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RESEARCH ARTICLE

From Approval to Occupancy: Regulatory Translation of Water-System Requirements in Lagos High-Rise Housing

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ABSTRACT

High-rise residential buildings in Lagos rely heavily on water stored, pumped, and distributed within the building, because public supply is limited. Whether they deliver adequate pressure and continuous supply depends on design decisions that regulation could check. This study examined how far Lagos regulatory instruments translate the technical requirements of building water systems into criteria that can be assessed and verified. A qualitative document analysis was conducted on seven instruments: the National Building Code 2006, the 2019 Lagos planning permit and building-control regulations, the Lagos Environmental Management and Protection Law 2017, and comparators from Singapore, South Africa and the United Kingdom. Provisions were coded at clause level against six performance dimensions and two regulatory mechanisms. The building code requires plumbing plans, tests, and inspection before approval, but delegates their technical criteria to a plumbing code whose own schedule does not name, even though it sets measurable criteria for fire-fighting water. The planning regulations require 20,000 litres of underground storage above four floors, a fixed volume unrelated to demand, and the building-control regulations require an annual water-quality test. No measurable criterion was identified in the Nigerian and Lagos instruments for outlet pressure, demand-linked storage, maintainability, or hydraulic commissioning, whereas Singapore states height-linked supply and demand-linked storage. The framework thus recognises building water systems without a clear standard for assessing them, a regulatory translation gap. The study recommends naming a plumbing standard in the code and introducing staged, verifiable water-system requirements from approval to occupancy, subject to local validation.

Keywords: *Building regulation; Translation gap; High-rise housing; Water systems; Building control; Lagos*

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1. INTRODUCTION

Residential development in Lagos has turned increasingly to tall buildings, particularly in Victoria Island, Ikoyi and the Lekki corridor, where land prices favour vertical housing for upper-income households. This growth is taking place against a long-standing deficit in urban infrastructure. Gandy (2006) traced the failure of water provision in metropolitan Lagos to structural

factors that have persisted through the colonial and post-colonial periods, and recent work indicates that the deficit persists (Olabode & Comte, 2024).

Public supply reaches only a limited share of Lagos residents, and households and buildings rely widely on boreholes, wells, and tankers. Recent work describes a wide gap between water demand and regulated supply in the city, together with extensive and largely unregulated use of groundwater (Olabode & Comte, 2024). Groundwater use in Lagos is driven largely by households and drilling contractors in the absence of an effective policy regime (Healy et al., 2020), and household self-supply is largely missing from official data (Danert & Healy, 2021). Self-supply on this scale is common in fast-growing cities and is often overlooked in official figures (Foster et al., 2022).

In a tall building, self-supply is a hydraulic problem as well as a question of source. Water has to be stored, lifted and distributed across many floors. Static head means that an undivided system over-pressurises lower floors and starves upper ones, so designers rely on pressure zoning, break tanks, booster sets and pressure-reducing valves. These choices affect pressure stability and pumping energy (Wong et al., 2017; Müller et al., 2021), and the space they need in plan and section is fixed early in design.

Building regulation is the point at which a public authority could check that these decisions have been made with care. Regulation shapes design practice rather than sitting outside it (Imrie, 2007), so what a regulatory system asks to see influences what designers attend to. In Nigeria, the National Building Code and the Lagos building-control regime developed largely in response to building collapse, and research on them has concentrated on structural safety, stage certification and enforcement capacity (Osuizugbo, 2019; Olatunji et al., 2019). A study of development control in Abuja likewise points to weak enforcement capacity and inadequate monitoring (Abaekwume & Onyeneke, 2026). Other work has assessed the code's adequacy for sustainable construction (Dahiru et al., 2012) and universal design (Sholanke & Adisa, 2025), and has examined residents' experience of building performance, including water supply, in public housing (Ibem et al., 2013; Babalola et al., 2020). Building regulation in general has received less scholarly attention than other regulatory fields (van der Heijden & de Jong, 2009).

The targeted searches carried out for this study did not identify published work specifically examining how Nigerian or Lagos regulatory instruments treat the internal water systems of high-rise residential buildings. It is therefore not known whether the technical requirements of these systems are stated in regulation, checked at approval, and verified during occupation. The study addresses four questions. How do Nigerian and Lagos State instruments address the design, approval, certification and operation of internal water systems in high-rise residential buildings? Which dimensions of water-system performance are explicitly specified, procedurally recognised, delegated to other instruments, or not identified? How do selected international frameworks treat pressure, storage, maintainability, hygiene and verification? Which of their principles could transfer to Lagos, and what would need local validation first?

The paper maps the regulatory treatment of internal water systems in Lagos high-rise housing, offers a clause-level coding framework for comparing building-water regulation across jurisdictions, and sets out staged regulatory options from approval to occupancy. It develops from the second author's master's research, an empirical study of user satisfaction and water-system performance in four high-rise residential buildings in Victoria Island (Wahab, 2026). The present article is a documentary analysis of regulation and reuses no empirical data from that study. It evaluates regulatory provisions only and makes no claim about how buildings in Lagos actually perform.

