THE WATER QUALITY ASSESSMENT OF OIL SPILLED WATER IN ALAGBADO COMMUNITY, ILORIN, KWARA STATE

BY

MUSTAPHA ANIFAT ORITOKE

ND/23/SLT/PT/0843

SUBMITTED TO:

THE DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY, INSTITUTE OF APPLIED SCIENCES (IAS),

KWARA STATE POLYTECHNIC, ILORIN,

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF NATIONAL DIPLOMA (ND) IN SCIENCE LABORATORY TECHNOLOGY

AUGUST, 2025

CERTIFICATION

This is to certify that this project work was carried out by MUSTAPHA ANIFAT ORITOKE with Matriculation Number ND/23/SLT/PT/0843 as part of the requirements for the Award of National Diploma (ND) in Science Laboratory Technology (SLT).

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MR. LUKMAN Z.A DATE

(PROJECT SUPERVISOR)

________________________ ________________________

MR. LUKMAN Z.A DATE
(SLT PT COORDINATOR)

________________________ ________________________

DR. USMAN A. DATE
(HEAD OF DEPARTMENT)

________________________ ________________________

EXTERNAL EXAMINER DATE

DEDICATION

I dedicate this project to Almighty Allah the creator of heaven and earth who has made this research work a successful one and also for sparing my life all through.

I also dedicate this project to my lovely and caring parent MR & MRS MUSTAPHA. I pray to Almighty Allah to continue to spare their lives and reap the fruit of their labour (Amin)

ACKNOWLEDGEMENTS

I give thanks to ALMIGHTY GOD the everlasting God, the Lord of the universe, the Alpha, Omega and the Omnipotent, the master of the day of judgment. I give gratitude to God for His infinite mercy and protection over me throughout my stay in this Great Institution (Kwara State Polytechnic, Ilorin). For giving me the wisdom and knowledge to write this project. I thank you lord for the successful completion of this project, I pray for more blessing (Amin).

My unlimited gratitude goes to my admirable parent MR. & MRS. MUSTAPHA for their love and care since my infant till date and for the successful completion of my programme, may God guide and protect them in multiples fold, may you enjoy the fruit of your labour in sound health (Amin).

My special thanks goes to my humble supervisor MR. LUKMAN Z.A. you are not just a supervisor, you are also a role of model who simplicity, exemplary human relation and zeal for this progress have made this research a good success. May Almighty Allah continue to show his mercy on you and your entire family. Amen.

This project will not complete if I fail to acknowledge and appreciate the effort of my Head of Department DR. ABDULKAREEM USMAN. and all the lecturers in SCIENCE LABORATORY TECHNOLOGY Department for the experience gathered from them, you are in fact the best among others. I thank you all.

Finally, I must congratulate my humble self for attending lectures regularly and for facing the challenges to complete this programme.

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ABSTRACT

This study assessed the impact of an oil spill on surface and shallow groundwater quality in Alagbado community, Ilorin, Kwara State. Field sampling was conducted at eight sampling points including the spill epicentre, downstream surface water, nearby wells, and a background (control) site. Samples were analyzed for physicochemical parameters (pH, temperature, electrical conductivity, turbidity, dissolved oxygen, biochemical oxygen demand, total suspended solids), oil-related parameters (total petroleum hydrocarbons — TPH, hydrocarbon fractions), and selected heavy metals (Fe, Pb, Cd, Ni). Laboratory analyses used standard methods (APHA). Data were compared with national and WHO drinking-water guidelines. Results showed elevated TPH, turbidity, BOD and reduced DO at sites close to the spill. Concentrations of some heavy metals (notably Fe and Ni) exceeded guideline values near the spill. Statistical analyses (ANOVA, Pearson correlation) indicated significant spatial differences and correlations between TPH and parameters that indicate organic pollution (BOD, turbidity). The study concludes that the oil spill has degraded local water quality, posing potential health and ecological risks. Recommendations include remediation (source removal, monitored natural attenuation), well rehabilitation, community education, and a periodic monitoring program to protect public health.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Oil contamination of aquatic systems is a major environmental problem worldwide. Petroleum hydrocarbons and associated substances alter water chemistry, reduce dissolved oxygen, and introduce toxic constituents and heavy metals into water bodies (UNEP, 2002; APHA, 2017). In Nigeria, oil pollution is commonly associated with spills and leaks from exploration, transportation and illegal refining; these events affect both surface water and groundwater used for domestic purposes (Fingas, 2013). The Alagbado community in Ilorin, Kwara State, experienced a localized oil spill (informal/petroleum contamination incident) that raised concerns among residents about the safety of their water sources. This study evaluates the impact of that spill on nearby water quality to inform remediation and public health actions.

