EFFECTS OF OIL PRODUCTION ON GROUNDWATER LEVELS IN LOKICHAR BASIN, TURKANA COUNTY. KENYA

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AUGUST, 2022

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University or any other award

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DEDICATION

I dedicate this work to my parents and my wife for the support they have offered to me during the study period.

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LIST OF ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
AWSB	Athi Water Services Board
CHIRPS	Climate Hazard InfraRed Precipitations with Stations
DPSIR	Driver-Pressure-State-Impact-Response
ENSO	El nino Southern Oscillation
EOPS	Early Oil Pilot Scheme
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
ESIA	Environmental and Social Impact Assessment
FP	Hydraulic Fracturing and Produced Water
GPS	Global Positioning System
IOD	Indian Ocean Dipole
LOKIWASCO	Lokichar Water & Sanitation Company Limited
MWS	Ministry of Water and Sanitation
NACOSTI	National Commission for Science, Technology and Innovation
NAS	Nairobi Aquifer System
NGOs	Non-Governmental Organizations
PWS	Produced Water Society
QPM	Quartile Perturbation Method
RTI	Radar Technologies International
SC	South Coast
SOI	Southern Oscillation Index
TDS	Total Dissolved Solids

UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WSPs	Water Service Providers
WTF	Water Table Fluctuation
l/d	Litres per day

ABSTRACT

Oil production requires large volumes of water for hydraulic fracturing. Globally, water demand for oil production has been increasing over the past decade. Kenya successfully completed the Early Oil Pilot Scheme (EOPS) project which was being undertaken in Lokichar basin in Turkana County in 2020 and expects to commence full commercialization in 2022. Water required for oil production during the EOPS was being obtained from ten boreholes drilled in the study area. Increased groundwater abstraction leads to decline in water levels. This study sought to investigate the effects of oil production on groundwater levels in Lokichar basin in Turkana County, Kenya. The specific objectives for this study were: to establish changes in groundwater demand in Lokichar basin, to determine borehole water levels in Lokichar basin and to establish rainfall trends in Lokichar basin. The changes in groundwater demand were related with the changes in borehole water levels to identify relationship. With rainfall being the major agent of groundwater recharge in the area, rainfall trends were analysed to establish whether it is contributing to groundwater level changes. Water levels for two boreholes within the study area were recorded between 12th August to 11th September 2020. To analyse rainfall trends, CHIRPS rainfall data for the study area was adopted. Kenya Ministry of Water and Irrigation design manual guidelines were adopted in estimating groundwater demand. Study findings showed that groundwater demand in Lokichar basin increased from 1,846,001.55 l/d in 2009 to 4,951,043.44 l/d in 2019 and is projected to increase to 145,235,374.23 l/d when full commercialization of the oil fields begins in 2022. This represents an increase in groundwater demand of 168% and 2833% for the periods 2009-2019 and 2019-2022 respectively. On borehole water levels, the study showed that the average daily levels remained fairly constant with Chinese 1 and Nawoyatira boreholes registering average daily water level of 18.12m and 19.5m respectively. The study however found out that major decline in borehole water levels is experienced during peak hours with levels declining to 29.0m and 26.6m for Chinese 1 and Nawoyatira boreholes respectively. Incorporation of oil production water demand into abstraction results to further decline in water levels to lows of 74m and 61m for Chinese 1 and Nawoyatira boreholes respectively. The study showed no statistically significant trend in the rainfall patterns between 1981 to 2019. The average annual rainfall amount was obtained as 142.48mm. The average annual groundwater recharge was estimated at 21.37mm. From the study findings, it has been concluded that increased groundwater abstraction led to borehole water level decline which is further exacerbated by incorporation of oil production water demand. It has therefore been recommended that an alternative source of water be identified during full commercialization of the oil fields to avoid overreliance on groundwater for oil production. Turkana County government should enact policies aimed at protecting the Laggers which are the main agents of groundwater recharge. Further research should be carried out to establish the extent of groundwater level changes during full commercialization of the oil fields.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study Problem

The demand for water globally has been increasing at an approximate rate of 1% per annum fueled by growth in population, economic growth as well as changes in the patterns of consumption (United Nations, 2018). It is expected that the global water demand will continue growing significantly over the next thirty years and is expected to reach 6,000km^3 per year by 2050 (Boretti and Rosa, 2019). Of the overall global water demand, energy production accounts for the second largest water consumer with agricultural production (irrigation water) accounting for the largest water demand. Water demand for energy production is expected to continue rising over the next two decades (Xylem, 2015). Energy production water demand is mostly required in oil and gas production which had a consumption of 30 billion gallons per day by the year 2015.

Water is required in oil and gas production to flood declining conventional and offshore wells, well drilling, injecting to fracture underground shale or to steam reservoirs for oil sands extraction. These processes require millions of gallons of water (Xylem, 2015). It is estimated that in stripper oil operations, approximately nine barrels (equivalent to 1,431 litres) of water is injected into the oil reservoirs to extract one barrel of oil (American Petroleum Institute, 2018). On the other hand, during oil and gas production, water is generated as a byproduct commonly referred to as Produced Water (Al-Ghouti, Al-Kaabi, Ashfaq and Da'ana, 2019). In most oil fields, produced water is utilized for the purposes of extraction but is supplemented using other sources (United States Environmental Protection Agency, 2015). With such large volumes of water being required to produce oil and gas, it is evident that water resources in areas where oil production is taking place are under immense water stress especially if the existing water sources are limited. A study of hydraulic Fracturing and Produced (FP) water from major shale producing areas in the United States showed that between the year 2011 and 2016, water use per well increased to up to 770% for hydraulic fracturing while produced water generated increased to 1440% over the same period (Kondash, Lauer, and Vengosh, 2018). The study recommended that further studies be undertaken to assess any changes in ground water table due to increased water use in areas where oil and gas production is taking place. In June 2011, France effected a national ban on fracking due to the high water consumption required to frack a single shale well (Food and Water Watch, 2012). While effecting the ban France's Environment Minister cited the effects of over abstraction of groundwater resources posing major risks to the water table.

Robert and Greg (2017) carried out a study on the effects of hydraulic fracturing in South Africa concentrating on arid area of Karoo. The study found out that there has been increased conflict over water resources between the local residents and oil producing companies due to reallocation of water from people to oil production. According to the study, each well required approximately 15million litres of water which led to reduced water supply to the residents (Robert and Greg, 2017).

Kenya has got only 640m^3 of renewable fresh water per capita and thus is classified as a water scarce country (United Nations, 2006). Approximately 41 percent of the Kenyan population depends on unimproved sources of water that include rivers, ponds and shallow wells. (Water.org, 2018). The areas mostly affected by lack of water in Kenya are the urban slums and rural areas especially the arid and semi-arid areas. With such scarcity of water resources, it is important that all the available water be utilized optimally.

Turkana County is an arid area that largely depends on groundwater for operations. The water is mostly obtained from boreholes that are mostly located on the banks of the Laggers (Turkana County Government, 2016). Except for Lake Turkana and Turkwel river, naturally occurring surface water bodies are negligible in Turkana County due to the high evaporation rates. Turkana County experiences both physical and economic water scarcity. This is brought about by lack of water infrastructure, low rainfall amounts and occasional draughts (Oyugi, 2016).

Tullow oil commenced oil production in Lokichar Basin, Turkana County under the Early Oil Pilot Scheme (EOPS) on 3rd June 2018. According to the oil project Environmental and Social Impact Assessment (ESIA) report, shale fracturing technology has been adopted for oil production in Lokichar Basin. Figure 1.1 shows the production profile for Lokichar oil fields as given in the project ESIA report (2020).

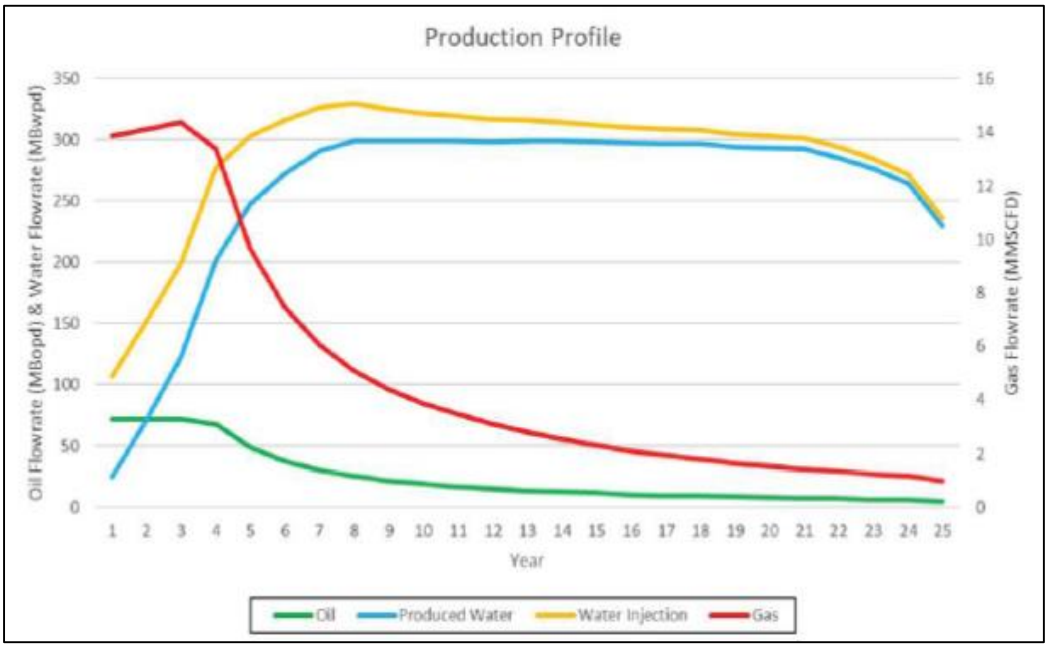

Figure 1.1: Oil Production Profile as at 2019

Source: Golder (2020)

From Figure 1-1 and the explanation in section 1.1, it is evident that large volumes of water will be required for oil production in Lokichar basin. The water required for oil production is being sourced from the ground given that no surface water sources exist in the area. Tullow oil have plans to construct a water pipeline from Turkwel Dam to Lokichar to supplement groundwater. This has however not been constructed as at end of year 2020. The only available source of water in Lokichar basin for oil production as at 2020 is groundwater which Tullow oil has been pumping from ten boreholes drilled within the project area (Golder, 2020). Groundwater is of great importance in Kenya, given its share (5%) of the total nation's renewable water resources (Mumma, Lane, Kairu, Tuinholf and Hirji, 2011). During the 2009 Census, approximately 43 percent of the rural population and approximately 24 percent of the urban population indicated that they depended on a borehole, spring or well as their main water source (Mumma *et al*., 2011). Use of groundwater for oil production will lead to over-exploitation which will ultimately lead to lowering of groundwater levels. Lowering of groundwater levels will reduce the amount available to the local residents who dependent on this source.

Lokichar basin is an arid area receiving a mean annual average rainfall of 121mm (Oyugi, 2016). The annual groundwater recharge in Lokichar basin was estimated by Price (2016) to be less than 20mm. Low groundwater recharge rate coupled with high rate of groundwater abstraction will lead to fluctuation of groundwater levels which will have far reaching effect in the region. Protection of the available groundwater resources in Turkana is therefore key for sustainable development.

1.2 Statement of the Problem

Oil production requires large volume of water for hydraulic fracturing. Oil production in Kenya commenced in August 2018 in Lokichar Basin, Turkana County (an arid region) under the Early Oil Pilot Scheme. By June 2020, 1,460,000 barrels of oil had been produced, translating to 13,140,000 barrels of water (2,089,260,000 litres) utilized over that period. Water required during EOPS was obtained from boreholes drilled within the basin. Residents on the basin rely on groundwater for their various water need. Commencement of oil production has therefore resulted to competition for groundwater resources in the basin, an area already experiencing acute water shortage. By 2022, Tullow oil targets production of 100,000 barrels of oil daily translating to 143,100,000 litres of water utilization / generation daily. With the water pipeline from Turkwel Dam having not been constructed, Tullow will rely on groundwater for their operations. This will lead to over-abstraction of groundwater which will result to decline in groundwater levels.

Research has been carried out on groundwater availability in Turkana County and preliminary findings established five large deep reserves within Lodwar, Lokichogio, Kakuma and Kalobeiyei areas and shallow aquifers distributed in the entire County. However, no research has been done to establish the effects of over abstraction of groundwater in Lokichar basin due to the onset of oil production.

This research therefore sought to investigate the effects of increased groundwater abstraction in Lokichar Basin on groundwater levels since the onset of oil production. Study findings will inform the precautionary measures to be undertaken to avert likely future crisis.

1.3 Justification of the Study

Lokichar basin, Turkana County is well suited for this study as it hosts the Twiga, Ngamia and Amosing oil fields where oil production is taking place. Oil production requires large quantities of water which are injected into the ground to extract the oil. Naturally occurring surface water sources are negligible in the basin due to high evaporation rate. In addition, Lokichar basin receives very low average annual rainfall and thus very little groundwater recharge takes place. With increased groundwater abstraction coupled with low groundwater recharge, borehole water levels are bound to decline.

Ground water levels are an important aspect as it determines the depth to which boreholes will be drilled to and thus affecting the cost of drilling and operating (pumping). Turkana County residents depend on groundwater (boreholes, shallow wells and springs) for daily use. Lowering of groundwater levels causes some boreholes, shallow wells and springs to dry up. In addition, deeper aquifers are usually more saline than the shallow well and therefore lowering of the ground levels renders the ground water unfit for human consumption. The findings of this study provide crucial information that can be used to ensure sustainable management of the available water resources. Further, data obtained will help in policy formulation towards regulating the amount of water that the oil industries can abstract from the existing sources / local aquifers. This will therefore protect local residents from lack of water that may result from over abstraction.

This study therefore aims at investigating the effects of oil production on ground water levels in Lokichar basin, Turkana County, Kenya with an aim of protecting local residents from lack of water resulting from over abstraction through recommending appropriate water use, management and conservation measures.

1.4 Objectives of the Study

1.5 General Objective

The general objective of this study was to establish the effects of oil production on groundwater levels in Lokichar Basin, Turkana County, Kenya.

1.5.1 Specific Objectives

The study explored the following specific objectives:

i. To establish changes in groundwater demand in Lokichar Basin before and after commencement of Oil Production (year 2009 to year 2022)

ii. To determine the borehole water level changes in Lokichar basin during oil production (year 2020)

iii. To establish rainfall trends and its relation to borehole water level changes in Lokichar basin.

1.6 Research Questions

The study addressed the following research questions:

i. Has groundwater demand in Lokichar basin changed since the onset of oil production?

ii. Has borehole water levels in Lokichar basin changed since the onset of oil production?

iii. Has there been significant changes How are the rainfall trends in Lokichar basin?

1.7 Significance of the Study

The study findings will provide crucial information on the status of water sources in Lokichar basin (borehole water levels) and the effect of continued increased abstraction of water for oil production. This information will help the community to come up with ways that will enhance optimal utilization of the available water resources. The study findings will further guide on whether it is sustainable to continue using ground water as the source of water for oil production (as was the case during the Early Oil Pilot Scheme) or an alternative water source need to be identified for purposes of oil production. This will protect the residents in Lokichar basin from water shortages that may result from increased groundwater abstraction for use in oil production.