2. LITERATURE REVIEW

Water-System Performance in High-Rise Buildings

Studies of water systems distinguish the performance a system delivers from the properties that enable it, and treat reliability, resilience and sustainability as related but distinct (Butler et al., 2017). In this study, **water-system performance** refers to the measurable attributes of an in-building system: pressure, storage, vertical distribution, maintainability and water quality. **Reliability** is the outcome these attributes support, namely the capacity to supply water at every point of use, within acceptable pressure, and to keep doing so when the source, equipment or operation is disrupted. Two further elements are treated not as performance attributes but as **regulatory mechanisms**: who is responsible for design and certification, and whether performance is verified at commissioning and in use.

Pressure in a vertical system is governed by static head. Pressure zoning divides a building into bands, each served by its own storage or booster arrangement, so that outlet pressure stays within a usable range. Wong and Mui (2007) modelled water consumption and flow rates for flushing water systems in high-rise residential buildings in Hong Kong to support system design, and Wong et al. (2017) proposed an energy-efficiency benchmark for tall-building supply. Müller et al. (2021) showed that the arrangement of booster stations materially changes investment and operating energy. The taller the building, the more the interaction between source pressure, static head, storage location, pumping, and zoning matters, and the less likely it is that an adequate outcome follows from default practice. This is the engineering reason for treating high-rise buildings as a distinct regulatory case.

Storage buffers a building against interruption of its source and against equipment failure, and its position in the section decides whether supply during an outage relies on gravity or on further pumping. Duplicated pumps and compartmented tanks allow one part of the system to be serviced while the rest continues to supply. Where supply is intermittent, private storage becomes vulnerable to contamination during long interruptions (Lee & Schwab, 2005), and intermittent supply has become a substantial field of research (Zyoud, 2022). Salehi (2022) observes that many households store water in building tanks to cope with frequent interruptions, which creates water-quality hazards that need monitoring.

A system that cannot be inspected or serviced without interrupting supply tends to be maintained reactively, so access to tanks, pumps and valves, and the ability to isolate parts of the system, are design questions with operational consequences. A review of guidance on water quality in building plumbing found significant gaps in standardised recommendations (Singh et al., 2020), and many large buildings lack water management plans (Proctor et al., 2020). In Nigeria, reliance on reactive maintenance has been linked to low user satisfaction in public buildings (Nwaulu-Ori et al., 2026), maintenance is a principal predictor of perceived housing quality in Lagos public estates (Babalola et al., 2020), and water supply is among the areas residents of public housing in Ogun State most want improved (Ibem et al., 2013).

This study adopts the high-rise definition of the National Building Code, which applies its high-rise provisions to buildings, including multiple-family dwellings, "when such buildings have floors used for human occupancy located more than 15m above the lowest level of fire department vehicles access" (s. 7.2.3.1). The threshold is a fire-safety classification used here to define the buildings studied, not a demonstrated hydraulic threshold. The Lagos planning regulations use a different trigger, buildings "of over four (4) floors or above twelve (12) metres in height" (reg. 26(7)).

Building Regulation and the Regulatory Translation Gap

Building regulation can prescribe solutions or specify outcomes. Meacham (2010a) describes performance-based regulation as requiring designers to show how a building meets a stated objective, and notes that such systems attract scepticism where the desired performance is not well defined or agreed. Performance-based systems focus on the outcomes buildings achieve

rather than on prescribed methods (Meacham, 2010b), and more recent work shows how risk can serve as an explicit basis for performance objectives (Meacham et al., 2021). Building water supply suits either approach: outlet pressure or storage relative to demand can be stated as outcomes, while zoning and booster arrangements can be prescribed or left to the designer. Because the relevant rules are usually spread across building codes, plumbing standards, utility regulation and water law, this study interprets each instrument within its wider regulatory system, while recognising that only one principal instrument was examined for each comparator.

Drawing on this literature, on work showing that what regulation asks to see shapes design (Imrie, 2007; van der Heijden & de Jong, 2009), and on evidence from energy-efficient buildings that as-built performance can diverge from design where commissioning and verification are weak (Eon et al., 2020), the paper introduces two analytical constructs. **Regulatory translation** is the process by which a technical requirement becomes something a regulator can act on. It has four steps: the technical requirement; regulatory recognition of the system; an assessment criterion stated in an instrument; and verification that the criterion is met at approval, completion, or in use. A **regulatory translation gap** exists where a framework recognises a building system or creates a point for its review, but does not translate its performance requirements into explicit criteria that can be assessed, certified, or verified. Approval may mean only that documents were accepted, whereas verification establishes that an installed system meets a stated criterion. Figure 1 shows the framework. On the left, building conditions and regulation shape water-system design, which is assessed against stated criteria and then verified. On the right, the four steps of the translation chain are shown, with the gap located between regulatory recognition and the assessment criterion.

