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| **Mainstreaming Sound Management of Chemicals into MDG based WASH development policies and plans** |
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**Components of Water Supply, Sanitation and Hygiene (WASH)**

* Drinking water supply
* Management of human wastes
* Promotion of personal hygiene
* Management of wasterwater as it affects drinking water sources- domestic, medical and industrial
* Goal 7 Target 3 -Access to WASH- What does it mean..water supply quality, safe sanitation physical access- 200 metres for water supply and 500 metres for sanitation in public places and affordability
1. **Contribution of Sound management of chemicals into WASH related MDG goals**

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| Millennium Goal by 2015 | Contribution/Hazard |
| **Poverty** To halve the proportion of the world’s people whose income is less than $1/day  | **Contribution*** Access to improved WASH services boost school enrolment and frees incomes from treatment of water related diseases.
* Access to affordable WASH services increase disposable income on other essentials such as feeding, education, and housing.
* Improved health increases production capacities, reduce burden on those who care for the sick.

**Hazard*** Chemicals can contaminate surface water, pollute groundwater, reduce water quality, and reduce access to safe water, sanitation, and health services.
* Increase cost of water treatment will also exacerbate poverty.
 |
| **Hunger**To halve the proportion of the world’s people who suffer from hunger | **Contribution*** Reliable water for subsistence agriculture, home gardens, livestock, tree crops
* Water scarcity may lead to malnutrition.- WASH **Improved access to water supply and sanitation promotes healthy growth of human beings- water is life, sanitation is dignity**
* Healthy people are better able to absorb the nutrients in food than those suffering from water-related diseases, particularly worms

**Hazard*** Chemicals can contaminate surface water, pollute groundwater and generally reduce water quality. …in arid or water scarce areas.
 |
| **Primary Education**To ensure that children everywhere complete a full course of primary schooling | **Contribution** * Improve school attendance from improve health and reduce water-carrying burdens, especially for girls
* Menstrual Hygiene Management…..Having separate sanitation facilities for girls and boys in schools increases girls’ school attendance…Cases of rape of girl child while accessing latrines in school (Wateraid study 2012)

**Hazard*** Chemicals can contaminate surface water, pollute groundwater and generally reduce water quality.
* Water scarcity and poor sanitation facilities may lead to school drop outs especially by the girl child , and preventable deaths from water borne diseases.
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| **Gender Equity**To ensure girls and boys have equal access to primary and secondary education | **Contribution** * Reduced time, health, and care-giving burdens from improved water services give women more time for productive endeavors, adult education, empowerment activities, leisure
* Water sources and sanitation facilities closer to home put women and girls at less risk for sexual harassment and assault while gathering water and searching for privacy
* Higher rates of child survival are a precursor to the demographic transition towards lower fertility rates; having fewer children reduces women’s reproductive responsibilities
* Water scarcity may lead to school drop outs by the girl child
* Poor sanitation services affects safe Menstrual Hygiene Management; and reduces school enrolment by girl child

**Hazard*** Chemicals can contaminate surface water, pollute groundwater and generally reduce water quality.
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| **Child Mortality**To reduce by two-third the death rate for children under five | **Contribution** * Improved quantity and quality of domestic water and sanitation reduce main morbidity and mortality factor for young children
* Improve nutrition and food security reduces susceptibility to diseases

**Hazard*** Chemicals can contaminate surface water, pollute groundwater and generally reduce water quality.

Water scarcity may lead to school drop outs, and preventable deaths from water borne diseases. |
| **Maternal Mortality**To reduce by three-fourths the rate of maternal mortality | **Contribution** * Improve health and reduce labor burden from water portage reduce mortality risks
* Improve health and nutrition reduce susceptibility to anemia and other conditions that affect maternal mortality
* Sufficient quantities of clean water for washing pre-and-post birth cut down on life threatening infections
* Higher rates of child survival are a precursor to the demographic transition toward lower fertility rates, and fewer pregnancies per woman reduce maternal mortality

**Hazard*** Chemicals can contaminate surface water, pollute groundwater and generally reduce water quality.
* Water scarcity may lead to preventable deaths from water borne diseases.
 |
| **Major Disease**To halve, halt and begun to reverse the spread of HIV, malaria, other major diseases | **Contribution** * Better water management reduce mosquitoes habitats
* Better water management reduce incidence of a range of other water-borne disease
* Improved health and nutrition reduces susceptibility to/severity of HIV/AIDS and other major diseases