1.8 Scope and Limitation of the Study

The study involved investigation of changes in groundwater levels in Lokichar basin. The changes in groundwater levels is envisioned to be brought about by increased water demand required for oil production that commenced in the study area in in August 2018. The study involved field measurement of borehole water levels, assessment of water requirement before and after the onset of oil production and analysis of rainfall trends to establish whether it has a contributing factor to the changes in borehole water levels.

The main limitation of the of the study was that during the period when field measurement of borehole water levels was being carried out, the Early Oil Pilot Scheme had just been concluded. Oil production was awaiting full commercialization scheduled to commence in the year 2022. This implied that the direct effect of water abstraction for oil production could not be visible in the fluctuating borehole water levels. This limitation was addressed by assessing the water requirement for oil production and incorporating the demand to borehole abstractions through simulation to establish effect.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature based on the study objectives namely water requirement in oil production, groundwater abstraction and rainfall trends. This review was necessitated by the increased groundwater abstraction in Lokichar basin that may lead to aquifer overdrafts and groundwater depletion. The main thematic areas reviewed are water requirement in oil production focusing on produced water and hydraulic fracturing, groundwater level changes due to increased abstraction and its long term effects and changes in rainfall patterns and its effect on groundwater levels. The chapter also discusses a conceptual framework that was adopted for this study.

2.2 Water Requirement in Oil Production

In oil production, water is used to flood declining conventional and offshore wells, well drilling, injecting to fracture underground shale or to steam reservoirs for oil sands extraction (Xylem, 2015). These are new techniques that producers have resorted to so as to bypass declining and inaccessible legacy sources of oil and gas. Water is also required for civil engineering works such as construction of access roads to the oil fields, well pads and field camps (Golder, 2020). On the other hand, during oil and gas production, water is generated as a byproduct commonly referred to as Produced Water (Al-Ghouti, Al-Kaabi, Ashfaq and Da'ana, 2019).

Hydraulic Fracturing is the process by which fluids are injected into low permeability shale rocks that contain oil or gas at high pressure to fracture the shale rock and release oil or gas (American Petroleum Institute, 2017). The fluid injected into the rocks is made up of a mixture of water, chemicals and proppant (most common proppants in use being sand or ceramic beads). The pressure causes fractures in the rock while the proppants help to keep the fractures open thus allowing oil and gas to flow from the spaces in the pores to the production wells. Water demand for hydraulic fracturing varies dramatically from shale to shale to tunes of millions of litres (Xylem, 2015).

The U.S. Department of Energy estimates that over 3,800,000 gallons of water are usually needed for fracking a well while an extra 80,000 gallons of water is required for drilling (Beck, 2010). Andrew *et al*. (2018) carried out a study that presented temporal data on the volumes of hydraulic Fracturing and Produced (FP) water from major shale producing areas in the United States. The study found out that between the year 2011 and 2016, the water use per well increased to up to 770% for hydraulic fracturing while the produced water generated increased to 1440% over the same period (Andrew *et al*., 2018). The study further recommended that further studies be undertaken to assess any changes in ground water tables due to increased water use in areas where oil and gas production is taking place. France in June 2011 effected a national ban on fracking due to the high water consumption required to frack a single shale well (Food and Water Watch, 2012). While effecting the ban France's Environment Minister cited the effects of over abstraction of ground water resources posing major risks to the water table.

Robert and Greg (2017) carried out a study on the effects of hydraulic fracturing in south Africa concentrating on arid area of Karoo. The study found out that there has been increased conflict over water resources between the local residents and oil producing companies due to reallocation of water from people to oil production. According to the study, each well required approximately 15million litres of water which led to reduced water supply to the residents (Robert and Greg, 2017). A study on the shale gas potential in the Ghadames basin in Libya carried out in 2013 has estimated that approximately 95% of the water utilized for hydraulic fracturing was made of fresh water (Elfigih, 2013). The ESIA report for the South Lokichar Basin in Kenya (2020) has indicated that shale fracturing technology will be adopted during oil production in Lokichar Basin. Considering the findings of the above researches, it is expected that high volumes of water will be required in Lokichar for oil production. With the area being arid and there being no existing surface water sources, the most probable source of water for hydraulic fracturing will be groundwater. Excessive abstraction of groundwater might to lead to lowering of groundwater levels thus making the resource inaccessible by the locals.

Water requirement for oil production is further increased by the generation of Produced Water. According to the U.S. Environmental Protection Agency (2018), for every barrel of oil, close to five barrels of produced water is generated. Generally, produced water is considered as waste water of oil and gas industry because it contains substantial levels of Total Dissolved Solids (TDS) as well as other constituents (United States Environmental Protection Agency, 2018). Produced water is at times used for Enhanced Oil Recover (EOR). However, this water is not fit for human or agricultural use. According to Produced Water Society (2017), 21.2 billion barrels of water were generated in 2012 from oil and gas wells in the United States. This implies that this volume of water was condemned in the United States in 2012. For an arid area like Lokichar basin that is already being faced with acute water shortages, such volumes of water should not be allowed to go into waste.

From the above studies, it is evident that large volumes of water are required / generated during oil production. This study sought to establish the volume of water required for oil production in Lokichar Basin in order to determine whether the existing local water sources (borehole water) can sustainably supply such quantities.

2.3 Increased Groundwater Abstraction and its Effect on Borehole Water Levels

There has been a worldwide increase in the use of groundwater for domestic, industrial as well as agricultural purposes due to ready access to pumped well. Globally, groundwater withdrawals total approximately 800km^3 (Konikow and Kendy, 2005). According to Konikow and Kendy (2005), increased overrelaince to ground water has led to its depletion to the the extent that well yields have decreased, pumping costs risen aquatic ecosystems damaged, water quality deteriorated and land irrevasably subsided. India relies on groundwater for agricultural production. According to the report of the 5th census of minor irrigation scheme (2017), ground water levels in India declined by 61% between the years 2007 and 2017. The decline in groundwater levels led to development of an initiative by the Indian Government aimed at increasing the effeciency of ground water use by 20% (Shekhar *et al*., 2020). A study has been carried out to estimate changes in groundwater levels with and without the water use effeciency programme. From the study findings, groundwater levels will decrease by 2.8m per year in Northwestern India up to the year 2028 if the proposed mitigation measures are not put in place. With the introduction of the mitigation measures, groundwater level decline reduces by between 36-37% (Shekhar *et al.*, 2020). Due to the draught that has affected Australia, the Government in the aim of conserving the available water resources is considering revocation of permits issued to firms pumping huge amounts of water from the aquifers and instead conserve the ground water reserves for drinking water use in many states through direct pumping into the distribution mains – water supply system (Tularam and Krishna, 2009).

According to UPGRro (2020), 60% of the residents in Addis Ababa City depend on groundwater. A study on the groundwater levels in Addis Ababa has established that water levels are declining at more than 3m per year in some areas. This has led to shallow community boreholes that were being operated by hand pumps to fail. Old well fields such as the Akaki well fields that were tapping water into shallow volcanic aquifers have also been abandoned (UPGro, 2020). According to Ibrahim (2019), the East – Oweinat region in Egypt relies on groundwater for agricultural production. This has led to increased groundwater pumping that has resulted in declining groundwater level. Recent studies in the region show that the water level decline in East- Oweinat region has declined at a rate of 2.34m over the past two decades (Ibrahim, 2019).

Oiro *et al*. (2020) conducted a study that involved modelling of groundwater levels to provide an assessment of the past and likely future evolution of Nairobi's groundwater resources. From this study, it was found out that ground water abstraction has increased more than 10 times since mid-1970s which is a rate similar to Nairobi's urban growth. The rate represents a 6m drop in water levels for every decade. It is further projected that Nairobi's groundwater levels will decline by 4m per year (Oiro, Komte, Soulsby, and Walraevens, 2018).

Turkana County is an arid area that largely depends on groundwater for operations. The water is mostly obtained from boreholes that are mostly located on the banks of the Laggers (Turkana County Government, 2016). Except for Lake Turkana and Turkwel river, naturally occurring surface water bodies are negligible due to high evaporation rates. Turkana County experiences both physical and economic water scarcity. This is brought about by lack of water infrastructure, low rainfall amounts and occasional draughts (Oyugi, 2016).

A large-scale grip map survey of the ground water resources was carried out in 2013 and results identified five deep aquifers and other easy to reach shallow aquifers in

Turkana County. Further studies showed that the water in these aquifers were saline and could therefore not be used for human purposes with further studies being recommended (Turkana County Government, 2016).

From the above studies, it has been established that over abstraction of groundwater leads to a decline in groundwater levels. This leads to drying up of shallow wells and increased cost of borehole drilling as well as pumping cost. This study sought to establish whether there has been a change in groundwater levels in Lokichar basin, Turkana County since the onset of oil production.

2.4 Rainfall Trends and its Relation to Recharge and Ground Water Levels

Amaya *et al*. (2018) assessed rainfall variability and its relationship to El Niño Southern Oscillation (ENSO) in a Sub -Andean Watershed in Central Bolivia. The study maximized the use of Quantile Perturbation Method (QPM) to analyze decadal anomalies of the precipitation conditions and their relationship with large scale drivers such as the Southern Oscillation Index (SOI). The study showed the influence of extreme scenarios of the SOI on rainfall over the study domain; where decreased recharge and groundwater table for Punata fan was attributed to dry spells that appeared in Pucara basin due to low phase of SOI. Alternatively, the positive phase of SOI led to wet conditions in the Pucara basin thus an increase in groundwater levels and recharge in Punata fan. A convergent result of 2011-2012 and 2015-2016 on groundwater levels compared to 1998 showed that the level difference observed is increasing with time. This observation might be expounded by the climate variability in the 1998 which had more wet conditions which increased the water levels while drier conditions during 2011-2012 and 2015-2016 lowered the ground water recharge rate.

Hu *et al*. (2019) researched on spatial and temporal groundwater variations associated with climatic and anthropogenic impacts in South-West Western Australia. Climate variability indicated that the coupled El Niño Southern Oscillation (ENSO) and positive Indian Ocean Dipole (IOD) cause low-level rainfall in the coastal regions subsequently affecting groundwater recharge. It had a significant correlation of 0.748 between groundwater and rainfall over the entire South- West Western Australia. On the contrary northeastern mountainous regions experienced less amount of rainfall, average 20-30mm/month, thus no change in groundwater. The study hypothesizes that rainfall amounting to 60 and 65-70 mm/month or more are required during the rainfall period of March to October to recharge groundwater over south of Perth and southern coastal regions.

Taylor *et al.* (2013) analysed the evidence of dependence of groundwater resources on extreme rainfall over East Africa. The study observed that the relationship between seasonal rainfall and ground water recharge is nonlinear since recharge is largely restricted to anomalously intense seasonal rainfall.

Ramos *et al*. (2020) in the study of evidence of groundwater vulnerability to climate variability and economic growth in coastal Kenya observed that there is a significant decline in groundwater during the prolonged season of drought whilst the humid periods leads to a slight recharge in the groundwater systems. Oiro *et al*. (2018) used stable water isotopes in the identification of spatial and temporal controls on ground water recharge in two contrasting East African aquifers systems. The study domain of the research was the Nairobi Aquifer System (NAS) and the South Coast (SC) aquifer system. The results concluded that groundwater recharge occurs during the heavy rain months in NAS while SC experienced a diffuse recharge in spatial and temporal scale due to significant water-table evapotranspiration processes.

Nyakundi *et al*. (2015) studied the impact of rainfall variability on ground water levels in Ruiru Municipality, Kenya. Using monthly ground water and rainfall data, analysis was done and graphs plotted to comprehend the dynamics of groundwater levels and rainfall. The study concluded that there was an impact of rainfall variability on groundwater levels as results showed a declining groundwater levels during low rainfall periods.

From the above studies, it is evident that groundwater levels are also dependent on the rainfall trends. Low rainfall period results to declining groundwater levels while high rainfall periods result in rising groundwater levels with other factors, such as abstraction rates being kept constant. This study sought to establish whether there has been a major change in rainfall patterns in Lokichar basin that could have affected the groundwater levels.

2.5 Conceptual Framework

The study adopted and modified the Driver – Pressure – State – Impact - Response (DPSIR) conceptual framework from Hazarik *et al.* (2015) that sought to establish the extent of groundwater level decline brought about by rapid urbanization and increased population. The current study however sought to establish the extent of groundwater level decline brought about by increased groundwater abstraction in Lokichar basin since commencement of oil production.

Groundwater level decline in Lokichar basin is attributed to driving forces such as need for water to cater for oil production, serve the rapidly increasing population and Lokichar Town and lack of alternative water source that has led to overreliance on groundwater. These forces have led to increased rate of borehole drilling to abstract more water to cater for the increased demand. The increased groundwater abstraction has led to decline in groundwater levels, increased cost of drilling that consequently affect water accessibility. The impact of the continued lowering of groundwater levels is groundwater flow failure, increased salinity and creation of water poor. Based on the negative impacts, there is need to develop responsive mechanisms to address the impacts. The mechanisms include developing alternative oil production water source (a proposal to construct a water pipeline from Turkwel Dam to Lokichar is under consideration), coming up with policies governing groundwater abstraction and protection of Laggers which are the main recharge medias in the study area. Figure 2.1 shows the adopted and modified DPSIR conceptual model on causes and responses of groundwater level decline.

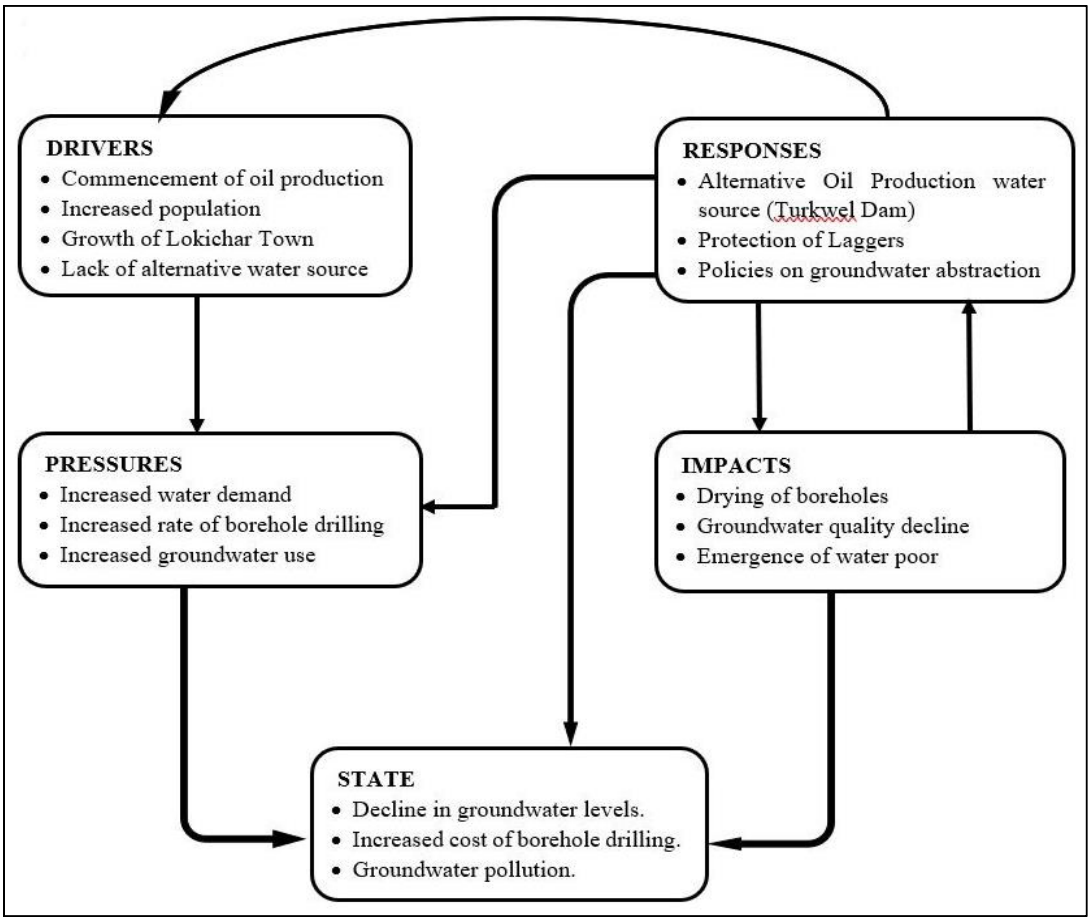

Figure 2.1: Modified DPSIR Conceptual Model

Source: Adopted and modified from Hazarik *et al.* (2015)

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter explains the research design adopted for this study. It also gives a detailed description of the study area as well as outlining the research instruments, methods of collecting data on groundwater demand, measurement of groundwater levels and collection of rainfall data. In addition, the chapter explains the data analysis procedures used for the various data collected.