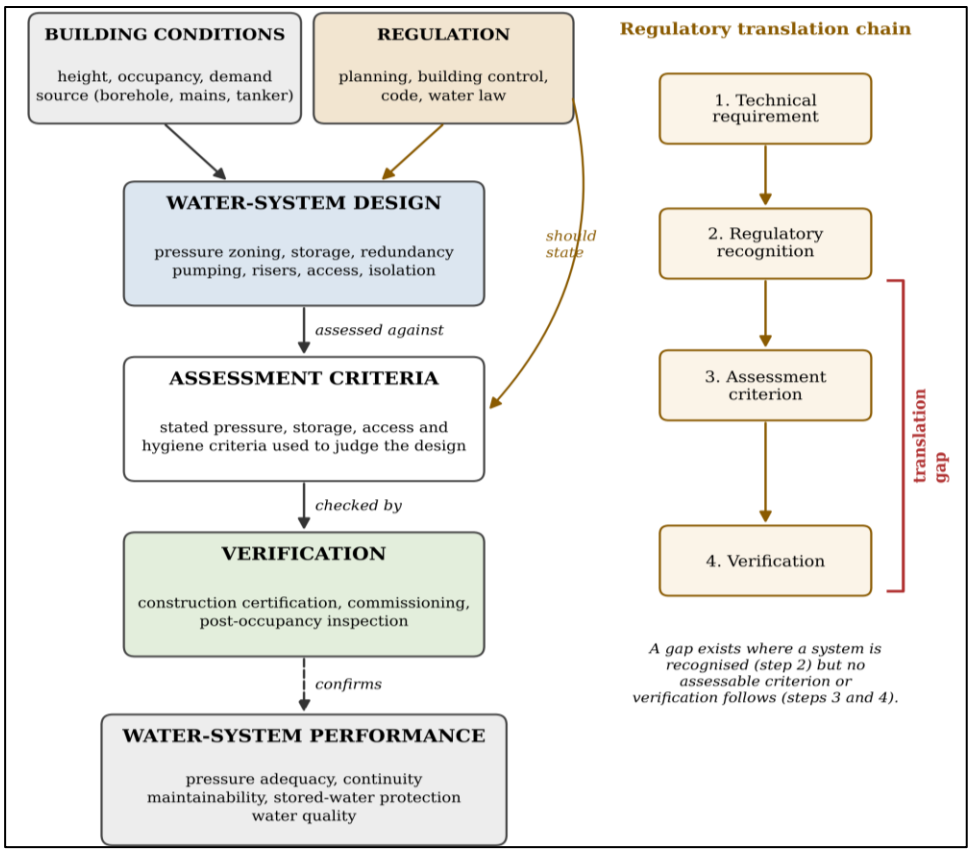


Figure 1. Conceptual framework: water-system design is assessed against criteria and verified (left); the regulatory translation chain and the location of the translation gap (right)

Regulatory Context in Lagos

Four regulatory functions are relevant, and different bodies hold them. Planning approval is administered by the Lagos State Physical Planning Permit Authority (LASPPPA) under the 2019 permit regulations (Lagos State Government, 2019a). Building control is administered by the Lagos State Building Control Agency (LASBCA), which certifies construction stages and issues a Certificate of Completion and Fitness for Habitation (Lagos State Government, 2019b). Water-sector regulation rests with the Lagos State Water Regulatory Commission (LASWARCO) under the Environmental Management and Protection Law 2017, which repealed the earlier Water Sector Law (Lagos State Government, 2017, s. 525; Obani, 2020). Technical standards for building services are set nationally through the National Building Code, whose force in a state depends on adoption and enforcement there. Toluhi (2012) observed that enforcement of the code remained unstructured, while LASBCA's published guide states that the agency "is being governed by Lagos State Urban and Regional Planning and Development Law 2019 as amended, LASBCA regulations and the National Building Codes" (Lagos State Building Control Agency, 2021, p. 1). Studies of Nigerian building control report moderate implementation and weaknesses in enforcement, inter-agency coordination and plan scrutiny (Olatunji et al., 2019; Osuizugbo, 2019), but none of those identified examines how the regime treats building water systems.

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3. MATERIALS AND METHODS

The study used qualitative document analysis, "a systematic procedure for reviewing or evaluating documents" (Bowen, 2009, p. 27). Regulatory instruments suit the method because they are written to be applied, so their omissions can be informative, provided they are read against the wider regulatory system. The analysis was primarily deductive: the coding framework was built from the literature reviewed above and from the second author's prior empirical study (Wahab, 2026) before the corpus was examined, and it was not changed during coding. The unit of analysis was the individual provision, that is, a clause or section.

Data Collection

Documents were identified through searches between 3 and 4 October 2026, using web search engines, Google Scholar, government and regulator portals (the Lagos State Ministry of Physical Planning and Urban Development, the Singapore Public Utilities Board and legislation.gov.uk), the FAO legal database FAOLEX and publisher repositories. Search terms combined jurisdiction names with terms such as "building code", "building control regulations", "physical planning permit regulations", "water sector law", "plumbing code", "water fittings regulations", "storage tank" and "high-rise". The search for prior studies was targeted rather than systematic.

Included were building, planning, building-control and water-sector instruments applicable to Lagos, technical standards referenced by regulation, and official regulatory handbooks in the comparator jurisdictions. Superseded versions, instruments concerned only with fire protection or drainage, model codes not adopted by a jurisdiction, instruments whose primary text could not be retrieved, and secondary descriptions of texts whose primary version could be obtained were excluded. The searches identified 14 candidate instruments, of which seven form the corpus (Table 1). The seven excluded were the Lagos State Water Sector Law (Lagos State Government, 2004), repealed by the 2017 Law; the parent planning law, which was not retrieved; Singapore Standard SS 636, which was not retrieved; the superseded 2012 edition of SANS 10252-1; the Hong Kong plumbing handbook, whose primary text was not retrievable; the International Plumbing Code, a model code rather

than a jurisdictional framework; and a document circulated online as a Nigerian building code that proved to be another country's code. LASBCA's public guide was read for context but not coded, because it is not a regulatory instrument.