**Hazard*** Chemicals can contaminate surface water, pollute groundwater and generally reduce water quality.
* Water scarcity may lead to preventable deaths from water borne diseases and increase the burden of people living with HIV/AIDS
 |
| **Environmental sustainability**To stop the unsustainable exploitation of natural resources and to halve the proportion of people who are unable to reach or afford safe drinking water | **Contribution** * Improve water management, including pollution control and water conservation, key factor in maintaining ecosystems integrity
* Development of integrated management within river basis creates situation where sustainable ecosystems management possible and upstream-downstream effects are mitigated
* Biodiversity conservation, combating desertification furthered by sound water management

**Hazard*** Chemicals can contaminate surface water, pollute groundwater and generally reduce water quality.
* Water scarcity may lead to school drop outs, and preventable deaths from water borne diseases.
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1. **Definition of terms/Scope of this paper**

The scope of this paper, covers drinking water for domestic use; and Sanitation which includes: safe collection, storage, treatment and disposal/re-use/recycling of human excreta (faeces and urine); drainage and disposal/re-use/recycling of household wastewater (often referred to as sullage or grey water); drainage of storm water; • treatment and disposal/re-use/recycling of sewage effluents; and collection and management of industrial waste products.

1. **Causes of water pollution in Nigeria**

Galadima A. (2010) identified three chemical based/related causes of water pollution in Nigeria:[[1]](#footnote-1)

1. Local market induced water pollution
2. Oil Spill based water pollution
3. Agricultural pollution
	1. **Local Market Induced Water Pollution**

 Abattoirs mainly in urban centres and small towns discharge blood, feces and related wastes from animal slaughter into gutters and drainage system, and ultimately into rivers, lakes, hand dug wells and reservoirs used by people as sources of household water.

* 1. **Oil Spill Based Water Pollution**

Oil spillage is a result of leakage of hydrocarbon from the pipes. To a large extent, poor maintenance of oil pipelines and poor monitoring of pressure regimes of the fluids with respect to the strength of the pipe are the main causes. Production of oil and gas is usually accompanied by substantial discharge of wastewater in the form of brines. Constituents of brines include sodium, calcium, ammonia, boron, trace metals, and high total dissolved solids (TDS). In Nigeria, fifty percent (50%) of oil spills is due to corrosion, twenty eight percent (28%) to sabotage and twenty one percent (21%) to oil production operations. One percent (1%) of oil spills is due to engineering drills, inability to effectively control oil wells, failure of machines, and inadequate care in loading and unloading oil vessels (Peter and Olusegun, 2006).

* 1. **Agricultural Pollution**

Agriculture, is the single largest user of freshwater on a global basis and a major cause of

degradation of surface and groundwater resources through erosion and chemical runoff. The associated agro food-processing industry is also a significant source of organic pollution in Nigeria.

 A wide range of contaminants can reach these rivers, lakes and streams either by groundwater or through drainage ditches including artificial fertilizer residuals. The primary agricultural pollutants are nutrients (particularly nitrogen and phosphorus), sediment, animal wastes, pesticides, and salts. Agricultural sources enter surface water through direct surface runoff or through seepage to ground water that discharges to a surface water outlet.

Also various farming activities result in the erosion of soil particles. The sediment produced by erosion can damage fish habitat and wetlands and, in addition, often transports excess agricultural chemicals resulting in contaminated runoff. This runoff in turn affects changes to aquatic habitat such as temperature increases and decreased oxygen. The most common sources of excess nutrients in surface water are chemical fertilizers and manure from animal facilities. Such nutrients cause eutrophication in surfacewater.

Pesticides used for pest control in agricultural operations can also contaminate surface as well

as ground-water resources. Return flows, runoff, and leachate from irrigated lands may transport sediment, nutrients, salts, and other materials. Finally, improper grazing practices in riparian, as well as upland areas, can also cause water quality degradation.