3.2 Research Design

The study adopted quantitative research design method. It involved obtaining numerical data on borehole water levels in the study area through field measurements as well as population census data from Kenya National Bureau of Statistics which was used in calculating water demands. Rainfall data was obtained from CHIRPS. The various numerical data were statistically analyzed to establish commonalities or cause effect relationships between changes in borehole water levels and increased groundwater demand as well as changes in borehole water levels and rainfall variations. The statistical analysis was carried out in MS Excel. The results of the analysis of groundwater demand, borehole water levels and rainfall variations were relied upon in making the conclusions.

3.3 Study Area

3.3.1 Location and Demographic Characteristics

The study was conducted in Lokichar basin, Turkana South Sub-County, Turkana County, Kenya. The basin lies between the Lokapei Lokichar Road to the west, Kapenguria Lodwar road to the North and Lokichar Loperot road to the south. The Basin is located between Easting 790000m and 820000m and Northing 240000m and

270000m. The study focused on boreholes in the vicinity of Lokichar town and those that were drilled by Tullow Oil Company during the Early Oil Pilot Scheme project. The boreholes are mostly drilled along the Laggers. According to the Kenya National Bureau of Statistics (2010 and 2020), Turkana County had a population of 855,399 and 926,976 as at 2009 and 2019 population census respectively. Turkana South had a population of 226,379 and 153, 736 over the same period. The reduction in population for Turkana South was due to changes in the delimitation which resulted in Lokori and Lomelo divisions being moved out of Turkana South to Turkana East. Lokichar location had a population of 23,452 and 27,036 persons as at 2009 and 2019 population census respectively. Lokichar basin hosts the Twiga, Ngamia and Amosing oil fields which are the identified oil production areas in Kenya and where the Early Oil Pilot Scheme has already taken place. Figure 3.1 shows the map of the study area.

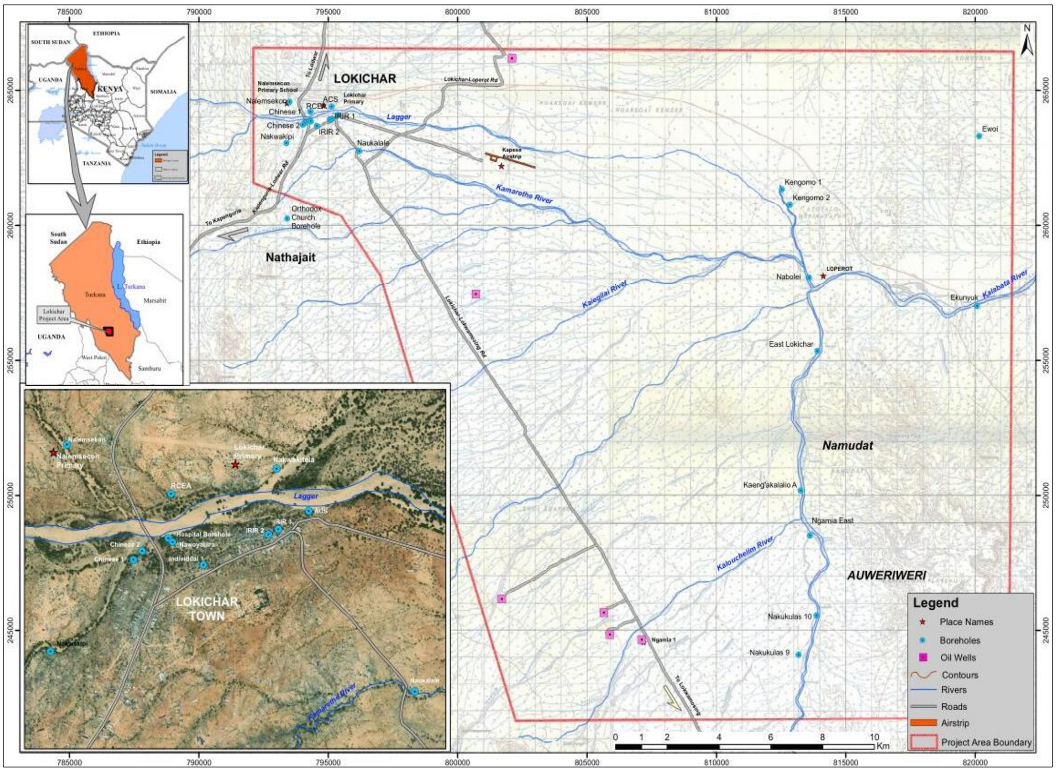

Figure 3.1:Map of Lokichar Basin

Source: Researcher (2021)

3.3.2 Aquifer Characteristics

The aquifer in the study area comprises of alluvial (unconsolidated sedimentary) and volcanic (igneous) aquifers that provide water at varying yields. Exploratory drilling was carried out by Price (2016) in the study area at Ngamia 4, East Lokichar and Lokwii Areas. Results from pumping tests carried out on the exploratory boreholes show that high yielding boreholes (approximately $12m^3$/hr) were those that encountered sandy sedimentary interflow deposits. Exploratory boreholes that intersected only the lavas were found to be low yielding (less than $1m^3$/hr). The high yielding boreholes were those located along the Laggers.

3.3.3 Climate

Lokichar basin is classified as an arid and semi-arid area and is characterized by warm and hot climate. The temperatures range between 20ºC and 41ºC with a mean of 30.5ºC (Oyugi, 2016). The rainfall pattern and distribution is unpredictable and unreliable both in time and in space. The area receives an annual average rainfall of 121mm with two rainfall seasons, the long rains occurring between April and July (commonly referred to as Akiporo) and the short rains occur between October and November. The driest periods in the area are January, February and September (Oyugi, 2016). The rainfalls are brief and accompanied with violent storms thus resulting in flush floods. The surface runoff and potential evaporation rates are extremely high.

3.3.4 Topography and Geology

The geology in the study area largely comprises Tertiary and Quaternary sediments and volcanic rocks. The basin was formed by rifting of basement rocks and is now partially infilled with superficial (drift) deposits. In certain sections of the study area the Precambrian basement rocks are exposed at the surface and comprise intensely folded gneisses and migmatites while in other sections the Precambrian basement rocks are overlain by Tertiary Turkana Grits, Tertiary sedimentary deposits and a Tertiary volcanic succession. The Turkana Grits are mapped as comprising grits, sandstones, silts and sandy limestones and are derived from the erosion of the Precambrian basement rocks. The Turkana Grits are highly fractured and jointed. The Tertiary sedimentary deposits were deposited by rivers and comprise sandstones separated by shales. The volcanic sequence includes basalts of various composition and phonolites, which are fine- grained extrusive rocks (Golder, 2020).

The superficial geology that underlies Lokichar basin is mapped as Alluvium. The alluvial material comprises Plio-Holocene unconsolidated alluvial fan material that have in places been redistributed by ephemeral stream, and fluvial sediments. There are localised outcrops within the Alluvium of Archaean basement rock and Tertiary volcanics. The main soil types comprise of Eutric and Calcaric regsols (Golder, 2020). The topographical features consist of plateaus, low lying plains with isolated hill ranges, minor scarps, foot slopes, footbridges and seasonal rivers (Moso, 2016).

3.3.5 Water Sources in Lokichar Basin

Lokichar basin is characterised as an arid / semi-arid area. The two main sources of water in Lokichar basin are surface water and groundwater sources.

a) Surface Water Sources

Lokichar basin has numerous seasonal rivers called Laggers. The Lagger river beds are usually filled up with a thick layer of sand. When it rains, the surface runoff flows on the Laggers with part of the surface runoff percolating into the thick layer of sand occupying the Lagger riverbed and thus act as major medium for groundwater recharge. The flow on the Laggers are however ephemeral lasting for less than a week after the rains stop. Water can be accessed immediately after the rains along the Laggers by hand scoping the sand to create small water pans. Water can be accessed on the Laggers for less than a week after rainfall cessation as the pans dry up. Plate 3.1 shows a water pan on the Lagger dug near Lokichar Town.

Plate 3.1: Water Pan near Lokichar Town Dug in August 2020 Immediately after the Rains.

Source: Researcher (2021)

The limitation of this water sources is that the water stored under the river is only available for a short period after the rains have stopped. Due to high rate of evaporation within the basin, this water evaporates in less than a week and can therefore not be relied upon.

b) Groundwater Sources

Residents of Lokichar basin rely on groundwater to meet their daily needs. 25 boreholes were identified during the field study of which 2 boreholes had been abandoned due to lowering water levels while 23 boreholes were operational. Of the operational boreholes, 10 are owned by Tullow Oil Company, 7 by LOKIWASCO and 6 are privately owned (NGOs and religious organisations). The boreholes within the basin have been drilled along the Laggers. This helps to recharge the aquifers when rains occur. Some of the main boreholes currently serving the residents of Lokichar basin are shown in Figure 3-1.

3.4 Data Collection

3.4.1 Groundwater Demand in Lokichar Basin

Both primary and secondary data for groundwater demand were collected during the months of February, August, and September 2020. The criteria adopted to select the period during which data was to be selected was based on the need to collect data when Early Oil Pilot Scheme was going on (February 2020) and after completion of the Early Oil Pilot Scheme (August / September 2020).

i. Primary Data

Data of the existing institutions, administrative offices, number of staff in the administrative offices, hospitals and number of hospital beds, shops, bars and schools in Lokichar basin were first identified and recorded in February 2020. The record was later validated during the months of August and September 2020.

The number of individual connections and the main water sources were also identified in February by the help of Lokichar Water & Sanitation Company Limited (LOKIWASCO). The main water consumers in the study area were also identified by the help of LOKIWASCO.

ii. Secondary Data

Data on human and livestock population in Lokichar basin was obtained from the Kenya National Bureau of Statistics. To determine the number of Livestock Units, the conversion factor given by the Kenya Ministry of Water and Irrigation design manual (2005) was adopted.

Data on oil production (under the Early Oil Pilot Scheme and planned full commercialization) was obtained from Tullow Oil Company.

3.4.2 Groundwater Level Measurement

Hourly groundwater levels on two selected boreholes were recorded for a period of 30 days starting from 12th August 2020 to 11th September 2020. The recording of borehole water levels was carried out using a dipper and a levelogger. The choice of the borehole where levels were to be recorded were guided by the borehole area of service. Water levels for the borehole serving the largest area / demand within Lokichar urban area (Nawoyatira), and one borehole within its area of influence (Chinese 1) were recorded for purposes of establishing any trend. The following are the boreholes where water level recording was carried out:

i. **Nawoyatira Borehole**

Water levels at Nawoyatira borehole were recorded using Solinst Levelogger model 3601 – LTC M200. The levelogger was programmed to record hourly water levels starting on 12th August 2020 7:00 a.m to 11th September 2020 6:00 p.m. The levelogger measures the total pressure acting on a transducer at their zero point / sensor. The total pressure is caused by the column of water lying above the levelogger pressure sensor and the barometric/ atmospheric pressure acting on the water surface.

Given that the measurement by the levelogger sensor results from two parameters (height of water column and atmospheric pressure), the recorded data require correction and verification. A Solinst Baralogger model 3001 LT F5/M1.5 was used to record the barometric pressure fluctuations so as to correct the data recorded by the levelogger and get true height of water column as shown in equation 3.1.

H=L-B

…………………………………………………………………….Equation 3.1

Where: L - Levelogger reading
B - Baralogger reading
H – Height of water column

To verify the data recorded by the levelogger, manual measurement of the borehole water levels using a dipper was carried out five minutes before lowering the levelogger, at noon on 19th August 2020, 26th August 2020 and 2nd September 2020. Manual recording of the water levels was also carried out immediately after removing the levelogger from the borehole on 11th September 2020 at 6:00 p.m. Manual borehole water level recordings were used to compare the barometrically compensated levelogger data with measured depth to water level (with a dipper) as shown in the following formula:

H=D-d

…………………………………………………………………….Equation 3.2

Where: D - Level Logger Deployment Depth
d - depth to water (manually recorded using a dipper)
H - Height of water column

2. Chinese 1 Borehole

Water levels on Chinese one borehole were recorded manually using a dipper on hourly basis commencing on 12th August 2020 at 7:00 a.m. to 11th September 2020 at 6:00 p.m. Plate 3.2 shows the researcher carrying out ground water level recording. Recorded Ground water levels are given in annex 2.0.

Plate 3.2: Borehole Water Level Measurement

Source: Researcher (2021)

3.4.3 Rainfall Trend

The datasets utilized in this study were Climate Hazards InfraRed Precipitation with Stations (CHIRPS) spanning for a period of 39 years (1981-2019). The data has been subjected to quality control and fit for analysis. The Climate Hazards Infrared Precipitation with Stations (CHIRPS) is a quasi-global rainfall dataset extending from 1981 to present. It has a resolution of 0.05^{o} (5km radius), consists of satellite estimates blended with gauged rainfall data to create gridded rainfall time series.

Dinku *et al*. (2018) assessed the performance of CHIRPS over East Africa, comparatively with other satellite data and showed a better performance with a higher skill, low or no bias and lower random errors.

3.4.4 Validation of Rainfall Data

Until the year 2015, there were no existing meteorological stations within Lokichar basin. However, in December 2015 and January 2016, Tullow Oil Company installed two meteorological stations at Kapese Airstrip and at Ngamia oil fields. Plate 3.3 shows Ngamia Meteorological Station installed in December 2015. Data from the two meteorological stations are not adequate to establish rainfall trends in the study area as they span over a very short period of time (data not historical)

Plate 3.3: Ngamia Meteorological Station
Source: Researcher (2021)

The historic meteorological data spanning from 1990 to 2019 were obtained from Lodwar Meteorological station which is approximately 85km to the north of Lokichar. The data has been used to give regional context in terms of rainfall averages. This data has also been used to validate the CHIRPS data. The recorded rainfall data from Lodwar meteorological Station is given in Annex 3.