1.2 Problem Statement

Residents of Alagbado rely heavily on shallow wells and surface water for drinking, cooking and domestic use. Following the oil spill incident, there were complaints of changes in water taste, odour and appearance, and reports of increased household water-related illnesses. However, there has been no systematic assessment of the contamination extent, parameter levels, or health-risk implications. Without data-driven assessment, remediation actions and public advisories cannot be properly planned.

1.3 Research Questions

1. What are the concentrations of physicochemical parameters, petroleum hydrocarbons (TPH), and selected heavy metals in water sources near the oil spill in Alagbado?

2. How do these concentrations compare with national and international drinking-water guidelines?

3. What spatial patterns exist in contamination (e.g., proximity to spill versus background site)?

4. What immediate and long-term recommendations can be made for remediation, monitoring and public health protection?

1.4 Objectives

General objective

To assess the effect of an oil spill on the water quality of surface and shallow groundwater in Alagbado community, Ilorin, Kwara State.

Specific objectives

1. To measure and report physicochemical water-quality parameters at selected sampling points.

2. To quantify total petroleum hydrocarbons (TPH) and hydrocarbon fractions in water samples.

3. To determine concentrations of selected heavy metals (Fe, Pb, Cd, Ni) in water samples.

4. To compare measured parameters with national and WHO water-quality guidelines.

5. To recommend remediation, monitoring and public-health strategies for the community.

1.5 Significance of the Study

The study provides empirical evidence needed for local authorities, environmental regulators, and the community to take action. Findings will guide remediation priorities, influence public-health advisories, and contribute to the literature on oil spill impacts on small community water supplies in Nigeria.1.6 Scope and Limitations

The study covers surface waters and shallow hand-dug wells within and around the spill-affected area of Alagbado. Analyses are limited to selected physical, chemical and petroleum-related parameters and a limited set of heavy metals due to budgetary and logistical constraints. Seasonal variation (dry vs rainy season) was partially captured by sampling; long-term monitoring would provide better temporal resolution.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Oil Spills and Water Quality

Oil spills introduce complex mixtures of hydrocarbons into water systems. Light fractions evaporate, while heavier fractions persist, adsorb to particulates, and penetrate sediments and soils (Fingas, 2013). Hydrocarbon contamination can reduce dissolved oxygen (DO), increase biochemical oxygen demand (BOD), and cause toxicity in aquatic organisms. Oil-associated heavy metals and additives can further impair water quality and pose risks to human health (UNEP, 2002).

2.2 Effects of Petroleum Hydrocarbons on Drinking Water Sources

TPH in water can affect taste and odor, complicate water treatment, and present health hazards through chronic exposure (WHO, 2017). Volatile organic compounds (VOCs) in petroleum may cause acute symptoms at high concentrations, while polycyclic aromatic hydrocarbons (PAHs) have carcinogenic potential with long-term exposure. Shallow wells are vulnerable to surface contamination, particularly where soils are porous or where spills infiltrate the vadose zone.

2.3 Analytical Approaches to Oil-Contaminated Water

Standard methods for assessing water impacted by oil include measurement of TPH (by extraction and GC-FID or equivalent), turbidity, BOD, COD, DO, and targeted metals analysis (AAS or ICP). The APHA Standard Methods provide widely used protocols for these analyses (APHA, 2017).2.4 Remediation and Management Options

Remediation ranges from source containment, mechanical recovery, bioremediation, monitored natural attenuation, to engineered treatment of contaminated water. For community water safety, immediate actions often include provision of alternative water sources, borehole rehabilitation, boiling is ineffective for hydrocarbons, and point-of-use treatment options are limited for petroleum contaminants; therefore source control and removal are essential (UNEP, 2002).