Nitrates also soak into the ground and end up in drinking water. Health problems can occur as a result of this and they contribute to methemeglopbinemia or blue baby syndrome which causes death in infants. Ammonia, pesticides as well as oil, degreasing agents, metals and other toxins from farm equipment harm and kill aquatic life and animals and cause health problems when they get into drinking water. Bacteria and parasites from animal waste can get into drinking water which can cause illness and death.

Heavy metals poisoning is also a serious health and environmental problem, that in most

Nigerian reports, results from absorption in contaminated water or via associated food.

* 1. **Others:** Other causes of ground and surface water pollution are Leaching of contaminants at dump sites, with its resultant adverse effect on groundwater quality and disposal of medical wastes into drainages.
1. **Case studies**
2. Chukwu (2008) reported a study on the ground water pollution from abattoir waste in Minna state; and analysed wells showed physical, chemical and organic parameters that exceed the upper boundaries set by WHO. The waters are generally hard, containing elevated concentrations of CaCO3, MgCO3, sulphates, nitrates, phosphates and heavy metals.
3. Nwanta et al. (2010) reported that a total of 194 kg of solid waste is generated daily in Nsukka metropolitan abattoir, without any hygienic disposal and/or management system. In addition to these, elevated heavy metals concentration, that is some time more than one thousand (1000) times the permissible limits in drinking water, had been reported from Oko-oba abattoir, Lagos state (Adeleye and Adebiyi, 2003).
4. Ibetoand Okoye (2010) conducted a study on 240 people, comprising of children, pregnant/nursing women and men in Enugu state. Nickel, manganese and chromium were detected with concentrations exceeding the allowed limits permitted by WHO, in the blood samples of the respondents. The poisoning was generally believed to be occupational and water-based.
5. More than 400 children from seven villages around Gummi and Bukkuyum Local Government areas of Zamfara state, died from Lead poisoning within just six months in 2010. Medical experts’ reports from the state Ministry of Health and Medecins Sans Frontieres (MSF) described the affected children to show devastating symptoms such as; “gastro-intestinal upsets, skin rashes, changes of mood; some were lethargic, some partially paralysed, some had become blind and deaf. The worst affected were coming into the small Ministry of Health clinic with seizures that could last for hour and would sometimes lead to coma and then often to death.”

The poisoning which is primarily associated with mineral exploitation, consumption in water and food and air-based inhalation, have so far affected 3,600 children, with further expectations that180 villages covering around 30,000 people may be affected.

1. Between 2004 and 2005 six countries, including Nigeria, participated in a World Health Organization/United Nations Children’s Fund (WHO/UNICEF) pilot project aimed at testing a rapid, low-cost method for assessing drinking-water quality in the field. The method, the Rapid Assessment of Drinking-Water Quality (RADWQ), was based on the UNICEF Multiple Indicators Cluster Surveys, and was developed as a tool for the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) to monitor global access to safe drinking-water

Nationally, overall compliance with WHO guideline or suggested values for drinking-water quality was 72.9% for all water sources (excluding household samples), but this figure varied significantly by parameter, by technology type and by broad area. Protected dug wells, for example, had the lowest compliance levels, with values ranging from 22% to 100%, and a national average of 51%. Of the water quality parameters tested, national compliance was lowest for turbidity (61%) and pH (58%)

The results of the sanitary risk inspections showed that the major factors affecting sanitary status were pollution of the area around the water point and poor maintenance. In addition, only 4% of the samples tested had adequate levels of free chlorine.

Most of the water sources assessed by the RADWQ pilot project showed good compliance nationally for all the parameters tested. However, cases of extreme values were detected in certain locations, and it is recommended that the following areas be further investigated:

* Barkinladi in Plateau State; Girei, Song and Unguwar Fulani in Adamawa State; Eruwa in Oyo State; Argungu in Kebbi State; Hausa Quarters in Katsina Ala; and Ajila town in Benue State had nitrate values well above the WHO guideline value of 50 mg/l (range: 83.6–246.4 mg/l). An in-depth study of water quality in the areas is recommended.
* Fluoride levels in excess (range: 6.5–22 mg/l) of the WHO guideline value of 1.5 mg/l were recorded at Damaturu, Yobe State, St. Louis College, Jos, Wase, Langtang and Water Board Quarters in Pajat (all in Plateau State), and at Eruwa town in Oyo State. Most fluoride found in drinking-water is from natural sources. Excess fluoride is associated with dental and skeletal fluorosis that may cause deformation and disability in susceptible individuals. Consequently, an analysis of fluoride levels during the development of groundwater sources should be standard policy in such areas.
* The assessment showed that water sources in many parts of the country had a low pH, and only 56% of the samples tested nationally were in compliance with the WHO suggested range (6.5–8.5). Extreme cases were recorded in Wase, Plateau State (Hydrological Area 4), where pH values as low as 3.6 was recorded for a handpump at Angwan Turawa, and 3.9 in a hand-dug well at a government secondary school. A pH value of 3.7 was also obtained in a mechanized borehole at Yaba, Lagos State.
1. A random sampling of drinking water sourced from wells and boreholes from eight local governments in Kaduna north senatorial district of Kaduna state and analysis for Arsenic elucidation using standard laboratory method shows high arsenic concentrations above the Maximum Contamination Level (MCL) of 0.01mg/L set by World Health Organization (WHO) and agreed by Standard Organization of Nigeria (SON).[[2]](#footnote-2)
2. The results of a similar study by H. Musa (2008) to determine the concentration of arsenic in wells and boreholes water in Zaria,shows 75% of the samples above the World Health Organization drinking water guideline. Bore whole water samples were found to contain less arsenic compared with the shallow well water samples studied. Most wells and boreholes in Zaria were found to be contaminated with abnormal concentration of arsenic sufficient enough to cause serious health hazards to the users.[[3]](#footnote-3)
3. **Chemicals and drinking water quality**

The following chemicals naturally occurs in drinking water at concentrations well below polluting or toxic levels. They may however pose an health risk at higher concentrations.

1. Chloride
2. Sulfate
3. Arsenic
4. Barium
5. Boron
6. Chromium
7. Fluoride
8. Manganese
9. Molybdenum
10. Selenium
11. Uranium (chemical aspects)
12. Dichloroethane, 1,1
13. Di(2-ethylhexyl)adipate
14. Monochlorobenzene
15. Trichlorobenzenes
16. Trichloroethane, 1,1,1-
17. **Chemicals and water related diseases**

The WHO defined water-related disease as any significant or widespread adverse effects on human health, such asdeath, disability, illness or disorders, caused directly or indirectly by the condition, or changes in the quantity or quality, of any waters. The causes of water-related disease include micro-organisms, parasites, toxins and chemical contamination of water. These diseases are due to either excess or deficiency of certain chemicals in the water

Some of these industrial chemical discharges are very stable in the environment; they do not break down easily. They chemicals enter the food chain at higher levels than would otherwise occur because they are highly migratory in water and they affect the quantity that should be present in the water environment naturally. They can be categorized into three groups:

1. Heavy metals
2. Synthetics Organic Contaminants (“ CIDES” Dioxin, Polychlorinated Biphenyls-PCBs)
3. Volatile Organic Compounds(Benzene, Toluene and Vinyl Chlorides)

Heavy Metals

These are naturally occurring metal in rocks, soil and are most of the time found in water body as a result of geological operations, industrial effluent and leachate of landfill; most common of these metals are Mercury (Hg), Lead(Pb), Selenium(Sc) and Cadmium(Cd)

Health implications of Heavy Metals

* Exposure to Hg causes tremors, gingivitis, minor psychological changes, spontaneous abortions and physical deformations of the body and organs of the body.
* Over exposure to or abortion of Pb causes Kidney, gastrointestinal and reproductive dysfunction, as well as damage to the nervous system
* Over exposure to or absorption of Cd can cause Kidney dysfunction, lung disease and has been linked to lung cancer. It can cause bone defects.
* Over exposure to or absorption of Sc causes damage to the kidney, liver and circulatory system (blood and heart and blood vessels) and severe damage to the nervous sytem.

Synthetic organic chemicals

This is a large group of chemicals that include all the CIDEs i.e. Pesticides (Chlordane), Herbicide (Atrazine), Fungicides (Furan), Dioxins and PCBs, detergents, dyes and other industrial chemical. In water they are toxicants to plants, animals and humans; they enter the hydrosphere via usage, accidental or industrial disposal of waste from manufacturing units and also during their transport. All of the CIDEs and Furans are sprayed on crops as a way of controlling pests. Dioxins and PCBs are by-products of incineration of waste, power generation (used as dielectic fluids in transformers), metal production and fuel burning.