Table 1. Instruments in the corpus and evidence examined

Instrument	Legal status	Version and evidence examined
National Building Code 2006	National code; force in Lagos depends on state adoption	First edition (LexisNexis Butterworths); full primary text
Physical Planning Permit Regulations 2019	Lagos State regulations (LASPPPA)	Official text from the Lagos e-Planning Permit portal; commencement date blank
Lagos State Building Control Regulation 2019	Lagos State regulations (LASBCA)	Complete text; commencement date blank
Environmental Management and Protection Law 2017	Lagos State law; Parts VIII (water supply) and X (LASWARCO)	Copy as passed; sections 238 to 263 absent, two of them cited from Obani (2020)
PUB Handbook on Application for Water Supply 2022	Singapore utility handbook giving effect to the Public Utilities Act	8th revision; primary text
SANS 10252-1:2018	South African standard referenced in national regulations	Edition 3.2; partial primary text
Water Supply (Water Fittings) Regulations 1999, Schedule 2	United Kingdom statutory instrument	SI 1999 No. 1148; primary text

Table 1 shows that four Nigerian and Lagos instruments and three comparators were examined, and that the legal status of each instrument is recorded separately from the status of the text, because an authentic text may still be of uncertain legal force. The National Building Code was examined in full, and its schedule of referenced standards (Section 14) was also checked as a page image to rule out an error of text extraction. The two 2019 Lagos regulations are complete texts with blank commencement dates, so their textual evidence is reported without any claim about enforceability. The 2017 Law was read in a copy from which sections 238 to 263 are missing, and the two relevant provisions among them are reported from a peer-reviewed legal analysis (Obani, 2020).

Data Analysis

Each provision was coded against six performance dimensions and two regulatory mechanisms (Table 2). The dimensions were derived from the literature and correspond to the recommendations of the master's study (Wahab, 2026), which called for pressure zoning in high-rise approvals, storage buffering and redundancy, riser coordination at plan approval, and inspection for maintenance.

Table 2. Coding framework

Code	Dimension or mechanism	Indicator sought
D1	Pressure adequacy and limits	Minimum or maximum outlet pressure; height-linked supply arrangements; zoning or pressure reduction
D2	Storage, redundancy and availability	Required storage; capacity relative to demand; compartmentation or duplicated equipment
D3	Vertical distribution space	Service shafts, risers or stacking of wet areas
D4	Maintainability	Access to tanks, pumps and valves; isolation so that servicing does not interrupt supply
D5a	Stored-water protection	Tank covers, overflows and location; cleaning and disinfection
D5b	Water-quality verification	Microbiological or chemical testing of water supplied
M1	Design and certification responsibility	Who must design, install and certify, and at which stage
M2	Verification at commissioning and in use	Commissioning tests; inspection or certification after occupation

As Table 2 shows, D1 to D5b describe attributes of the water system, while M1 and M2 describe how responsibility for them is assigned and checked. Availability is treated as the service outcome supported by storage and redundancy, not as an independent engineering variable, so it is coded within D2. Certification was coded to M2 only as a procedural point unless it verified a stated water-system criterion. Each provision was also given a relationship code, recorded separately from the evidence status of its text (primary, partial primary or secondary). A provision was coded **E** (explicit) where it directly regulated the internal water installation and stated a quantity, threshold or specific obligation; **P** (procedural) where it created an approval, certification or inspection stage without a criterion specific to water installations; **R** (delegated) where it assigned the matter to another code or standard that could not be examined; **I** (indirect) where it concerned water services or providers rather than the building installation; and **T** (terminology) where it only defined a term. **N** recorded that no relevant provision was identified in the text examined, and was never read as evidence that a requirement is absent from the wider regulatory environment. Borderline cases were resolved conservatively: P rather than E unless a water-specific criterion was stated, and T rather than P where a provision only defined a term. A pressure rating of equipment was distinguished from pressure adequacy at outlets: provisions on equipment ratings were recorded but not coded. Relationship codes were used instead of a numerical score, because points accumulated across instruments of different scope are not comparable between jurisdictions.

Passages were extracted verbatim with clause references. The complete extraction and coding sheet is provided as Supplementary Table S1, which contains 55 rows: 46 coded provisions and 9 contextual provisions recorded but not coded. The fixed decision rules and this audit trail make every coding judgement open to inspection.

Comparators were chosen for analytical contrast. Each had to regulate building water installations explicitly and have a mature building-control system. Singapore also has extensive high-rise housing and a tropical climate; South Africa is a sub-Saharan jurisdiction with a national standard for water installations in buildings; and the United Kingdom has a mature statutory treatment of water fittings and a legal tradition that influenced Nigeria's. No comparator relies on private supply to the extent Lagos does, which limits how far any of them can serve as a model. Model codes were excluded because the aim was to compare regulatory systems rather than to identify the best technical standard. Comparators were read as sources of principles, not as benchmarks, recognising that a matter absent from the instrument examined may be governed by another.