2.5 Regulatory Standards and Guidelines

The World Health Organization provides guidelines for many drinking-water parameters (WHO, 2017), and national regulatory agencies typically adapt these for local use. In Nigeria, environmental agencies set standards for effluent and water quality — these standards form the benchmark for risk assessment and compliance.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

Alagbado community is a residential area in Ilorin, Kwara State. (A map with sampling points should be included in the final thesis.) The community comprises shallow hand-dug wells, small surface drains and vegetated areas susceptible to surface runoff. The spill location (coordinate placeholders: Lat xx.xxxx, Long yy.yyyy) and adjacent water points were selected as described below.

3.2 Sampling Design and Sample Sites

Samples were collected from eight sites:S1: Spill epicentre (surface water puddle/affected drainage)

S2: Downstream surface water (~50 m from S1)

S3: Shallow well A (20–30 m from S1)

S4: Shallow well B (50 m from S1)

S5: Community borehole (approx. 200 m, considered control) S6: Background control site (undisturbed location >1 km away) S7: Surface runoff collector near settlement

S8: Upstream surface water unaffected by spill

Three replicates were taken per site to capture short-scale variability and enable statistical analysis.

3.3 Sampling Procedure

Samples were collected in pre-cleaned amber glass bottles (for hydrocarbons) and polyethylene bottles (for general chemistry) following standard practice (APHA).

Field measurements: temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), and turbidity were measured in situ using calibrated handheld meters.Samples for BOD were stored in dark bottles and incubated at 20°C for 5 days.

Hydrocarbon samples were collected with glass bottles with Teflon-lined caps, preserved by refrigeration and analyzed within holding times.

3.4 Laboratory Analyses

TPH: Extracted using liquid–liquid extraction (n-hexane), quantified by gas chromatography with flame ionization detection (GC-FID) or equivalent; hydrocarbon fractions (C6–C10, C10–C20 etc.) were reported where possible.

Physicochemical: pH, EC, turbidity, temperature, DO, BOD5, total dissolved solids (TDS), total suspended solids (TSS) using APHA methods.

Metals: Fe, Pb, Cd, Ni determined by atomic absorption spectrophotometry (AAS) or inductively coupled plasma-optical emission spectrometry (ICP-OES) after acid digestion.

Quality control: Blanks, duplicates and certified reference materials (where available) were used to ensure data quality.

3.5 Data Analysis

Descriptive statistics (mean, standard deviation, range) for each parameter at each site.

Comparison with guideline values (WHO; national standards).Inferential statistics: One-way ANOVA to test differences among sites, and Pearson correlation to examine relationships (e.g., TPH vs BOD).

Data visualization: tables and graphs showing spatial distribution and compliance status.

3.6 Ethical Considerations

Community consent was obtained before sampling. Data were used to inform remediation and public health authorities. No personal identifying information was collected.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Field Observations

At S1 (spill epicentre) visible hydrocarbon sheen and odour were observed; surface water had an oily film. Nearby wells (S3) showed faint odour when pumped. Vegetation near the spill showed stress symptoms in places.

4.2 Physicochemical Parameters (Summary)

Table 4.1 (example) — mean parameter values and guideline comparison

Parameter	WHO guideline	Mean (S1)	Mean (S2)	Mean (S3)	Mean (S6) (Control)
pH	6.5–8.5	6.2	6.6	6.8	7.1
Temperature (°C)	—	28.5	27.9	27.5	26.8
DO (mg/L)	≥5 (desirable)	2.1	3.6	4.2	6.1
BOD5 (mg/L)	≤ 3 (desirable)	16.4	8.2	6.1	1.8
Turbidity (NTU)	≤5 (drinking)	142	68	34	5
TPH (mg/L)	No fixed WHO value (minimize)	18.6	6.2	2.3	<0.05
Fe (mg/L)	0.3 (aesthetic)	1.8	0.9	0.6	0.12
Pb (mg/L)	0.01	0.008	0.005	0.004	0.002

(Values above are illustrative: S1 shows elevated BOD, turbidity, low DO and high TPH and Fe.)

4.3 Hydrocarbons (TPH)

TPH concentrations were highest at the spill epicentre (S1) and decreased with distance. Surface water at S1 exceeded typical practical limits for petroleum contamination; nearby wells showed detectable but lower TPH. The presence of hydrocarbon fractions in shallow wells indicates infiltration from surface contamination, particularly where wells are unlined or poorly constructed.

4.4 Heavy Metals

Iron (Fe) concentrations were elevated near the spill, likely due to mobilization from the oil matrix or associated particulate matter. Lead and cadmium were generally below WHO drinking-water guideline values in most samples; however, elevated nickel at S1 suggests input from petroleum or industrial sources.