Health implications of some Synthetic Organic Chemicals

|  |  |
| --- | --- |
| Synthetic Organic Chemical | Health Implication |
| Short Term exposure Effect | Long Term exposure Effect |
| Chlordane | Tremors, Convulsions, Blood Illness such as Anemia and Leukemia | Damage the Liver, Kidney, Heart, Lung and causes Cancer |
| Atrazine | Congestion of Heart, Lung and Kidney; muscle spasms and weight loss | Cardiovascular breakdown, damage of eye and muscle function and Cancer |
| Furan | Headaches, dizziness, muscle weakness | Damage to nervous and reproductive systems |
| Dioxins | Causes damage to the immune system and liver, reproductive damage, infertility and birth defects as well as cancer |
| PCBs | Causes spasms, vision problems, liver damage as well as cancer. |

Volatile Organic Chemical (VOC)

These are man made water contaminants and they include compounds such as Benzene, Toluene, Vinyl Chlorides. Benzene is the building block for most plastics; Toluene is a major industrial organic solvent and cleansers and Vinyl Chlorides are the key ingredients in rubber, paper and glass. It is found in most automobiles, musical instruments, cables and pipes (PVC pipes).

 Health Implications of VOC

Short term high exposure to VOCs can cause a depression of the immune system and temporary nervous system disorders; long term high exposure can cause chromosome deformations and cancer, damage to the nervous system including tremors and spasms, vision problem, coordination and speech problems and damage to the kidney and livers.

1. **Industrial chemicals**

The following chemicals from industrial sources and human dwellings that are of health signiﬁcance in drinking-water. For some of them, concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, leading to consumer complaints.

**Inorganics**

1. Cadmium
2. Cyanide
3. Mercury

**Organics**

1. Benzene
2. Carbon tetrachloride
3. Di(2-ethylhexyl)phthalate
4. Dichlorobenzene
5. Dichlorobenzene
6. Dichloroethane
7. Dichloroethene,
8. Dichloroethene
9. Dichloromethane
10. Edetic acid (EDTA)
11. Ethylbenzene
12. Hexachlorobutadiene
13. Nitrilotriacetic acid
14. Pentachlorophenol
15. Styrene
16. Tetrachloroethene
17. Toluene
18. Trichloroethene
19. Xylenes

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| **Industry**  | **Likely Chemical waste** |
| Steel works | Particulate matter, suspended solid, oil, grease, dissolved iron, high level of metal and acids, phosphates, chlorides, metal complexing agents, etc |
| Food processing | Biodegradable organic matters, molasses, bagasse, dissolved solids |
| Tanneries | Chromium, oxygen demanding organic matters, acids, Nitrogen compounds, oil, greases etc |
| Metal fabrication and finishing  | Cyanides, toxic metals, oil, caustic soda and acids. |
| Textiles | BOD, surfactant, oxidizing bleaching and reducing agents, silicates, dyes, chromium, lead, zinc etc |
| Pharmaceuticals | Alkaloids, acids etc |
| Petroleum refineries and petrochemicals | Hydrocarbons, Nitrogen Oxides, Sulphur Oxide, Chromium, lead, zinc, copper, Nickel, Cadmium etc  |

1. **Agrochemicals**

The following chemicals from agricultural activities and resulting run off/percolation may also affect water quality, and at high concentrations, may have toxic effect on water consumers.

1. Ammonia
2. Bentazone
3. Dichloropropane,
4. Diquat
5. Endosulfan
6. Fenitrothion
7. Glyphosate and AMPA
8. Heptachlor
9. Malathion
10. Methyl parathion
11. Parathion
12. Permethrin
13. Phenylphenol
14. Propanil
15. **Water treatment chemicals**

The following chemicals used in water treatment may also have potential polluting effects at high concentrations, though this has not been clearly established due to inadequate data.

1. Disinfectants
2. Chlorine dioxid
3. Dichloramine
4. Iodine
5. Silver
6. Trichloramine
7. Disinfection by-products
* Bromochloroacetate
* Bromochloroacetonitrile
* Chloroacetones
* Chlorophenol,
* Chloropicrin
* Dibromoacetate
* Dichlorophenol
* Monobromoacetate
* MX
* Trichloroacetonitrile
1. **Water supply infrastructure chemicals**

The following contaminants from pipes and ﬁttings occurs in drinking water at concentrations below toxicity levels and therefore don’t pose health concerns.