Several limitations follow from this design. The plumbing and mechanical codes to which the National Building Code delegates could not be examined, because the code does not identify them, and engineers in practice may apply other standards. A finding that a requirement was not identified is therefore a statement about the instruments examined, not about professional practice, and the Nigerian system may rely on standards applied by convention, just as a comparator instrument may leave service levels to other legislation. Each comparator is represented by a single principal instrument, so an N code for a comparator is weaker evidence of absence than it is for Lagos. The parent planning law could not be retrieved, and whether Lagos has formally adopted the National Building Code was not established. Because the coding dimensions partly reflect the recommendations of the second author's earlier study, the framework may emphasise the attributes that study found problematic. The corpus also did not attempt to catalogue later administrative guidelines or agency initiatives. Finally, the study concerns regulatory provision only, not enforcement or building performance.

4. RESULTS AND DISCUSSION

Nigerian and Lagos Instruments

National Building Code 2006. The code (Federal Republic of Nigeria, 2006) defines a "vertical service space" as "a shaft essentially oriented vertically that is provided in a building to facilitate the installation of building services including mechanical, electrical and plumbing installation" (s. 2.123), but does not require one. It defines a plumbing "riser" only as "the vertical supply pipes in a sprinkler system or straw-pipe system" (s. 2.97), that is, for fire protection.

Section 9 provides that "The design and installation of plumbing systems, including ... water supply ... in buildings shall comply with the requirements of this part and the Plumbing Code listed in the Schedule" (s. 9.1.8.28.1.1). Before a permit is issued, plumbing plans must show each floor at not less than 1:100, all water-supply piping, and "building sections showing vertical and diagrammatic elevations of the soil, waste, vent and water supply lines with traps and valves" (ss. 9.1.8.28.2.1 and 9.1.8.28.2.2). The plans must also show "the minimum water pressure in the main in front of the building or structure" (s. 9.1.8.29.2). "After the prescribed tests and final inspection indicate the work complies in all respects with the provisions of the plumbing code listed in the Schedule, a certificate of approval and acceptance shall be issued" (s. 9.1.8.30.3). Every dwelling must have water "in sufficient quantity to maintain all water supply and plumbing fixtures in a safe and sanitary manner" (s. 9.1.8.31.1). For private sources, "samples shall be submitted periodically to the health official for analysis and approval" (s. 9.1.8.31.3), without a stated interval, and mains-supplied piping may not be connected "with or to piping from underground storage tanks or other unapproved sources" (s. 9.1.8.31.5). Non-potable outlets must be identified (s. 9.1.8.31.6). Mechanical systems "shall be constructed, installed and maintained in accordance with the mechanical code" (s. 9.1.8.1.2) and "shall not be placed in operation until having been tested and approved" (s. 9.1.8.3.1). Water tanks of more than 2,200 litres must have fire-rated supports and a means of emergency discharge, and roof tanks exposed to the weather must have "approved covers" (ss. 12.3.29.12 to 12.3.29.15). Frame inspection follows approval of first-fix plumbing (s. 13.7.5.3), building service equipment "shall not be connected to the water, fuel or power supply or sewer system until authorised" (s. 13.7.6.1), and a certificate of fitness for habitation, as-built drawings and a maintenance manual are required after construction (s. 13.2.4.1).

Section 14, the schedule of referenced standards, lists no plumbing code and no mechanical code; its table for Section 9.1 has column headings but no entries. The code therefore delegates the technical criteria for plumbing approval and testing to a standard it does not identify. By contrast, the code is quantitative for fire-fighting water in the same buildings. Standpipe risers "shall be sized to maintain a residual pressure of at least 65 psi (448kPa) at the topmost outlet of each riser" (s. 12.2.13.16), pressure-reducing devices are required above 690 kPa (s. 12.2.13.29), systems are flow tested (s. 12.2.13.32), and in high-rise buildings maintenance inspections of fire-protection systems are "made quarterly and logged in a journal" (s. 7.2.3.1.1). No provision setting domestic outlet pressure, storage relative to demand, zoning, redundancy or access for maintenance was identified.

Physical Planning Permit Regulations 2019. These regulations (Lagos State Government, 2019a) contain the only quantitative requirement for domestic water storage among the Nigerian and Lagos instruments: "Underground water storage of not less than twenty thousand litres shall be provided in structures above four (4) floors" (reg. 26(3)). The application form asks for the capacity of the underground tank in high-rise buildings (Schedule 1). The regulation sets a fixed minimum volume, however, and does not link it to the number of dwellings, occupants or daily demand; consequently, the ratio of required storage to demand declines as demand increases. It also says nothing about elevated storage, compartmentation or standby pumps, which are the features that allow storage to be cleaned and pumps to fail without

interrupting supply. Floor plans must show the "services proposed" (reg. 4(2)(v)), and the site plan must show the location of the borehole, septic tank and soak-away "in ways ensuring safety, health, good sanitation and structural stability of adjoining properties" (reg. 4(2)(iii)(c)), although no separation distance is stated. Mechanical drawings must be "prepared, signed, sealed by a Mechanical Engineer registered to practice in Nigeria" (reg. 4(4)), and "A high-rise or public building shall be certified by a registered Engineer in respect of its mechanical and electrical plans" (reg. 26(5)). No criterion was identified against which these drawings are assessed for water performance.