For purposes of rainfall data validation, three CHIRPS data sets at Lodwar town, Kapese airstrip and Ngamia oil fields have been obtained. A comparison has been carried out of the rainfall recorded at Lodwar, Kapese and Ngamia meteorological stations with the downloaded CHIRPS data for the respective regions. The results show consistency of the two datasets for Kapese and Ngamia Stations. There are however slight discrepancies in the data recorded at Lodwar weather station due to numerous missing data. Due to the consistency noted between the two data sets, CHIPRS data for the period 1981 to 2019 (39 years) for Lokichar town has been adopted for analysis of rainfall trends in the study area.

3.5 Data Analysis Procedures

On the first objective, changes in ground water demand were analysed by determining the groundwater demand for the year 2009 (before commencement of oil production) and 2019 (after commencement of oil production). A projection was carried out for groundwater demand for the year 2022. Groundwater demand was determined by focusing on all water demand sectors in Lokichar basin including Domestic water demand, Livestock water demand, Institutional water demand, Commercial water demand and Industrial water demand. Industrial water demand represents oil production water demand in this case. The Kenya Ministry of Water and Irrigation Design Manual (2005) guidelines were adopted in computing the various sectorial water demands. The computed water demands were further analysed in MS-Excel to establish the trends over the period 2009 to 2022. The Kenya Ministry of Water and Irrigation Design Guidelines are given in Table 3.1.

The second objective (borehole water levels) were analysed in MS-Excel, ARCGIS, AutoCAD Civil3D and surfer 10. Surfer 10 was used to analyse and present the general ground water flow direction in Lokichar Basin. Maps of the radius of influence for the various boreholes were drawn in ARCGIS and AutoCAD Civil3D. ARCGIS Software was used to georeference the physical features and to download global satellite imagery for the study area. The georeferenced physical features and satellite imageries were modified in AutoCAD Civil3D which including plotting of radius of influence, labelling of boreholes and other physical features, plotting, etc. Descriptive statistics were used to show changes in borehole water levels during the study period. The changes in borehole water levels were related to groundwater abstraction (demands) over the various periods to show the effect of increased groundwater abstraction to borehole water levels.

On the rainfall trends, graphical method was used for analysis involving bar plots and trends. It was used to demonstrate rainfall performance and variability over the study area. The bar plots involved the plotting of annual totals of rainfall against the years. To establish the statistical significance, Mann-Kendal test was applied. The analysis was carried out to determine whether there has been a major change in rainfall amounts that might have resulted to changes in groundwater recharge / levels.

Table 3.1: Guidelines on Estimation of Water Demand

<table>
<tr><th rowspan="2">CONSUMER</th><th rowspan="2">UNIT</th><th colspan="3">RURAL AREAS</th><th colspan="3">URBAN AREAS</th></tr>
<tr><th>High potential</th><th>Medium potential</th><th>Low potential</th><th>High Class Housing</th><th>Medium Class Housing</th><th>Low Class Housing</th></tr>
<tr><td>People with individual connections</td><td>1/head/ day</td><td>60</td><td>50</td><td>40</td><td>250</td><td>150</td><td>75</td></tr>
<tr><td>People without connections</td><td>1/head/ day</td><td>20</td><td>15</td><td>10</td><td>-</td><td>-</td><td>20</td></tr>
<tr><td>Livestock unit</td><td>1/head/ day</td><td colspan="3">50</td><td colspan="3">-</td></tr>
<tr><td>Boarding schools</td><td>1/head/ day</td><td colspan="6">50</td></tr>
<tr><td>Day schools
with WC
without WC</td><td>1/head/ day</td><td colspan="6">25
5</td></tr>
<tr><td>Hospitals
Regional
District
other</td><td>1/bed/ day</td><td colspan="6">400
200
100 } + 20 1 per outpatient and day (minimum 5000 1/day)</td></tr>
<tr><td>Dispensary and Health Centre</td><td>1/day</td><td colspan="6">5000</td></tr>
<tr><td>Hotels
High Class
Medium Class
Low Class</td><td>1/bed/ day</td><td colspan="6">600
300
50</td></tr>
<tr><td>Administrative offices</td><td>1/head/ day</td><td colspan="6">25</td></tr>
<tr><td>Bars</td><td>1/day</td><td colspan="6">500</td></tr>
<tr><td>Shops</td><td>1/day</td><td colspan="6">100</td></tr>
<tr><td>Unspecified industry</td><td>1/ha/day</td><td colspan="3"></td><td colspan="3">20,000</td></tr>
<tr><td>Coffee pulping factories</td><td>1/kg coffee</td><td colspan="6">25 (when re-circulation of water is used).</td></tr>
</table>

Source: Kenya Ministry of Water and Irrigation Design Manual (2005)

3.6 Ethical Considerations

Before commencing data collection, the researcher obtained permits from Kenyatta University Graduate School and National Commission for Science, Technology and Innovation (NACOSTI). The NACOSTI permit is attached as Annex 4. Upon getting to Lokichar, permission to proceed with data collection was granted by the area chief.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the study results and discussions. The chapter is divided in three parts. The first section outlines the results and discussion of the ground water requirement in the study area, the second section gives the results and discussion of groundwater levels while the third section gives the analysis and discussion of the rainfall trends in the study area. The water requirement and the rainfall trends have been analysed in order to establish their relationship with groundwater level fluctuations.

4.2 Groundwater Demand in Lokichar Basin

Residents of Lokichar basin rely on groundwater to meet their daily need. According to LOKIWASCO, the entire water supply network within Lokichar town and the surrounding area is served through a network of boreholes dug along the Laggers. Equally, the water utilized for oil production during the EOPS was obtained from boreholes (Golder, 2020). Surface water sources are ephemeral and only last for few days after the rains and thus contributes for less than 1% of the domestic and Livestock water demands in the area. All other water sectors in the study area depend entirely on groundwater. The Kenya Ministry of Water and Irrigation Design Manual (2005) guidelines for assessment of water requirements / demands has been adopted to calculate the water demand in the study area.

Three study horizons (year 2009, year 2019 and year 2022) have been considered. Year 2009 shows groundwater demand in the study area before commencement of oil production while year 2019 shows groundwater demand during the Early Oil Pilot

Scheme. Year 2022 shows the groundwater demand after full development of the oil fields by Tullow Oil Company.

4.2.1 Domestic Water Demand in Lokichar Basin

Approximately 60% of the population in Lokichar Basin lives within Lokichar town with the remaining population residing within Tullow Oil camps and rural areas. Individual connections are concentrated within Lokichar town. Housing in Lokichar town is classified under low class housing while Lokichar rural is classified under low potential area.

Data on the number of water consumer connections were obtained from LOKIWASCO. The household population data was obtained from the 2009 and 2019 Kenya population and housing census reports. An analysis of the 2009 and 2019 Kenya population census reveals that household population in Lokichar basin grew at a rate of 1.53% over a period of 10 years (0.153% annual growth rate). According to KNBS (2019), the national growth rate over the same period was 2.3%. With the discovery of oil within the basin, it is envisaged that the population in the area will grow at a higher rate. Based on the population growth rate in the basin between year 2009 and 2019 and the envisaged population growth brought about by oil discovery and production, a population growth rate of 0.75% per annum has been adopted between year 2019 and 2022. The estimated domestic water demand in Lokichar basin for year 2009, 2019 and 2022 are 1,011,954 litres per day, 1,166,603 litres per day and 1,195,768 litres per day respectively as shown in Table 4-1. Figure 4-1 shows the trend in domestic water demand in the study area between year 2009 to 2022.

Table 4.1: Domestic Water Demand in Lokichar Basin

No.	Item	Demand Category	Population			Water Demand (l/day)		
			Year 2009	Year 2019	Year 2022	Year 2009	Year 2019	Year 2022
1	Urban - With Individual Connections	Low Class Housing	10,553	12,166	12,470	791,505	912,465	935,277
2	Urban - Without Individual Connections	Low Class Housing	3,518	4,055	4,157	70,356	81,108	83,136
3	Rural - With Individual Connections	Low Potential	1,876	2,163	2,217	75,046	86,515	88,678
4	Rural - Without Individual Connections	Low Potential	7,505	8,652	8,868	75,046	86,515	88,678
Total Domestic Water Demand (l/day)						**1,011,954**	**1,166,603**	**1,195,768**

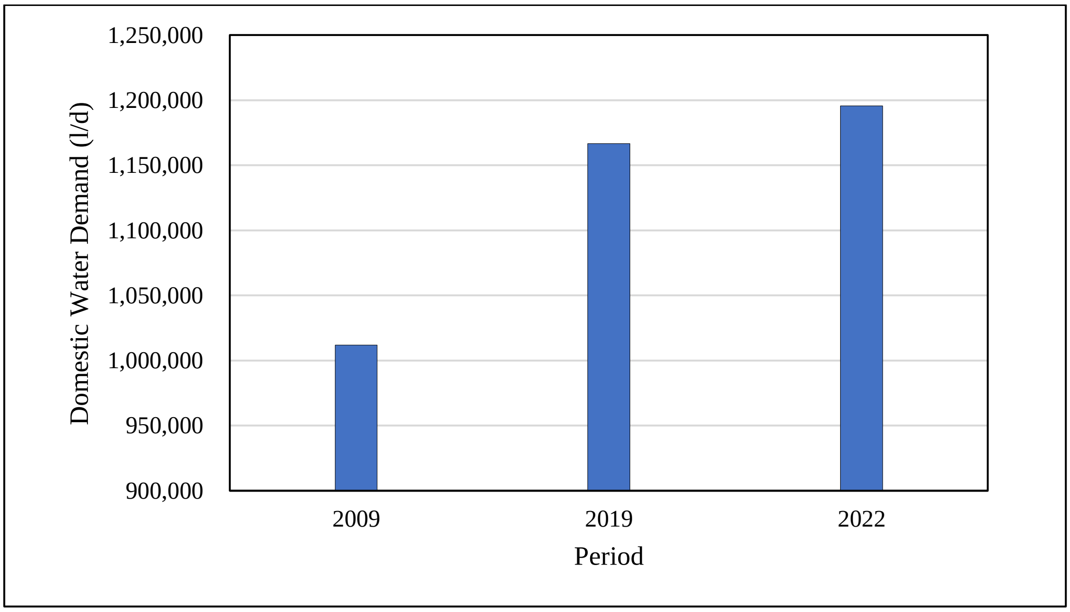

Figure 4.1: Trend in Domestic water Demand between 2009 to 2022

Source: Researcher (2021)

Domestic water demand increased by 15% between the year 2009 to 2019 (1.5% per annum) and is expected to increase by 2.5% between 2019 and 2022. According to the

National Water Master Plan (2013), domestic water demand in Kenya is expected to increase by 116% between year 2010 to 2030. The low growth in domestic water demand in Lokichar basin compared to the national growth rate is due to a low population growth rate experienced and low number of consumer water connections in the area.

4.2.2 Livestock Water Demand in Lokichar Basin

Due to the extreme temperatures and low rainfall experienced in the study area, the livestock reared are goats, sheep, and camels. These are the contributing factors to livestock water demand in the study area. Data on livestock population was obtained from the 2009 and 2019 Kenya Population report. The report gives the population of livestock per district. To get the number of livestock within Lokichar basin, the total number of livestock in Turkana South district was divided by the number of divisions (six) in the district. Analysis of 2009 and 2019 livestock data shows that the number of livestock in Lokichar basin increased at an average rate of 0.3% per annum. For purposes of projecting the 2022 livestock population in the study area, a growth rate of 3.2% per annum recommended by the National Water Masterplan (2013) has been adopted. The estimated livestock water demand in Lokichar basin for year 2009, 2019 and 2022 are 373,273 litres per day, 382,308 litres per day and 384,192 litres per day respectively as shown in Table 4-2. Figure 4-2 shows the trend in livestock water demand in the study area between year 2009 to 2022.

Table 4.2: Livestock Water Demand in Lokichar Basin

No.	Item	Livestock Units (LU)	Number of Livestock			Water Demand (l/day)		
			Year 2009	Year 2019	Year 2022	Year 2009	Year 2019	Year 2022
1	Sheep	15 Sheep = 1 LU	20,517	21,036	21,142	68,390	70,120	70,473
2	Goats	15 Goats = 1 LU	53,695	55,504	55,783	178,983	185,013	185,943
3	Camels	2 Camels = 1 LU	5,036	5,087	5,111	125,900	127,175	127,775
Total Livestock Water Demand (l/day)						**373,273**	**382,308**	**384,192**

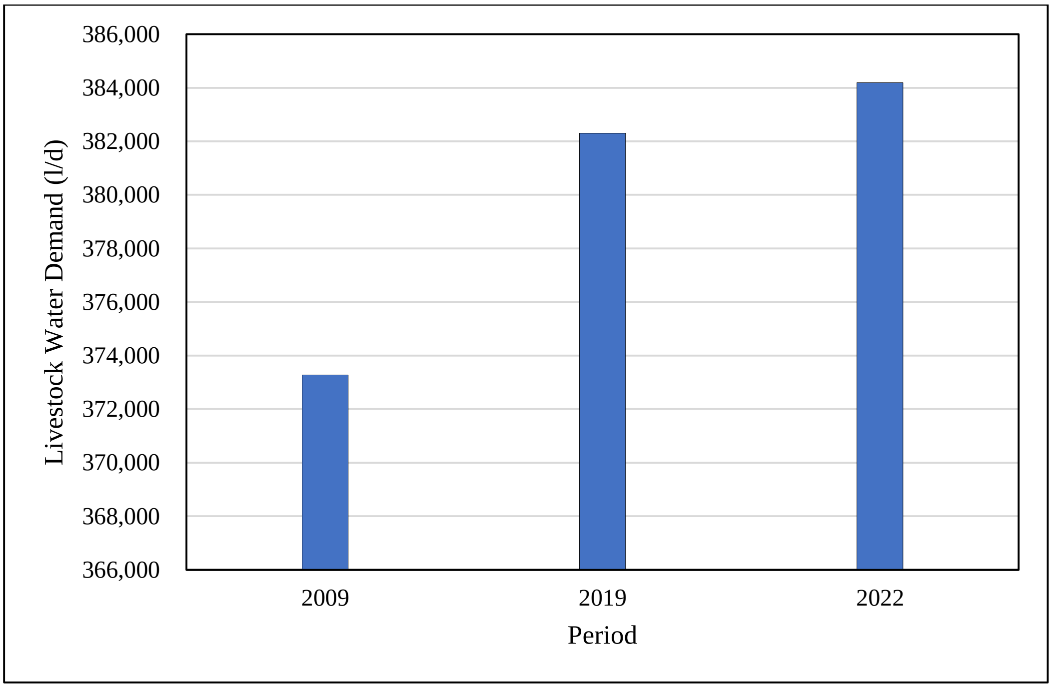

Figure 4.2: Trend in Livestock Water Demand between 2009 to 2022

Source: Researcher (2021)

Livestock water demand experienced minor increase between 2009 and 2022 (2.4% between 2009 to 2019 and 0.5% between 2019 to 2022). According to the National Water Master Plan, livestock water demand is expected to grow by 95% between 2010 to 2030. The low rate of livestock water demand in the study area is a result of low rainfall received that makes it difficult to rare certain animals.