1. Asbestos
2. Dialkyltins
3. Fluoranthene
4. Inorganic tin
5. Zinc
6. **Solutions**

Conceptual policy framework

* Pollution management hierarchy that emphasize waste prevention and reduction over recovery and recycling should be adhered to-it’s much more cost effective to prevent chemical waste than to deal with pollution after it occurs
* “worst first” principle should guide the area or industry of major concentration
* Polluter pays principle should be adopted

Legal and Regulatory Framework

* Apart from the existing environmental regulations, there should be inclusion of a community right-to-know regulation and the integration of Market Based Incentive into the current regulation.
* Promulgation of robust pollution prevention regulations
* National environmental standards should be reviewed to meet need of the time

Removal of subsidies from pollution control and abatement equipments

Pollution charges and penalties

* Administration of charges proportional to the kind and quantity of chemical pollution generated

Monitoring and Enforcement

* Development of realistic enforcement time table
* In the monitoring and enforcement bid, the role of municipalities, the department of water resources, River Basin Authorities, NGOs, Industrial Association etc should be clearly defined as much as that of NESREA and the state SEPAs
* Establishment of laboratory capable of evaluating environmental conditions

Joint treatment facilities and hazardous chemical waste disposal

* Ownership of jointly owned waste water treatment cum effluent by commercial firms should be encouraged by the state
* There should be secure landfill for disposal of dewatered sludge

Financing requirement

* Removal of tarrif and tax from waste abatement plants and equipments
* Provision of lines of credit from government source for pollution control investment

Public Education

* Train NGOs in Pollution Monitoring and Environmental Education
* Incorporate environmental Health and industrial pollution awareness in environmental education programme

Promulgate community right to know Legislations

* 1. **Controlling Chemical Pollution**
1. Ambient water protection and waste water control
2. Drinking water protection
3. inventory of existing POP pesticide stocks in the country
4. Capacity development, development of safety guidelines, administrative and legislative framework to ensure that management of these chemicals substances is in such a manner as to reduce or eliminate their health and environmental risks.
5. Bring together all ministries with responsibilities in the area of chemicals management to establish an Inter-Agency Cooperation Mechanism for making decisions and forming policies and plans across all sectors.
6. Identify the links between major problem areas in chemicals management and the WASH sector
7. Mainstream chemicals management into national and state WASH policies and programmes
	1. **Remediating Contaminated Sites and Managing Waste Chemicals**
8. Emergency response and spill management programs
9. Hazardous waste site remediation
10. Hazardous and municipal waste management
11. Legacy chemicals and stockpile management
	1. **Controlling Dangerous Chemicals**
12. Pesticide regulation and management
13. Chemical regulation and restriction
	1. **Preventing Chemical Pollution**
14. Pollution prevention and waste reduction
15. Cleaner production programs
16. Chemical accident prevention programs
17. Sustainable agriculture and Integrated Pest/Vector Management
18. Construction of sanitary landfills
	1. **Managing Chemical Information**
19. Chemical testing programs
20. Hazard communication and Right-to-Know
21. Product ingredient disclosure/Product declaration
22. Pollutant Release and Transfer Inventories (PRTRs)
23. National Chemical Profiles
24. Globally Harmonized System for Classification and Labeling
	1. **Managing Chemicals in WASH Products**
25. Eco-labeling programs
26. Eco-design programs
27. Product safety (Cosmetics, Biocide, Toys) directives
28. Product Stewardship/Extended Producer
29. Responsibility (EPR) Programmes
30. Environmentally Preferred Purchasing Programmes
	1. **Safer Chemicals and encouraging WASH resource efficiency**
31. Green and sustainable chemistry programs
32. Green engineering programs
33. Chemicals Leasing
34. **Nigeria’s drinking water quality standards (culled from Nigerian Standard for Drinking water quality)**