Building Control Regulation 2019. This instrument (Lagos State Government, 2019b) requires the developer to "carry out annual, adequate test for water borne disease on any water supplied to a building including those from borehole and wells" (reg. 17(1)) and to ensure the "availability of wholesome water" at points of use (reg. 17(2)). The developer must also "ensure the proper maintenance of all installations, including sanitary fixtures or fittings such as water pipes" (reg. 22(1)(m)), and a maintenance manual must be prepared for every building project (reg. 21(8)). Hot-water systems must resist the temperature and pressure that may occur in normal use or malfunction (reg. 17(4)); this was recorded as an equipment safety requirement and not coded to D1. Approved mechanical designs must be submitted before construction (reg. 3(iv)). Registered mechanical engineers must issue a Certificate of Worthiness for mechanical elements "before occupation of high-rise buildings" (reg. 9(1)), and the Certificate of Completion and Fitness for Habitation depends on mechanical certification and may be withdrawn if a defect is found (reg. 10). A compliance form attests to the "adequacy in size" of underground and overhead water tanks (Schedule 10), but no criterion for judging adequacy is stated. Mechanical ventilation "shall be commissioned by testing and adjusting" (reg. 16(2)), but no equivalent commissioning requirement for water systems was identified.

Environmental Management and Protection Law 2017. The Law repeals the Water Sector Law (s. 525) and governs water supply (Part VIII) and LASWARCO (Part X) (Lagos State Government, 2017). The owner or occupier of premises supplied with water commits an offence if a fitting is kept so that water is likely to be contaminated, and "shall be regarded as responsible for every water fitting on the premises" (s. 266). A "service" is defined as the pipes, valves, cisterns and fittings supplying a tenement from any waterworks, "being the property of the owner or occupier of such tenement" (s. 213), and regulations may be made for "the construction, laying, fitting, alteration or re-adjustment of services" (s. 272(1)(g)), but no regulations made under this power were identified. These provisions are framed around supply from public waterworks, and whether they reach a tower supplied only by its own borehole was not established. LASWARCO's functions include regulating "the abstraction, consumption, production, distribution, supply, sale and use of water", setting standards of performance of services, issuing "licences for private facilities" and regulating "the sinking, operation and management of boreholes and water wells" (s. 312(1)). It may "enter into, inspect and check any premises, facility or estate" to collect water samples (s. 313(6)), and sector operators are referred to the "Lagos State Drinking Water Quality Standard" (s. 313(1)(j)). Providers of "prescribed services" need a licence unless exempted by gazetted order (ss. 343 and 344), but the term is not defined, so it is unclear whether a residential tower supplying its own occupants is covered. Two provisions missing from the copy examined are reported in the legal literature: a duty on the Lagos Water Corporation to ensure that boreholes are hygienically sited and free from contamination (s. 259), and a statement that the Corporation bears no responsibility for the efficiency or safety of installations it has inspected or tested (s. 262) (Obani, 2020). Beyond these provisions, nothing on storage, pressure, or plumbing within buildings was identified in the sections available. Notably, the Law uses height as a trigger for wastewater, requiring a clearance for "a high-rise building that is higher than three (3) floors" (s. 301(2)) and on-

site treatment for buildings of three floors and above in high-density areas (Schedule 3), but no comparable trigger for water supply was identified in the sections available.

Comparator Frameworks

The Singapore handbook links the supply arrangement directly to height: direct supply is permitted where the highest fitting is no more than 25 m above mean sea level, a high-level tank is required between 25 m and 37 m, and a low-level tank with pumping above 37 m (PUB, 2022, s. 2.2.1). High-level tanks "should be sized to be equivalent to the one day's water requirements" and compartmented so that maintenance and cleaning can "be carried out without interruption" (ss. 2.2.2 and 2.2.3). A Professional Engineer must design installations with pumps or tanks, and storage tanks must be inspected and, where necessary, cleaned and disinfected "at least once every 12 months", with the result certified (ss. 3.2.1 and 3.11). The clauses of SANS 10252-1:2018 available for examination give design flow pressures at fittings, from 10 kPa for basins to 200 kPa for high-pressure flush valves (the standard's own Table 3), and require cleaning, inspection, testing and disinfection before an installation is used (cl. 9) (South African Bureau of Standards, 2018). In the United Kingdom, Schedule 2 of the Water Supply (Water Fittings) Regulations 1999 requires cistern covers, overflows with warning and insulation (para. 16(4)), forbids concealing fittings that need maintenance (para. 7(2)), and requires servicing valves for isolation (paras. 10 and 11), but sets no service-pressure or storage requirement.