4.2.3 Institutional Water Demand

The major institutions within Lokichar Basin are Tullow Sub-County hospital, Sub-County administration offices, Kapese primary school, Lokichar girls, Katilu boys, Nalemsokon primary and Uhuru high school. MWI design manual recommends that for purposes of computing education water demand, 30% of the total population be assumed to be school going. To compute the health water demand, MWI recommends that 0.8 beds be taken to cater for every 1,000 persons. With Tullow Sub-County hospital serving the entire Turkana South, calculation of the total number of beds required has been carried out based on the Sub-County population and not the basin population. On the administration water demand, the government and non-governmental organization offices within the basin were identified. The number of staff working in these offices was estimated based on the services they offer to the residents. To project the institution water demand for the year 2022, it has been assumed that no additional institutions will be established in the area between the year 2020 and 2022. The projected population has been adopted for purposes of estimating the population of school going children (30% of the population) for the case of education water demand and the number of hospital beds for the case of health water demand. The estimated institutional water demand in Lokichar basin for year 2009, 2019 and 2022 are 449,780 litres per day, 522,006 litres per day and 535,194 litres per day respectively as shown in Table 4.3. Figure 4.3 shows the trend in institutional water demand in the study area between year 2009 to 2022.

Table 4.3: Institutional Water Demand in Lokichar Basin

1. Education Water Demand								
No.	**Item**	**Demand Category**	**Population**			**Water Demand (l/day)**		
			2009	**2019**	**2022**	**2009**	**2019**	**2022**
1	Urban	Low Class Housing	14,071	16,227	16,627	316,598	365,108	374,108
2	Rural	Low Potential	9,381	10,814	11,085	112,572	129,768	133,020
2. Health Water Demand								
No.	**Item**		**Population**			**Water Demand (l/day)**		
			2009	**2019**	**2022**	**2009**	**2019**	**2022**
1	Rural and Urban (Entire Sub-County)		226,379	292,262	303,952	18,110	23,381	24,316
3. Administration Water Demand								
No.	**Item**		**Number of Staff**			**Water Demand (l/day)**		
			2009	**2019**	**2022**	**2009**	**2019**	**2022**
1	Turkana South Sub-County Offices		100	150	150	2,500	3,750	3,750
Total Institutional Water Demand (l/day)						**449,780**	**522,006**	**535,194**

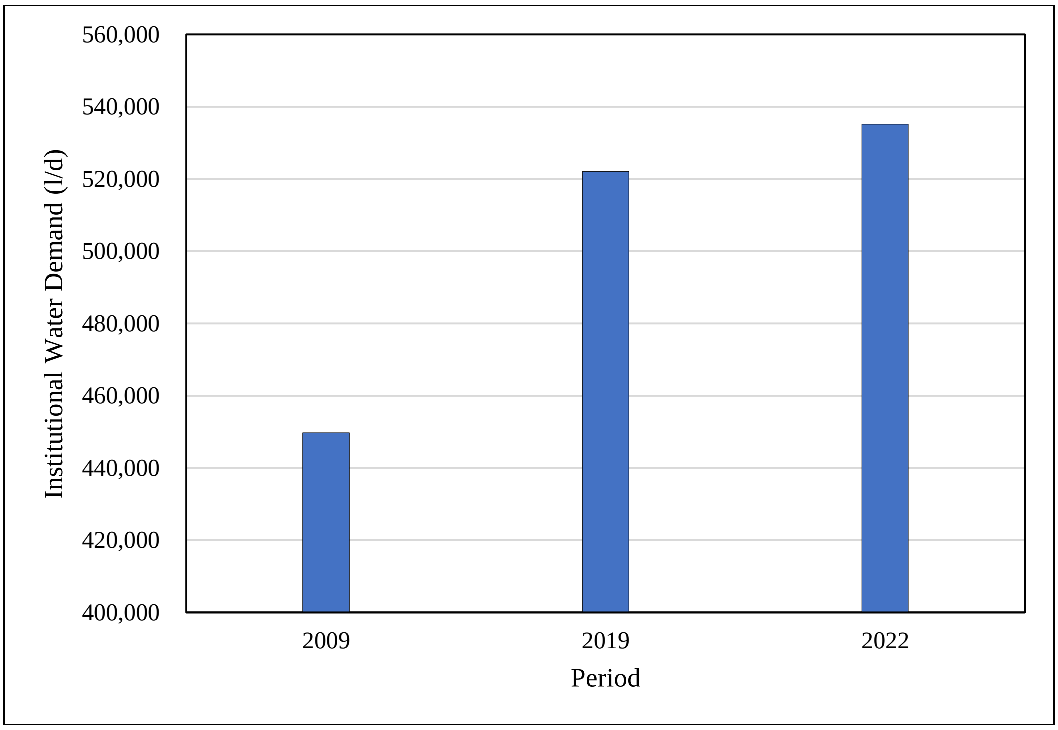

Figure 4.3: Trend in Institutional Water Demand between 2009 to 2022

Source: Researcher (2021)

Institutional water demand has increased at low rate between year 2009 and 2022 (16% between 2009 and 2019 and is expected to increase by 2.6% between 2019 to 2022). The slow rate of increase of the institutional water demand is brought about by the slow growth of the existing institutions and few new institutions being established in the area.

4.2.4 Commercial Water Demand in Lokichar Basin

Shops and bars are the contributing factors to commercial water demand in Lokichar basin. MWI design manual specifies a water consumption rate of 500 litres per day for bars and 100 litres per day for shops. To estimate the commercial water demand, the number of shops and bars within Lokichar town was estimated using google earth imagery back dated to 2009 and compared with the 2019 / 2020 imageries where a physical count of the shops and bars was carried out. To project the commercial water demand for the year 2022, it was assumed that the number of shops and bars will rise proportionately with the household population (0.25% per annum). The estimated commercial water demand in Lokichar basin for year 2009, 2019 and 2022 are 11,000 litres per day, 19,500 litres per day and 21,700 litres per day respectively as shown in Table 4-4. Figure 4.4 shows the trend in commercial water demand in the study area between year 2009 to 2022.

Table 4.4: Commercial Water Demand in Lokichar Basin

No.	Item	Number of Shops & Bars			Water Demand (l/day)		
		2009	2019	2022	2009	2019	2022
1	Shops	60	120	132	6,000	12,000	13,200
2	Bars	10	15	17	5,000	7,500	8,500
Total Commercial Water Demand (l/day)					11,000	19,500	21,700

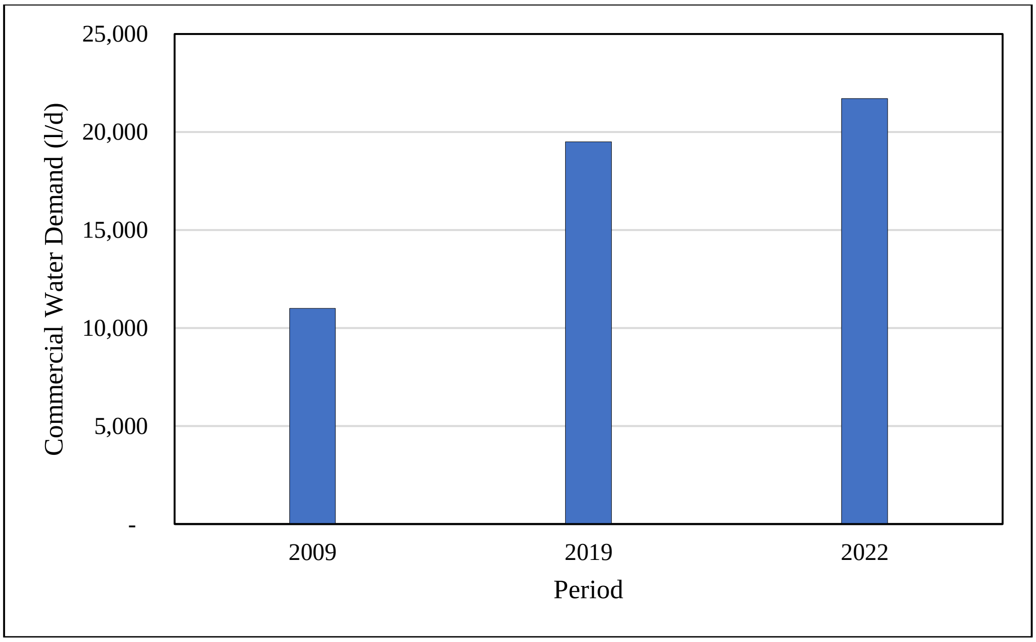

Figure 4.4: Trend in Commercial Water Demand between 2009 to 2022

Source: Researcher (2021)

Commercial water demand has been increasing significantly in Lokichar basin between the year 2009 and 2019 and is projected to continue increasing to year 2022. Between the year 2009 and 2019, commercial water demand in the study area increased by 77% and is further expected to increase by 10% between 2019 and 2022. The high increase in commercial water demand has been brought about by the increased number of shops and bars in the area to cater for Tullow oil workers.

4.2.5 Industrial Water Demand in Lokichar Basin

As at the year 2009, there were no industrial activities going on within Lokichar basin thus no industrial water demand has been estimated for that period. To estimate the industrial water demand for the year 2019 and 2022, data on the daily oil production taking place in Lokichar basin and the projected oil production after full development of the oil fields was obtained from the Early Oil Pilot Scheme report by Tullow Oil Company. To extract one barrel of oil, nine barrels of water is required. The estimated industrial water demand in Lokichar basin for year 2019 and 2022 are 2,862,000 litres per day and 143,100,000 litres per day respectively as shown in Table 4.5. Figure 4.5 shows the trend in industrial water demand in the study area between year 2009 to 2022.

Table 4.5: Industrial Water Demand in Lokichar Basin

No.	Item	Barrels of Oil produced per day			Water Demand (l/day)		
		2009	2019	2022	2009	2019	2022
1	Oil Production	0	2,000	100,000	0	2,862,000	143,100,000
Total Industrial Water Demand (l/day)					**0**	**2,862,000**	**143,100,000**

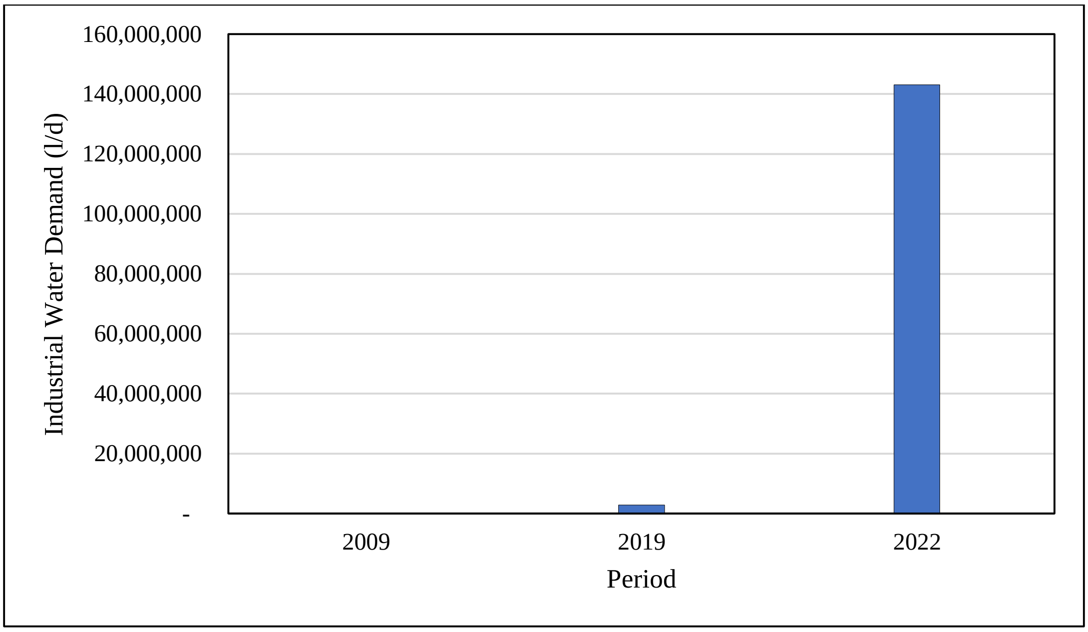

Figure 4.5: Trend in Industrial Water Demand between 2009 to 2022

Source: Researcher (2021)

There were no major industries in Lokichar basin in 2009 and thus no industrial water demand was registered. However, in 2019 after the commencement of oil production, industrial water demand rose from 0 to 2,862,000 litres per day. This is more than the water demand from all other sectors combined. A projection of the industrial water demand for the year 2022 shows that the demand will increase to 143,100,000 litres per day representing 4,900% growth rate (99% of all the water required in the study area). This implies that 99% of the water generated in the study area will be directed to oil production with other sectors left to share the remaining 1%. The National Water Masterplan show that industrial water demand will increase by 124% between year 2010 to 2030. The industrial water demand in Lokichar basin will therefore increase at higher rate than the projected national rate.

4.2.6 Overall Groundwater Demand in Lokichar Basin

Figure 4-6 shows the sectorial groundwater demands for the study periods 2009, 2019 and 2022. From the figure, it is clear that by the year 2022, industrial water demand will by a large extent supersede all other sectors. This may result to inaccessibility of water by some sectors. This is in line with the study by Robert and Greg (2017) conducted in Karoo area in South Africa that showed that water for other sectors was reallocated to oil production that ended up causing conflicts between local residents and oil producing companies.

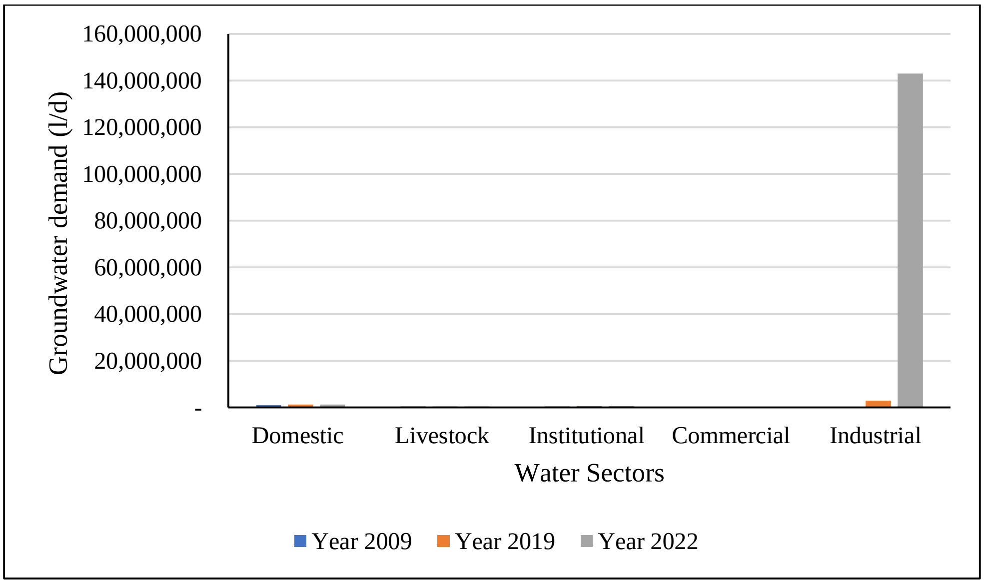

Figure 4.6: Comparison of Sectorial Water Demand

Source: Researcher (2021)

A comparison of industrial water demand and a summation of water demands from all the other sectors has been carried out to establish the magnitude of the change in demands caused by the commencement of oil production. A plot of industrial water demand and a combination of other demands show that all other demands will be suppressed by the industrial demand by 2022 as shown in Figure 4-7. This is in line with the study by Robert and Greg (2017).