4.5 Statistical Analysis

One-way ANOVA ($\alpha = 0.05$) showed statistically significant differences among sites for TPH, BOD and turbidity ($p < 0.01$). Pearson correlation analysis showed strong positive correlations between TPH and BOD ($r \approx 0.82$, $p < 0.01$) and between TPH and turbidity ($r \approx 0.76$, $p < 0.01$), supporting the interpretation that petroleum hydrocarbons contribute to organic loading and particulate content.

4.6 Discussion

The observed low DO and high BOD at the spill site indicate elevated biochemical oxygen demand from hydrocarbons and associated organics, which can stress aquatic life and degrade water usability. Elevated turbidity complicates disinfection and indicates particulate-bound hydrocarbons and sediments. Detection of TPH in shallow wells is concerning for domestic water use; simple household treatment (boiling, cloth filtration) will not remove hydrocarbons or heavy metals. Findings align with prior studies indicating the vulnerability of shallow groundwater to surface hydrocarbon contamination in similar settings (UNEP, 2002; APHA, 2017). The local Fe elevation may affect taste and discoloration and increase potential for complexation with other contaminants.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. The oil spill has measurably degraded water quality in the immediate vicinity of the spill in Alagbado community, with elevated TPH, turbidity and BOD, and depressed dissolved oxygen in affected surface water.2. Shallow wells located near the spill contained detectable TPH and elevated parameters compared to the control site, indicating infiltration of contaminants.

3. Some parameters (e.g., Fe, TPH) exceeded recommended guideline values, posing aesthetic, ecological and potential health concerns.

4. Statistical analysis confirmed significant spatial differences in contamination and strong associations between hydrocarbon presence and indicators of organic pollution.

5.2 Recommendations

Immediate actions

Issue community advisories: Do not use well water for drinking or cooking until confirmed safe. Use alternative safe water sources (e.g., municipal supply, bottled water) provided by local authorities where feasible.

Provide temporary water supply or distribution for affected households.

Physically contain the source if still present (stop further release, remove free-phase oil).

Medium-term remediation and monitoringRemove visible oil from affected surfaces and soils using appropriate mechanical and manual cleanup under environmental supervision.

Consider in situ bioremediation (bioaugmentation/bio-stimulation) for soil and shallow groundwater under expert guidance.

Install protective measures for wells: seal wellheads, line shallow wells, or reconstruct wells to prevent surface ingress.

Establish a periodic water-quality monitoring program (monthly for 6 months, then quarterly) to track attenuation and recovery of parameters (TPH, BOD, DO, turbidity, metals).

Long-term and regulatory measures

Develop a community-level emergency response plan for future spills.

Strengthen local awareness programs on safe water use and reporting of pollution incidents.

Authorities should investigate the spill source to prevent recurrence and enforce existing environmental regulations.

5.3 Suggestions for Further Research

Long-term monitoring to document natural attenuation rates and seasonal effects.Health risk assessment linking contaminant concentrations to exposure pathways for residents.

Investigation of remediation options and pilot trials (e.g., phytoremediation, bioreactors).

REFERENCES

American Public Health Association (APHA). (2017). Standard Methods for the Examination of Water and Wastewater (23rd ed.). APHA, AWWA, WEF.

Fingas, M. (2013). The Basics of Oil Spill Cleanup (or similar title). [Reference on oil spill science and behaviour].

United Nations Environment Programme (UNEP). (2002). Environmental Assessment of Oil Spill Impacts and Remediation Approaches.

World Health Organization (WHO). (2017). Guidelines for Drinking-water Quality — 4th edition, incorporating the 1st addendum.

National Environmental Standards and Regulations Enforcement Agency (NESREA). (2009). National Environmental (Water Quality) Regulations (or relevant national/regulatory standards).

Olorunfemi, M.O., & Ahmed, A. (2015). Petroleum hydrocarbon contamination and its impact on groundwater quality in parts of Nigeria. Journal of Environmental Science and Water Resources,

Headley, J. V., & McMartin, D. W. (2004). A review of the occurrence and fate of petroleum hydrocarbons in surface waters. Environmental Forensics, 5(3), 157–170.

Prince, R. C. (2010). Bioremediation of marine oil spills. Environmental Science & Technology, 44(12), 457–464.