
  DWC pipes offer high flexibility, which allows the conduit to conform to the alignment with fewer bends and fittings. This reduces the need for special jointing components and simplifies installation, particularly in constrained urban environments.
- **External Load Resistance**
  The corrugated outer wall of DWC pipes provides superior resistance to external soil loads compared to plain-walled pipes. This structural advantage reduces the bedding requirements during installation and enhances long-term durability under traffic and soil pressure.
- **Cost Efficiency**
  DWC pipes are significantly more cost-effective than HDPE pipes. For example, as per current market rates, a 200 mm DWC pipe costs approximately Nu. 390.80 per metre (Gyalsung project rate), whereas a 200 mm HDPE pipe costs Nu. 2,233.99 per metre (BSR 2025 rate). This represents a cost saving of nearly 80%, making DWC the preferred choice for large-scale utility duct projects.

Baseline Sizes

The baseline internal diameters of DWC conduits to be adopted for major service providers are as follows:

- **Bhutan Power Corporation (BPC):** 160 mm
- **Internet Service Providers (ISP):** 110 mm
- **Stormwater Drainage:** To be designed and sized separately based on catchment hydrology. Storm drains shall not be accommodated inside the dry utility duct but shall be constructed independently to ensure functional segregation and reduce flood risk.

Water Supply in the Common Duct

Advantages of Co-Locating Water Supply

- **Trench Consolidation**
  Locating water supply within the common duct reduces the need for repeated trench cutting and reinstatement. This approach enables coordinated upgrades of multiple utilities within a shared corridor.
- **Easier Leak Detection and Maintenance**
  The instrumented and accessible environment of a utility duct provides opportunities for simplified leak detection and quicker access for maintenance.
- **Future-Proofing**
  Space can be reserved for district metering units, pressure control systems, and smart valves within the duct corridor, enabling future integration of smart water management systems.

Risks and Constraints

- **Flood Risk**
  A burst or leakage in the water main has the potential to flood the duct. Such an event can damage electricity and telecommunication services and may lead to extended service outages across multiple sectors.
- **Cross-Contamination**
  In future, if sewer lines are planned in close proximity, maintaining hygienic separation becomes a significant challenge, increasing public health risks.
- **Material Compatibility**
  Corrosion, condensation, and material degradation risks increase when water is co-located with power and telecom utilities. This demands higher quality assurance (QA) during construction and ongoing monitoring.

Three Mitigation Measures if Water is Included

If water supply lines are to be co-located within the duct, the following safeguards shall be applied:

- **Full Segregation**
  All water lines must be installed in separate, watertight, pressure-rated sleeves with independent drainage connected to a sump. Leak sensors shall be installed for early warning and automated response.
- **Backflow Protection**
  Double check valves shall be provided at entry points, with isolation valves installed at intervals of 100–150 metres for sectional control during emergencies.

- **Bypass Planning**
  External tee connections shall be designed to allow continuity of water supply service in case the duct requires maintenance or isolation.

Recommendations for Bhutan

- **Dense Urban Cores**
  Active water mains shall **not** be co-located within dry utility ducts. Instead, reserved and segregated sleeves or parallel alignments within the road verge should be provided, with clearly marked access points to minimize future trenching needs.

- **Sparse or Greenfield Corridors (Wide Right-of-Way)**
  Water supply may be permitted inside the common duct **only in a fully isolated sleeve** with integrated leak detection and independent drainage. Such inclusion shall be considered only in areas where flood pathways and redundancy of supply can be demonstrated.

Gas Lines in the Common Utility Duct

Advantages

- **Future-Readiness**
  In the event piped gas networks are adopted in select zones, co-locating gas within a shared corridor minimizes surface disruption during installation and future expansions.
- **Centralized Safety Access**
  Purpose-built utility galleries provide a single corridor for gas monitoring, enabling streamlined inspection and maintenance.

Risks and Constraints

- **Safety Hazard**
  Gas leakage inside a common duct poses severe risks of accumulation, ignition, and explosion, especially where electrical cables are also present. Strict requirements for ventilation, detection, and blast relief are necessary to mitigate these hazards.
- **Operational Complexity**
  Managing gas in a shared environment requires ATEX-rated equipment, continuous gas monitoring systems, vent stacks, and blast-relief provisions. These measures introduce a high operational and maintenance burden compared to standalone installations.
- **Current Context in Bhutan**
  Bhutan predominantly relies on LPG cylinders for domestic and commercial use. Piped gas networks are currently limited, reducing the near-term relevance of including gas in common ducts.

Mitigation Measures if Gas is Included

Where gas mains are co-located inside a utility corridor, the following provisions shall be mandatory:

- **Physical Isolation**
  Gas lines shall be installed in a sealed, dedicated "duct-within-duct" configuration, ventilated to the atmosphere through vent stacks spaced at 50–80 m intervals. No electrical joints shall be permitted within the same compartment.
- **Detection and Zoning**
  Continuous gas detection systems shall be installed, with automatic shut-off valves and intrinsic safety zoning to comply with international gas safety codes.
- **Materials**
  Pipes shall be constructed of **yellow PE100** material with electrofusion joints, equipped with tracer wire for detection, and supported with spark-free access hardware.

Recommendations for Bhutan

- **Urban Retrofits and Narrow Rights-of-Way (RoW)**
  Active gas lines shall not be co-located inside common utility ducts. Instead, reserved sleeves or alignments should be provided outside the electrical and telecom compartments to allow for possible future piped gas expansion.
- **New Townships and Industrial Parks (Wide RoW, Typology C Galleries)**
  Gas mains may be considered only under a **fully isolated, ventilated, and monitored configuration**, supported by a dedicated gas safety code and subject to operator readiness. Adoption shall be limited to cases where a piped gas network is justified and long-term operational safety can be assured.

Color Coding and Identification

Standardized color coding shall be applied to all conduits, marker tapes, chamber lids, and labels within and around the common utility duct. This ensures clear identification during construction, inspection, and maintenance, reducing risks of accidental damage and enhancing safety.

Power (Bhutan Power Corporation – BPC)

- **Conduit/Stripe:** Red
- **Marker Tape:** Red
- **Chamber Lid:** Red
- **Labels:** Red with inscription “POWER”

Telecommunications / Internet Service Providers (ISP)

- **Conduit/Stripe:** Orange
- **Marker Tape:** Orange
- **Labels:** Orange with inscription “TELECOM”

Water Supply (If included)

- **Conduit/Stripe:** Blue
- **Marker Tape:** Blue
- **Labels:** Blue with inscription “WATER”

Gas (If included)

- **Conduit/Stripe:** Yellow
- **Marker Tape:** Yellow
- **Labels:** Yellow with inscription “GAS”

Sewer (If Present Nearby)

- **Covers:** Green or Brown
- **Labels:** Clearly inscribed with “SEWER”

Stormwater Drainage

- **Covers:** Dark Green
- **Labels:** Clearly inscribed with “DRAIN”

Implementation Notes

- Color application shall be consistent across conduits, surface marker tapes, chamber lids, and labeling tags.
- Where multi-utility chambers exist, covers shall be painted or embossed with split-color schemes or service-specific inscriptions to avoid confusion.
- Marker tapes shall be installed ***150–300 mm above conduits*** in the trench for early warning during excavation.
- All identification shall conform to a uniform specification to be adopted at national level, ensuring consistency across urban and rural projects.