Table 3. Selected provisions by dimension and jurisdiction

Dimension	Lagos and Nigeria	Singapore	South Africa	United Kingdom
D1 Pressure	Mains pressure recorded (P); criteria delegated to unnamed plumbing code (R)	Height-linked supply (E)	Design pressures at fittings (E)	None in Schedule 2 (N)
D2 Storage	20,000 litres above four floors, fixed volume (E); tank adequacy attested (P); criteria delegated (R)	Storage sized to daily demand (E)	Not verified	None in Schedule 2 (N)
D3 Vertical distribution	Service space defined (T); sections required (P)	None (N)	Not verified	None in Schedule 2 (N)
D4 Maintainability	Duty to maintain; manual (P); criteria delegated (R)	Maintenance without interruption (E)	Not verified	Servicing valves; no concealment (E)
D5a Stored-water protection	No cross-connection; tank covers; liability for fittings (E)	Tank location; annual inspection, cleaning where necessary (E)	Disinfection before use (E)	Covers and overflows (E)
D5b Water quality	Annual test (E); periodic sampling (P)	Annual sample results (E)	Testing before use (E)	None in Schedule 2 (N)
M1 Responsibility	Registered engineers prepare and certify plans (P)	Professional Engineer (E)	Not verified	None in Schedule 2 (N)
M2 Verification	Plumbing tests, content delegated (P and R); annual water test (E); mechanical certification before occupation (P); no hydraulic test identified	Annual certified inspection (E)	Testing before use (E)	None in Schedule 2 (N)

E explicit; P procedural; R delegated; T terminology; I indirect; N none identified in the instrument examined; Not verified: relevant clause not available in the partial text examined. The table identifies provisions in the instruments examined and is not a score of regulatory comprehensiveness.

Table 3 shows that the Lagos framework addresses every dimension in some form, but its explicit provisions concern stored-water protection, water quality and a fixed storage volume. Singapore states explicit criteria for pressure arrangement, demand-linked storage, maintainability and periodic verification; South Africa states outlet design pressures and testing before use; and the United Kingdom states maintainability and cistern-protection requirements.

The Regulatory Translation Gap

The Nigerian and Lagos framework does not ignore domestic water. It requires plumbing plans and sections, a record of mains pressure, sampling of private supplies, protection against cross-connection, a minimum storage volume, engineer-prepared mechanical drawings, an annual water-quality test, and tests and inspection before approval and occupation. What was not identified is a criterion stating what a high-rise water system must deliver in outlet pressure, continuity of supply or storage relative to demand, or a test of hydraulic performance before occupation. Two internal contrasts sharpen this reading. Fire-fighting water in the same buildings is regulated quantitatively, which shows that measurable hydraulic criteria are not alien to the code; and ventilation must be commissioned, whereas no equivalent requirement for water systems was identified. The pattern is consistent with Sholanke and Adisa's (2025) finding, in the field of universal design, that many of the code's provisions are vague and lack detailed specifications or dimensions.

The central finding is therefore not regulatory silence but procedural recognition without an identifiable technical assessment standard. Table 4 traces each requirement through the four steps of the translation chain.

Table 4. The regulatory translation chain for domestic water in the Nigerian and Lagos instruments

Requirement	Regulatory recognition	Assessment criterion	Verification
Outlet pressure (D1)	Plumbing plans; mains pressure recorded	None; delegated to unnamed plumbing code	Plumbing tests, content delegated
Storage (D2)	Sufficient quantity; tank capacity on application	20,000 litres above four floors; not linked to demand	Tank adequacy attested without criterion
Vertical distribution (D3)	Service space defined; sections required	None identified	None identified (plan approval only)
Maintainability (D4)	Duty to maintain; maintenance manual	None identified	None identified
Stored-water protection (D5a)	Tanks, sources and fittings addressed	No cross-connection; tank covers	Inspection before connection; no periodic tank inspection
Water quality (D5b)	Private and building supplies addressed	Annual test for waterborne disease; parameters not stated	Annual test; reporting route not stated
Hydraulic commissioning (M2)	Plumbing and mechanical tests	None; content delegated	Required for ventilation only

As Table 4 shows, some form of recognition was identified for every requirement, but assessment criteria exist only for stored-water protection and water quality, and as a fixed quantity for storage. The gap takes two forms. For pressure and hydraulic testing, the procedural chain is complete while its technical content is missing: the code creates points at which plumbing is examined but delegates the criteria to a plumbing code its schedule does not name, which may leave approving officers to rely on professional convention. For storage, a criterion exists but is prescriptive rather than performance-linked, so compliance does not show that a building of a given size can keep supplying water after its source fails. Water quality comes closest to completing the chain, with an explicit periodic test, although no test parameters or reporting route were identified. The fire-water provisions, meanwhile, show that the code itself can state hydraulic criteria in measurable terms. This gap is consistent with the observation that performance-based systems attract scepticism where performance is not well defined (Meacham, 2010a), and with evidence from energy-efficient buildings that as-built performance can diverge from design where verification is weak (Eon et al., 2020).

Water-system deficiencies may be less visible than structural failure within enforcement regimes built around collapse prevention. LASBCA's guide is consistent with this orientation: it describes the agency's purpose as achieving "a structurally safe, secured and sustainable building among others to prevent incidences of building collapse in the state" (Lagos State Building Control Agency, 2021, p. 1), and mentions plumbing only as a cause of dampness in distressed buildings. A public

guide does not show how inspections work in practice, however, and establishing why no such criteria were identified would require evidence from regulators.