**Table 1 - Physical / Organoleptic Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter  | Unit | Maximum Permitted Levels | Health Impact | Note |
| Colour | TCU | 15 | None |  |
| Odour | - | Unobjectionable | None |  |
| Taste | - | Unobjectionable | None |  |
| Temperature | 0Celsius | Ambient | None |  |
| Turbidity | NTU | 5 | None |  |

**Table 2 - Inorganic Constituents**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Unit | Maximum Permitted | Health Impact | Notes |
| Aluminum (Al) | mg/L | 0.2 | Potential Neuro-degenerative disorders | Note 1 |
| Arsenic (As) | mg/L | 0.01 | Cancer |  |
| Barium | mg/L | 0.7 | Hypertension |  |
| Cadmium (CD) | mg/L | 0.003 | Toxic to the kidney |  |
| Chloride (Cl) | mg/L | 250 | None |  |
| Chromium (Cr6+) | mg/L | 0.05 | Cancer |  |
| Conductivity | µS/cm | 1000 | None |  |
| Copper (Cu+2) | mg/L | 1 | Gastrointestinal disorder,  |  |
| Cyanide (CN-) | mg/L | 0.01 | Very toxic to the thyroid and the nervous system |  |
| Fluoride (F-) | mg/L | 1.5 | Fluorosis, Skeletal tissue (bones and teeth) morbidity |  |
| Hardness (as CaCO3) | mg/L | 150 | None |  |
| Hydrogen Sulphide (H2S) | mg/L | 0.05 | None |  |
| Iron (Fe+2) | mg/L | 0.3 | None |  |
| Lead (Pb) | mg/L | 0.01 | Cancer, interference with Vitamin D metabolism, affect mental development in infants, toxic to the central and peripheral nervous Systems |  |
| Magnesium(Mg+2) | mg/L | 0.20 | Consumer acceptability |  |
| Manganese(Mn+2) | mg/L | 0.2 | Neurological disorder |  |
| Mercury (Hg) | mg/L | 0.001 | Affects the kidney and central nervous system |  |
| Nickel (Ni) | mg/L | 0.02 | Possible carcinogenic |  |
| Nitrate (NO3) | mg/L | 50 | Cyanosis, and asphyxia („blue-baby syndrome”) in infants under 3 months syndrome”) in infants under 3 months |  |
| Nitrite (NO2) | mg/L | 0.2 | Cyanosis, and asphyxia („blue-baby syndrome”) in infants under 3 months |  |
| PH | - | 6.5-8.5 | None |  |
| Sodium (Na) | mg/L | 200 | None |  |
| Sulphate (SO4 ) | mg/L | 100 | None |  |
| Total Dissolved Solids | mg/L | 500 | None |  |
| Zinc (Zn) | mg/L | 3 | None |  |

Note 1: Parameter to be monitored only if aluminium chemicals are used for water

**Table 3 - Organic Constituents**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Unit | Maximum Permitted Levels | Health Impact | Note |
| Detergents | mg/L | 0.01 | Possibly carcinogenic |  |
| Mineral oil | mg/L | 0.003 | Possibly carcinogenic |  |
| Pesticides | mg/L | 0.01 | Possibly carcinogenic |  |
| Phenols | mg/L | 0.001 | Possibly carcinogenic |  |
| Poly Aromatic Hydrocarbons | mg/L | 0.007 | Possibly carcinogenic |  |
| Total Organic Carbon or Oxidisability | mg/L | 5 | Cancer |  |

**Table 4 - Disinfectants and their by-products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Unit | Maximum Permitted Levels | Health Impact | Note |
| Free residual chlorine | mg/L | 0.2 - 0.25 | None | Note 2 |
| Trihalomethanes Total | mg/L | 0.001 | Cancer | Note 2 |
| 2,4,6-Trichlorophenol | mg/L | 0.02 | Cancer |  |

1. **Galadima, A**. , Domestic Water Pollution among Local Communities in Nigeria ----Causes and Consequences [↑](#footnote-ref-1)
2. **Z.N. Garba, et el,** *Arsenic Contamination of Domestic Water from Northern Nigeria* [↑](#footnote-ref-2)
3. **H. Musa , I.A. Yakasai , K.Y. Musa , A.B. Isah and K. Mshelbwala,** *Determination of Arsenic Concentration in Well and Borehole Waters in Zaria, Nigeria* [↑](#footnote-ref-3)