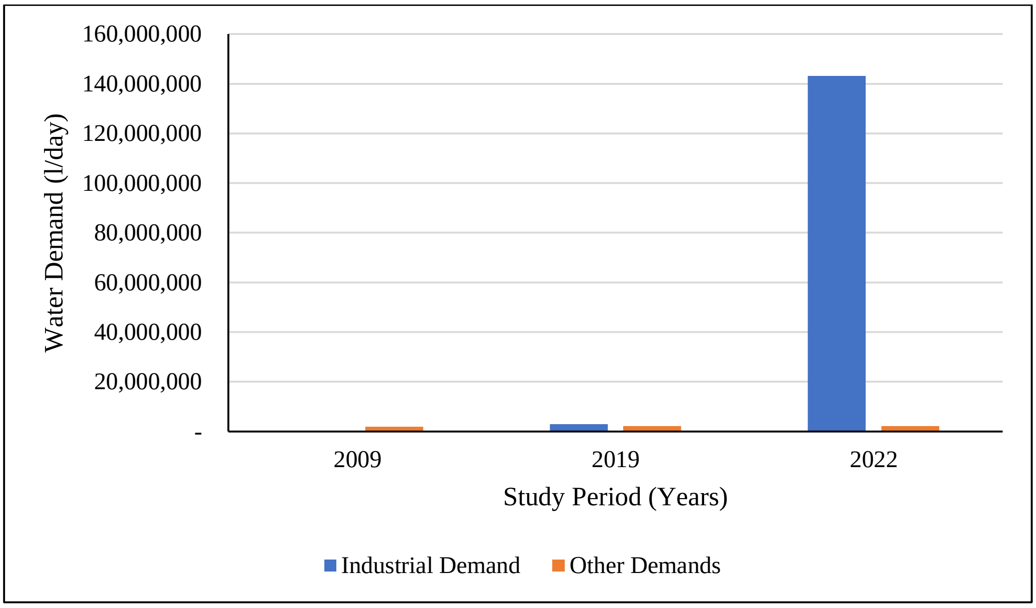

Figure 4.7: Industrial Demand vis-a-vis a Summation of other Demands

Source: Researcher (2021)

Between year 2009 and 2019, there was an increase of 168% in the overall groundwater demand. It is projected that between 2019 and 2022, the overall groundwater demand will increase by 2,833% as shown in Figure 4.8. This is in line with the study by Robert and Greg (2017). The increase in groundwater demand for an area that has already been experiencing acute water shortages will pose a great danger to the available groundwater resources due to a possibility of groundwater over abstraction which can subsequently lead to groundwater depletion or lowering of groundwater levels to depths that are no longer economical. There is therefore need to obtain an alternative source of water for oil production and stop reliance on groundwater.

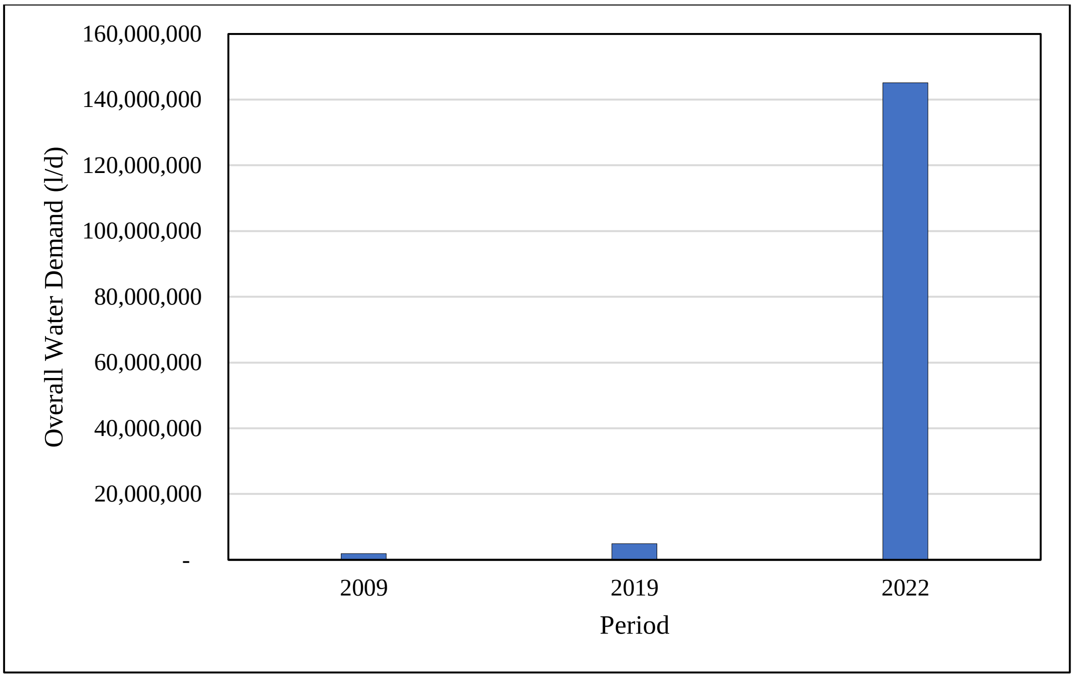

Figure 4.8: Trend in Overall Water Demand in Lokichar Basin

Source: Researcher (2021)

4.3 Groundwater Levels

4.3.1 Ground Water Flow Direction

There is very little borehole monitoring data available within Lokichar basin. Even with the available data, it is unreliable to use for ground water flow direction analysis as the monitoring wells are also used as water supply wells thus correct record on pumping cannot be precisely determined. Price (2016) carried out an analysis of groundwater flow direction by contouring the water levels in shallow aquifer units within the South Lokichar basin using maximum water levels recorded in some boreholes and established that ground water flow direction is predominantly Northeastwards.

Under the current study, borehole depths were obtained from LOKIWASCO records. The borehole locations (Northing, Easting and Elevation) were measured using GPS. Borehole depths and elevations were analysed using Surfer 10 software to estimate the direction of ground water flow in an attempt to validate the work carried out by

Price (2016). The analysis showed that ground water flow direction in Lokichar Basin is Eastwards as a shown in Figure 4.9. The results showed a near similarity with the outcomes from Price (2016) study.

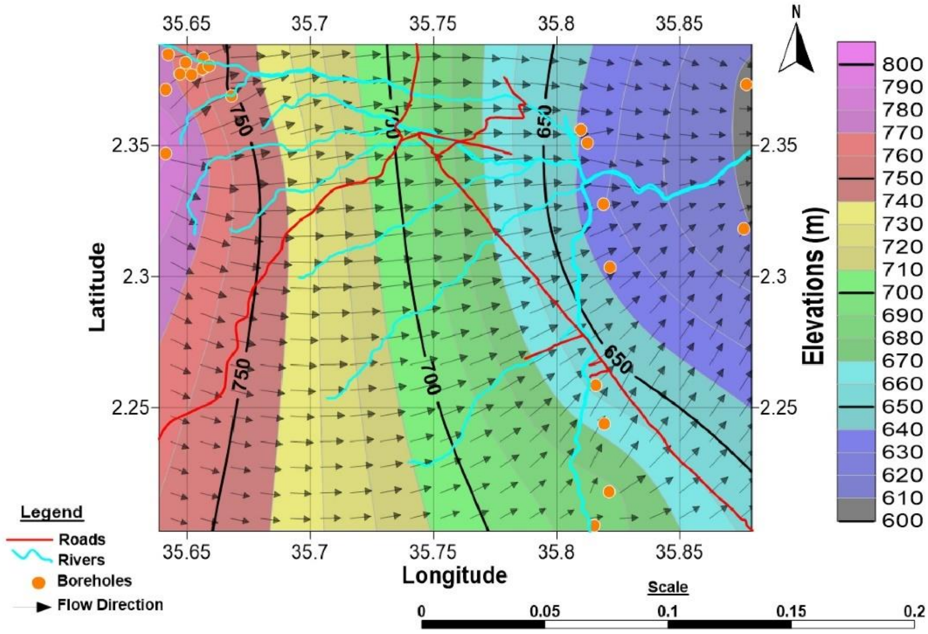

Figure 4.9: Groundwater Flow Direction in the Study Area

Source: Researcher (2021)

4.3.2 Radius of Influence

Ten water abstraction boreholes have been drilled by Tullow Oil Company and have been used for water extraction required for enhanced oil recovery during the Early Oil Pilot Scheme. The 10 boreholes also supply water to the surrounding dwellings such as Nakukulas trading centre. There are other 13 boreholes within Lokichar Town which supply water to the residents and the existing institutions. More water boreholes are scheduled to be drilled once the full commercial oil production commences. It is therefore important to establish the radius of influence for the existing boreholes in order to establish the extent of the areas that are being affected by water extraction for oil production. A drawdown on these boreholes will affect all other water sources within the radius of influence. The radius of influence has been calculated based on equation 4.1:

$$Ro = \sqrt{2.25T \frac{t}{Sy}}$$

…………………………………………………………..Equation 4.1

Where: R_0 - Radius of Influence (m)
T - Transmissivity (m^2/s)
t - Pumping time (s) (in this case 18months have been considered)
S_y - Specific Yield

Data on transmissivity and specific yield for ten boreholes drilled by Tullow oil have been obtained from secondary sources. However, no data exist for the 13 boreholes within Lokichar Town. For purposes of estimating the radius of influence for boreholes whose data is missing, the average transmissivity and specific yield for the ten boreholes whose data is available have been adopted. To get a more conservative assessment of the radius of influence, Fetter (1996) recommends that a sensitivity analysis be conducted for the lower bound of the specific yield at 0.02. Table 4-6 shows the calculated radii of influence using actual values of specific yield and the resulting expected radii of influence after carrying out the sensitivity analysis.

The radius of influence calculated from actual specific yield and that resulting from the sensitivity analysis has been plotted in Figure 4-10. The Figure of the area of influence show that all boreholes within Lokichar town apart from Naukalale and Orthodox Church share a common area of influence. This implies that a drawdown in one of the borehole results to a drawdown in the adjacent boreholes. Equally, for the boreholes drilled by Tullow oil, Nakukulas 9 and Nakukulas 10 as well as Kengomo 1 and Kengomo 2 share a common radius of Influence. The results are in line with the study by Golder (2020) that showed Nakukulas 9 and Nakukulas 10 boreholes sharing a common area of influence. If Tullow oil develops the planned extra boreholes around the existing once, there is high probability of having more boreholes with common areas of influence. The radii of influence from the sensitivity analysis show that all boreholes within Lokichar town share a common area of influence. It is therefore expected that a drawdown in one of the borehole within Lokichar town will cause a drawdown in the rest. For the case of the boreholes drilled by Tullow oil, Nakukulas 9, Nakukulas 10, Ngamia East, Kaeng'akalalio A as well as Kengomo 1 and Kengomo 2 share a common radius of influence. Increased ground water abstraction in one borehole will therefore have an effect on the other boreholes.

Table 4.6: Radius of Influence for Boreholes within the Study Area

No	Borehole	Transmissivity (m^2/s)	Specific Yield	Radius of Influence Based on: Actual Specific Yield (m)	Radius of Influence Based on: Sensitivity Analysis (m)
1	IRIR 1	1.26×10^{-3}	0.2136	787	2572
2	IRIR 2	1.26×10^{-3}	0.2136	787	2572
3	Chinese 1	1.26×10^{-3}	0.2136	787	2572
4	Chinese 2	1.26×10^{-3}	0.2136	787	2572
5	Nawoyatira	1.26×10^{-3}	0.2136	787	2572
6	Hospital (Privatised)	1.26×10^{-3}	0.2136	787	2572
7	Nakwakitela	1.26×10^{-3}	0.2136	787	2572
8	RCEA	1.26×10^{-3}	0.2136	787	2572
9	ACS	1.26×10^{-3}	0.2136	787	2572
10	Naukalale	1.26×10^{-3}	0.2136	787	2572
11	Nakwakipi	1.26×10^{-3}	0.2136	787	2572
12	Nalemsikon	1.26×10^{-3}	0.2136	787	2572
13	Orthodox Church	1.26×10^{-3}	0.2136	787	2572
14	Nakukulas 9	6.00×10^{-3}	0.100	2510	5612
15	Nakukulas 10	6.00×10^{-3}	0.100	2510	5612
16	Ngamia East	7.05×10^{-5}	0.500	122	608
17	Kaeng'akalalio A	4.17×10^{-6}	0.100	66	148
18	East Lokichar	2.50×10^{-4}	0.100	512	1146
19	Nabolei	4.08×10^{-5}	0.100	207	463
20	Kengomo 1	7.05×10^{-5}	0.036	453	608
21	Kengomo 2	9.55×10^{-5}	0.500	142	708
22	Ewoi	3.73×10^{-5}	0.100	198	442
23	Ekunyuk	3.27×10^{-5}	0.500	83	414

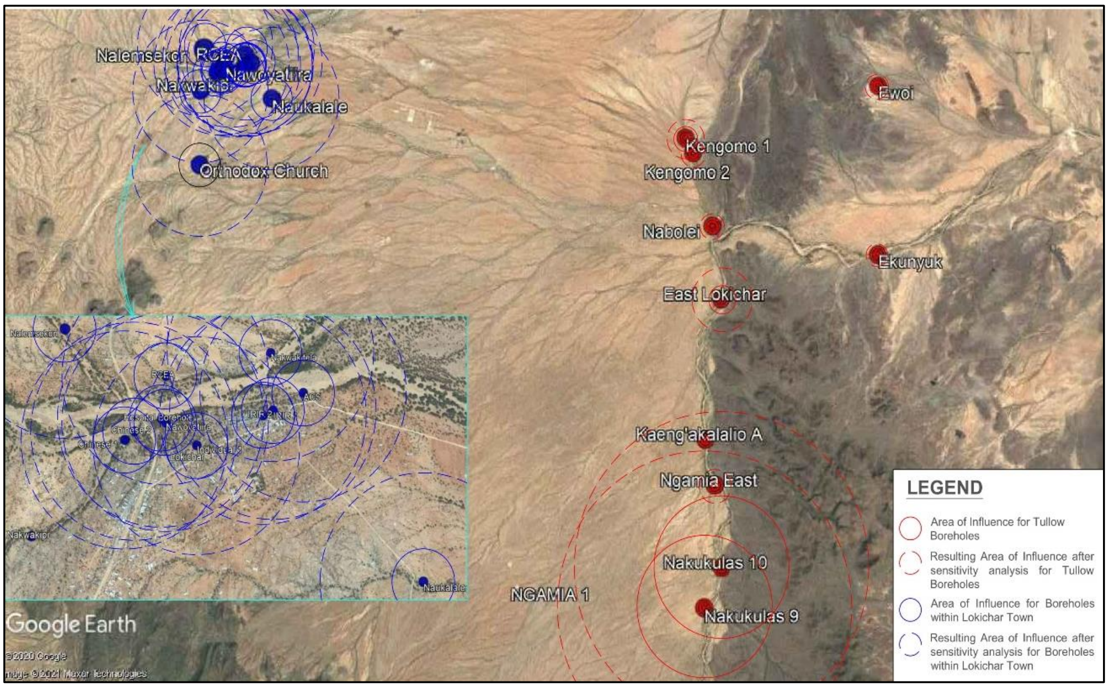

Figure 4.10: Radii of Influence for Boreholes within the Project Area

Source: Researcher (2021)

4.3.3 Hourly Borehole Water Levels

Analysis of the hourly borehole water levels for Chinese 1 and Nawoyatira borehole shows that the water levels are usually high during morning and evening hours and lowest between 1 and 3:00 p.m. During the study period the lowest water level for Chinese 1 borehole was recorded on 5th September 2020 at 2:00 p.m. at depth of 29.0m while the highest water level was recorded on 15th August 2020 at 7:00 a.m. at a depth of 3.5m. In the case of Nawoyatira borehole, the lowest water level was recorded on 29th August 2020 at 3:00 p.m. at a depth of 26.60m while the highest water level was recorded on 13th August 2020 at 8:00 a.m. at a depth of 3.84m. Figure 4-11 shows the trend in water level for Chinese 1 and Nawoyatira boreholes between 12th August 2020 and 10th September 2020. Data on the recorded borehole water levels are given in Annex 2.