The gap carries particular weight in Lagos. Where buildings rely on private boreholes, internal storage and pumping, responsibility for reliable supply shifts from the public network to the building. Water-sector regulation is directed mainly at providers and services, and its reach to installations inside privately supplied buildings was not established. Responsibility is also divided: LASPPPA approves plans, LASBCA certifies construction, and LASWARCO regulates water, but none of the instruments examined clearly assigns responsibility for verifying the hydraulic performance of a privately supplied residential tower, and whether the annual water test is reported to any agency was not established. This points to an accountability gap rather than a case for merging agencies. Certification regimes can improve practice when they make the professionals who sign off buildings accountable (Dennehy et al., 2023), which suggests that a clearly designated authority for coordinating water-system verification would be valuable even if functions remain distributed.

Transferability and Regulatory Options

Comparator provisions cannot be transferred as they stand. Singapore's height bands assume a pressurised public main, whereas many Lagos towers draw on private sources, so a comparable trigger would need to refer to the building's own storage and pumping. Storage sized to one day's demand presupposes a source that refills within a day, which cannot be assumed for boreholes subject to power cuts, so the appropriate storage autonomy would need local reliability analysis. An annual inspection interval may likewise reflect Singapore's administrative capacity and may not suit Lagos. The absence of a criterion from one instrument also does not prove its absence from the wider system, a caution that applies to the comparators and equally to Nigeria, where approving officers may apply standards that the code does not name. What transfers are principles: link the supply arrangement to height, state storage relative to demand, require storage that can be maintained without interrupting supply, extend existing engineer certification to the hydraulic performance of pumped installations, and verify performance after occupation.

Table 5. Illustrative regulatory options for consideration and validation

Stage	Option	Basis	To be validated locally
1. Planning approval	Extend required plumbing plans and mechanical drawings to include water source, demand, storage strategy, zoning and risers.	Singapore: supply linked to height	Height trigger; content of submission
2. Services design	Engineer's report on outlet pressure, pump duty and standby, zoning, isolation, and demand-linked compartmented storage	Singapore; South Africa	Pressure limits; storage autonomy period
3. Construction certification	Criteria for the existing tank adequacy attestation and mechanical certification	Existing LASBCA forms and Certificate of Worthiness	Criteria content; inspector competence
4. Commissioning	Pressure test at highest and lowest outlets and pump-failure response before occupation	NBC fire-water testing; LASBCA ventilation commissioning	Test protocol; who witnesses
5. Occupancy	Maintenance plan; tank cleaning and pump inspection records	Singapore; LASBCA maintenance manual (reg. 21(8))	Standards for borehole-fed systems
6. Periodic certification	Certified tank inspection reported to an agency; pump inspection as an extension beyond the Singapore provision	Singapore; LASBCA annual water test	Interval, scope and reporting route

Table 5 presents these principles as staged options from approval to occupancy. They are normative proposals drawn from the comparators and engineering reasoning, not findings, because the study did not establish how often pumps fail, how long outages last or what storage autonomy Lagos towers need. Options 3 to 6 could build on existing provisions: the code's plumbing tests, LASBCA's compliance forms and Certificate of Worthiness, its ventilation commissioning requirement, its

maintenance duties and its annual water test. The most direct step would be to name, in Section 14 of the code, the plumbing standard against which plumbing tests are assessed. Any option would add design, testing and inspection costs, and would raise questions this study cannot answer, such as whether LASBCA engineers, independent engineers registered with the Council for the Regulation of Engineering in Nigeria (COREN) or LASWARCO should inspect, whether enough accredited laboratories exist, and who pays. The annual water test already required offers a practical starting point: a reporting route for it, once established, could be extended to cover tanks and pumps. Assessing these questions would require regulatory impact assessment, cost analysis and consultation with the agencies concerned.

5. CONCLUSION

This study asked how far the instruments governing high-rise residential development in Lagos translate the technical requirements of building water systems into criteria that are specified and verified. The National Building Code regulates domestic water procedurally through plans, tests, inspection, and sampling, but delegates its technical criteria to plumbing and mechanical codes that its own schedule does not name. The planning regulations set a fixed underground storage volume for buildings above four floors, and the Building Control Regulation adds an annual water-quality test and mechanical certification before high-rise occupation. No measurable criteria were identified in these instruments for outlet pressure, storage relative to demand, maintainability or hydraulic commissioning, although the same code states such criteria for fire-fighting water. The framework therefore shows a regulatory translation gap: building water systems are recognised, but without an identifiable technical standard for assessing them. This finding concerns the instruments examined. It does not establish that engineers apply no such criteria in practice, that buildings fail to meet them, or that Lagos has no plumbing standards.

The study recommends, first, that the plumbing standard against which plumbing tests are assessed be named in the National Building Code. Second, high-rise approval should require a water-system design report covering outlet pressure, zoning, standby pumping, and storage linked to demand. Third, pressure testing should be added to commissioning before occupation, and the existing annual water test should be extended into periodic certified inspection of tanks and pumps, with a designated agency receiving the results. These options require technical and stakeholder validation before adoption. Future work should establish through interviews which plumbing standards approving offices apply in practice and how LASPPPA, LASBCA and LASWARCO interpret their mandates, confirm the gazetted status of the 2019 regulations, examine the missing sections of the 2017 Law, and extend the comparison to other rapidly growing African cities.

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7. COMPETING INTERESTS

None to declare.

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