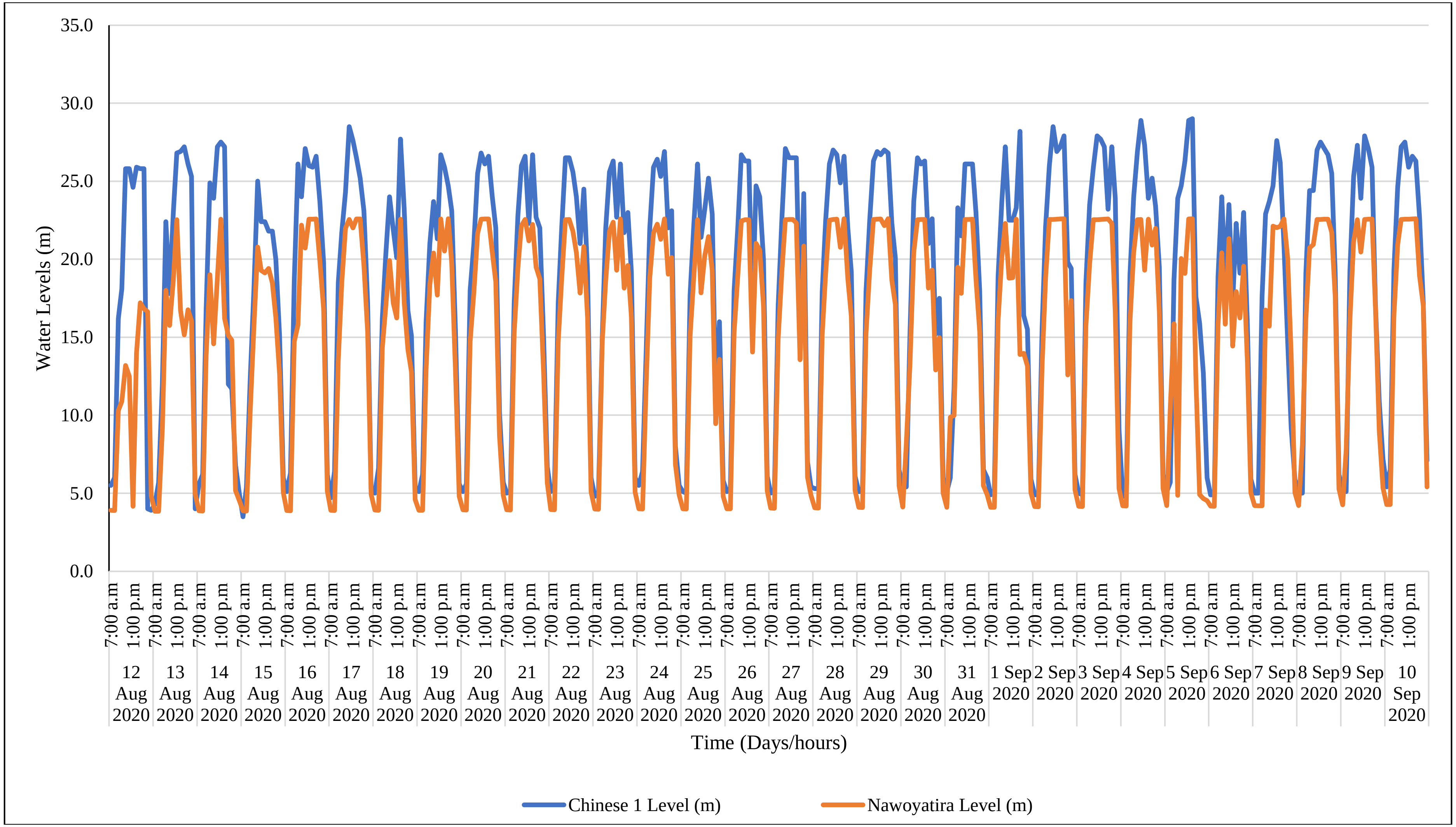

Figure 4.11: Trend in Water Levels for Chinese 1 and Nawoyatira Boreholes

Source: Researcher (2021

Groundwater levels in the study area are usually high during morning hours. This can be explained by the fact that water consumption during the night hours is usually low and thus very little water is pumped from the boreholes at night. This gives enough time for replenishing from the aquifers. During day time between 9:00 a.m. and 1:00 pm, the borehole water levels start dropping and achieves the lowest level at around 1:30p.m. The lowering of ground water levels during this period is caused by high rates of pumping as this is the time when most of the residents in the basin are utilizing the water. From this time, ground water levels starts rising again up the end of the recording period. The low number of individual water connections also results to most of the consumption occurring during the day where residents carry water from communal watering point in water cans. According to Buddemeir (2010), withdrawal of large volume of water per minute in a borehole result to sudden decline in water levels which start rising again when withdrawal is stopped. Figure 4-12 and Plate 4-1 shows average ground water levels and residents fetching water from a communal water point respectively as recorded during the study period.

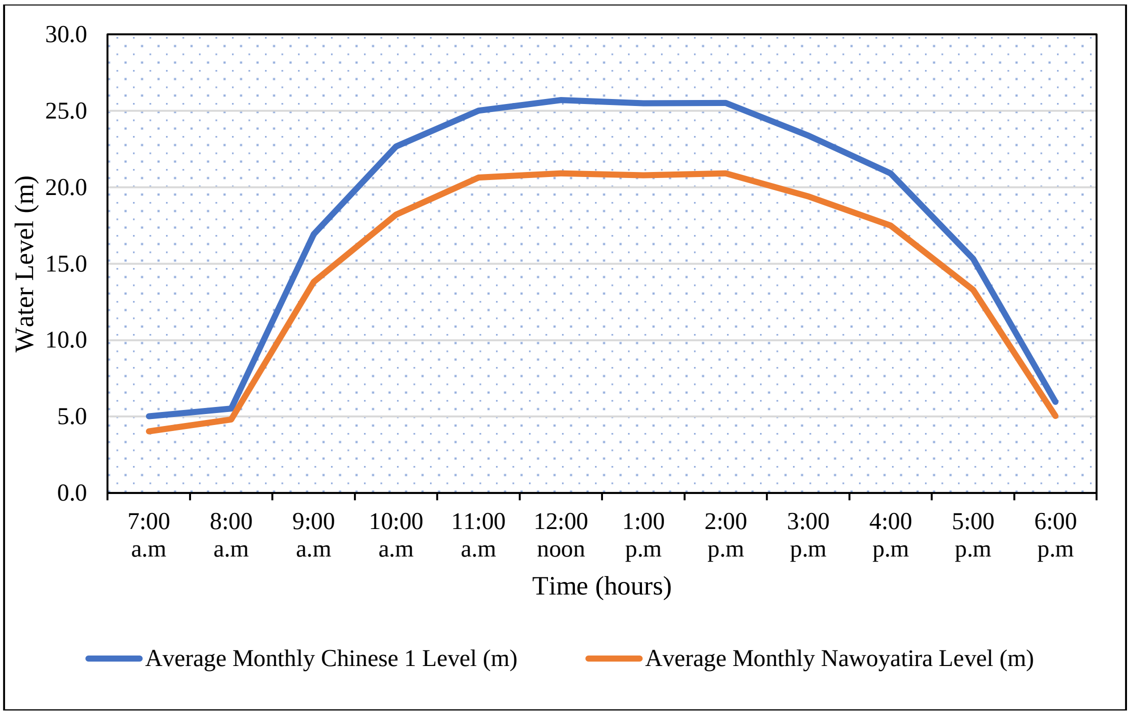

Figure 4.12: Average Borehole Water Levels in Lokichar Basin

Source: Researcher (2021)

Plate 4.1: Communal Water Point (Chinese 1 Borehole)

Source: Researcher (2021)

4.3.4 Daily Groundwater Levels

Analysis has been carried out to establish changes in average daily groundwater levels in the study area. From the analysis, no major changes in groundwater levels have been noticed over the study period. The average daily water level for Chinese 1 borehole is 18.12m while that of Nawoyatira is 19.5m During the field data collection, oil production in Lokichar basin had been suspended after completion of the Early Oil Pilot Scheme. This implies that no water was being abstracted from the ground for purposes of oil production during the field data collection. This may have resulted to nearly constant average ground water levels. Figure 4.13 shows the average daily ground water levels for Chinese 1 and Nawoyatira Borehole

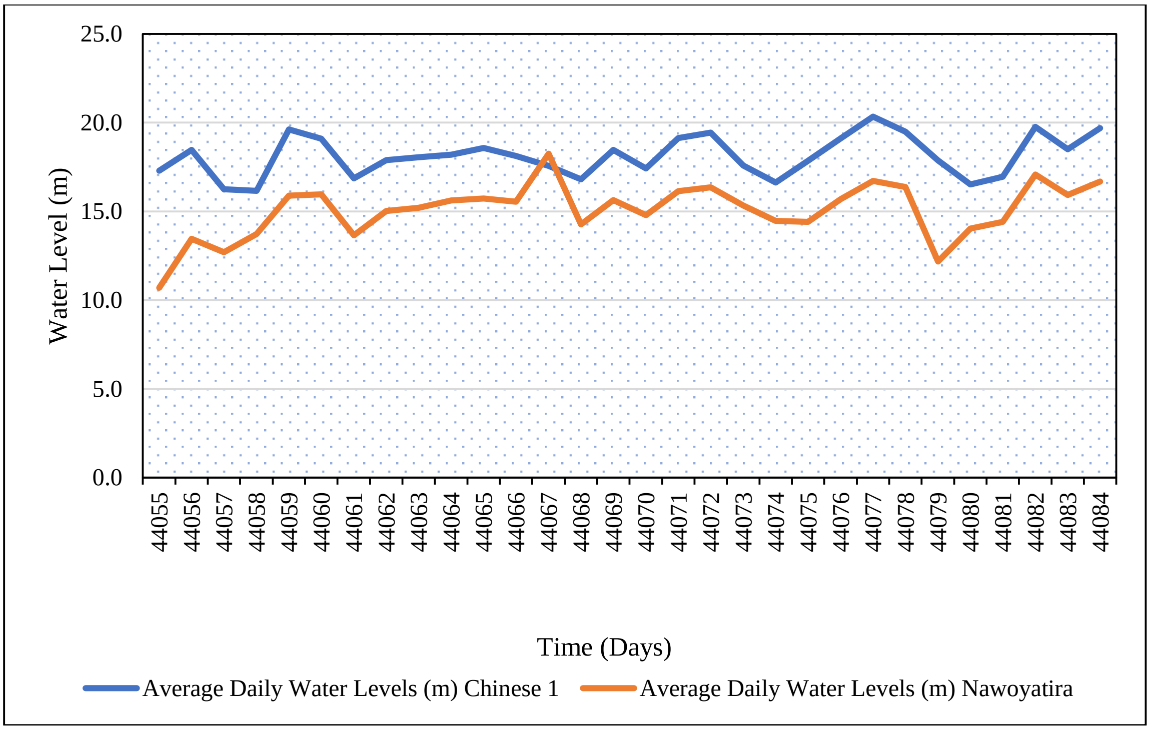

Figure 4.13: Average Borehole Water Levels

Source: Researcher (2021)

4.3.5 Trends in Daily Groundwater Levels

A sensitivity analysis has been carried out to establish the effect of the difference in the quantity of groundwater abstraction to the adjacent boreholes. The current rise and fall in groundwater levels is being influenced by the amount of water being abstracted from the boreholes. To conduct the sensitivity analysis, the oil production water demand for the year 2019 (amount of groundwater already utilized under the EOPS) has been adopted as the additional demand for the two boreholes. It has also been assumed that ground water recharge within the basin remains constant. To execute the Early Oil Pilot Scheme, Tullow oil had drilled ten water supply boreholes. The 2019 demand was therefore distributed uniformly between the 10 boreholes. The demand for one borehole has then been assigned to Chinese I and Nawoyatira boreholes in the ratio of their current supply. The resulting borehole water levels were plotted as shown in Figure 4.14.

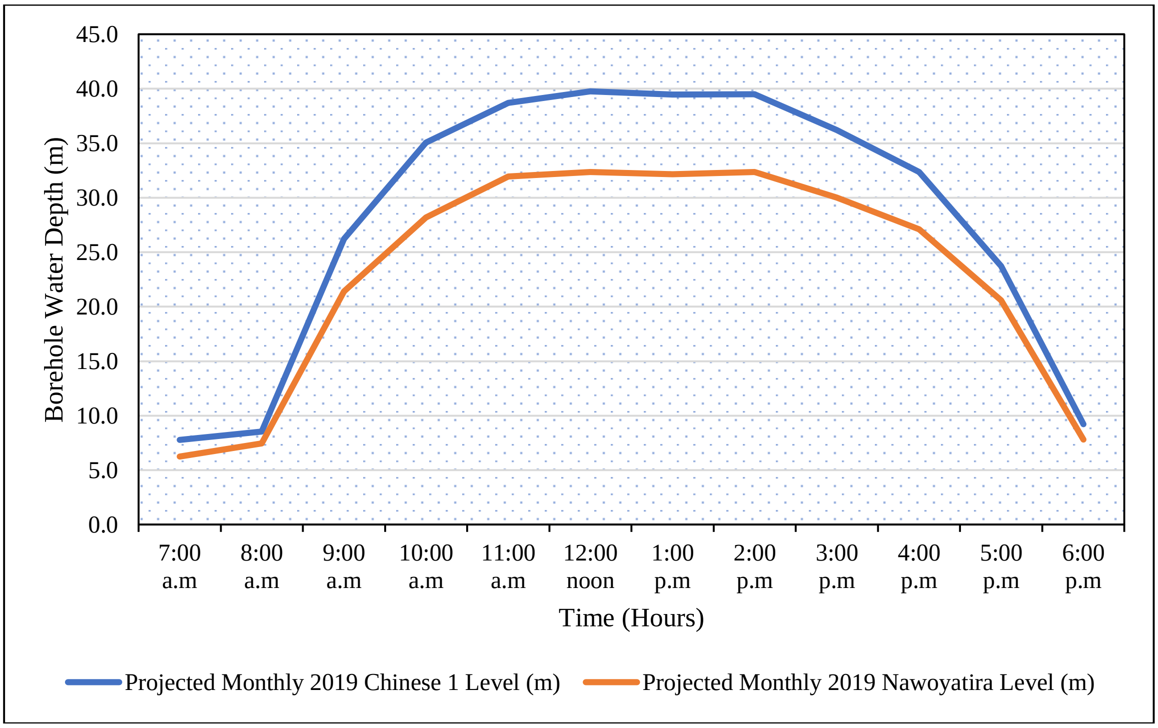

Figure 4.14: Projected Monthly Groundwater Levels (2019)

Source: Researcher (2021)

By including the industrial water demand on the borehole water levels for Chinese 1 borehole, the average daily groundwater levels drop from 5.02m to 7.77m at 7:00 a.m., 25.50m to 39.47m at 1:00 p.m. and 5.96m to 9.23m at 5:00 p.m. Likewise, for

Nawoyatira borehole, the levels drop from 4.01m to 6.26m at 7:00 a.m., 20.78m to 32.16m at 1:00 p.m. and 5.04m to 7.8m at 5:00 p.m. The drop in water levels is in line with the study by Buddemeier (2010) that showed that withdrawal of high volume of water per minute from a borehole results to sudden lowering in levels.

To cater for the projected industrial water demand for the year 2022, Tullow oil will be required to drill additional high yield boreholes. 300 boreholes yielding 20m^3/hour are required to cater for the projected industrial water demand by the year 2022. This is assuming that the intended construction of the water pipeline from Turkwel Dam will not have been completed by then. For purposes of projecting the borehole water levels, the projected 2022 water demand has been distributed to the 300 boreholes. The demand for one borehole has been assigned to Chinese 1 and Nawoyatira Borehole and the resulting levels plotted as shown in Figure 4.15.

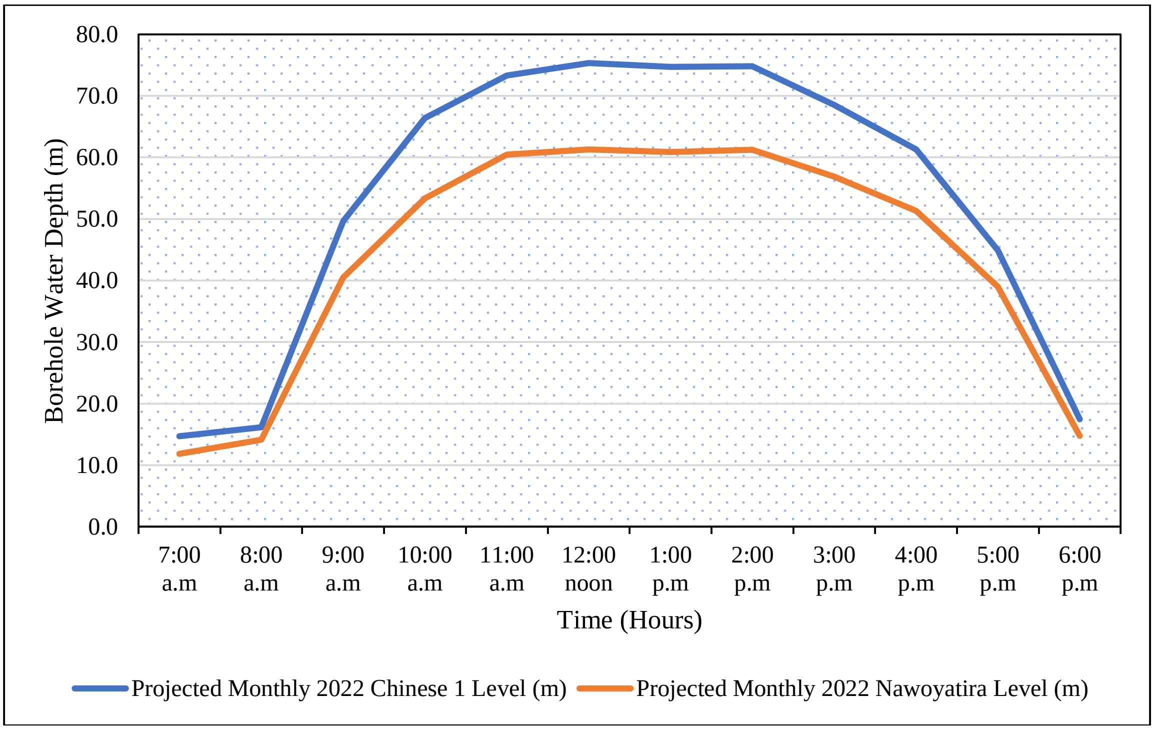

Figure 4.15: Projected Monthly Borehole Water Levels (2022)

Source: Researcher (2021)

Water levels in Chinese 1 borehole will decrease to 14.71m at 7:00 a.m., 74.74m at 1:000 p.m. and 17.48m at 5:00 p.m. while those at Nawoyatira will decrease to 11.8m, 60.9m and 14.77m over the same period.

4.4 Rainfall Trends

Statistical significance trend analysis has been carried using the Mann-Kendall test. The test is used to determine whether a time series data has a monotonic upward or downward trend. The no trend in this case represents the null hypothesis while the existence of the monotonic downward or upward trend represents the alternative hypothesis (Gedefaw, et al., 2018). The statistic S is calculated using equation 4.2:

$$S = \sum_{i=1}^{n-1} \sum_{j=k+1}^{n} sign(xj - xi)$$

………………………………………Equation 4.2

Where: S – Statistic
x_i and x_j – Annual rainfall values in years i and j.
n – number of data points

The S statistic only applies if the number of data values are less than 10. For the case of this study, 39 years have been analyzed (Hussain, Nabi, and Buuta, 2015). For number of data above or equal to 10, Z- statistic is considered and is given by the equation:

$$z = \begin{cases} (s-1)/se, & s > 0 \\ 0, & s = 0 \\ (s+1)/se, & s < 0 \end{cases}$$

Equation 4.3

Where: S – statistic
S_e – square root of the variance

A positive value of Z shows an upward trend while a negative value shows a downward trend. The variance is given by equation 4.4:

$var = 1/18[n(n-1)(2n+5) - \sum ft(ft-1)(2ft+5)]$ ……………Equation 4.4

Where n – number of tied groups
f_t – number of data point in the i^{th} tied group

The Mann-Kendell trend analysis was carried out in MS-Excel assuming a significance level (alpha) of 0.05. This represents a 5% significance level. From the analysis, the p-value has been obtained as 0.276 (representing 27.6%). This value is greater than 0.05 and therefore no trend has been established.

4.4.1 Analysis of Rainfall Amount

Analysis of the annual rainfall amount has been carried out to establish the changes in the rainfall amounts from 1981 to 2019. From the analysis, the lowest annual rainfall amount was recorded in 1984 at 37.07mm while the highest annual rainfall amount was recorded in 2007 at 309.56mm. The average annual rainfall for the study area is 142.48mm. Oyugi (2016) carried out a study on Turkana County water and sewerage sector policy and found the average annual rainfall for the County to be 121mm. this nearly ties with the research findings of 142mm. Figure 4.16 shows the annual rainfall trends in the study area.

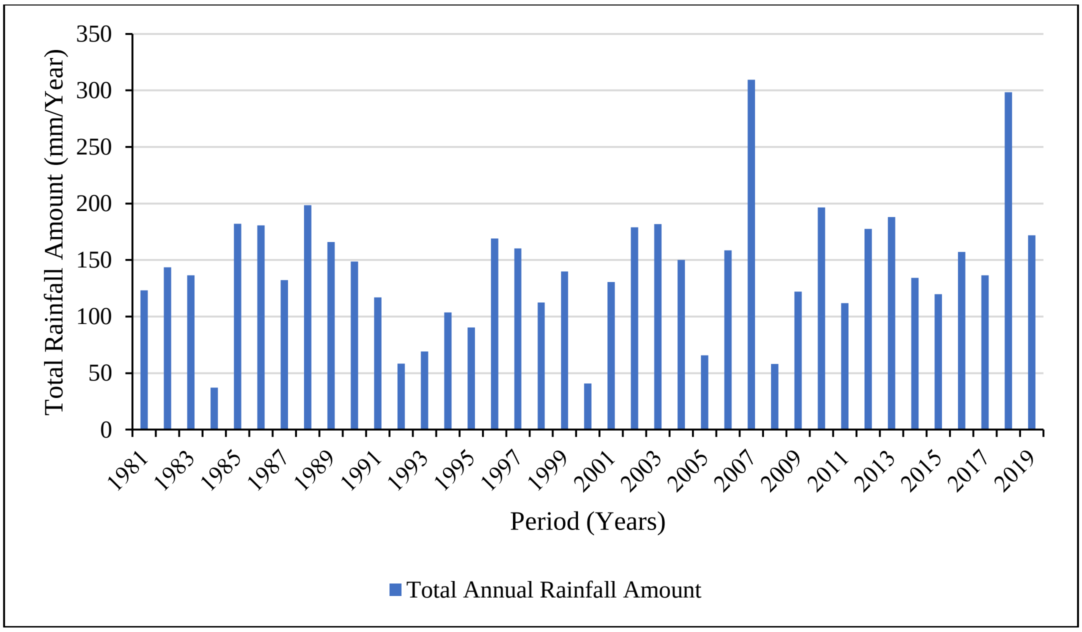

Figure 4.16: Average Annual Rainfall

Source: Researcher (2021)

4.4.2 Average Monthly Rainfall

Figure 4.17 shows the average monthly rainfall for the study area. From the analysis, the highest average monthly rainfall was recorded in the month of April at 39.55mm while the lowest average monthly rainfall was recorded in the month of October at 0.00mm (the study area has never received rainfall during the month of October since 1981). From the analysis, the long rains in the study area span between March to August. The short rains only last for one month in December. Oyugi (2016) in his study of Turkana County found out that the long rains start in April and ends in July (Akiporo) while the short rains span between October and November. On the long rains, the study of Turkana County and the current study showed similar results. However, under the current study, no rainfall was recorded in the month of October while Oyugi (2016) found out that the short rains also cover the month of October.

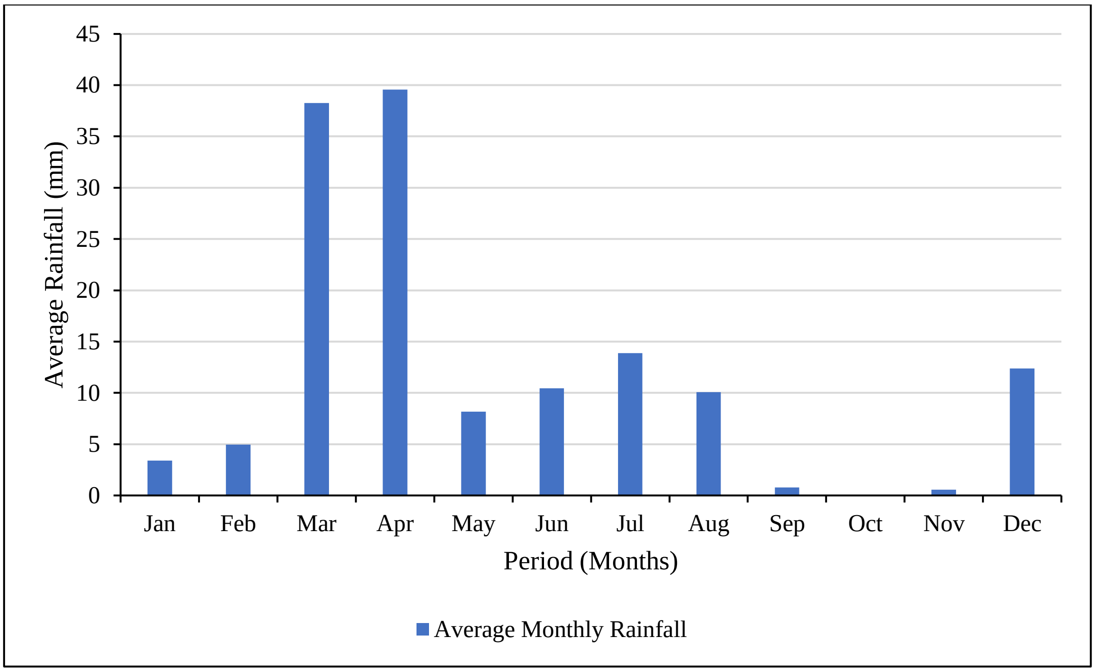

Figure 4.17: Average Monthly Rainfall

Source: Researcher (2021)

From Figures 4.16 and 4.17, it is evident that there has been no major changes in the amount of rainfall received in the study area between 1981 to 2019. This implies that any major changes in groundwater levels in the study area over the same period are not caused by rainfall variability.

4.4.3 Number of Rainy Days

Analysis was carried out on the total number of rainy days per annum in the study area. Figure 4.18 shows the variations in the number of rainy days per year. From the analysis, year 2018 received the highest number of rainy days at 51 days while only seven days experienced precipitation in 1984. No major variations are noticed in the number of rainy days per year.

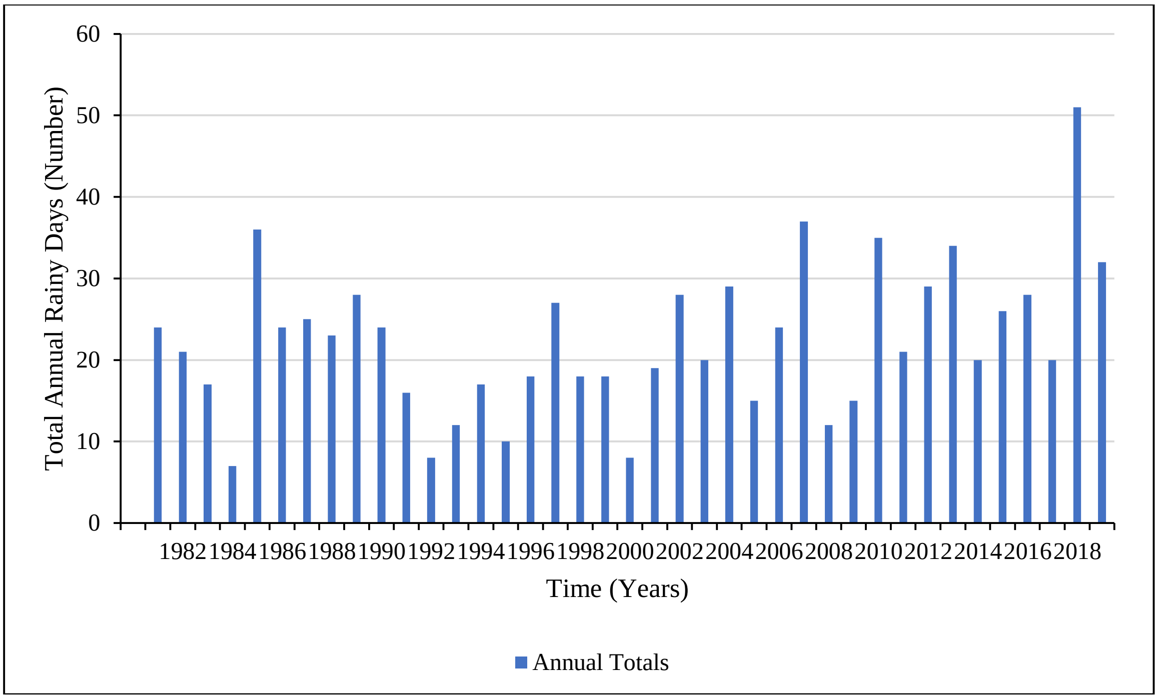

Figure 4.18: Number of Rainy Days

Source: Researcher (2021)

Further analysis show that the month of April experiences the highest number of rainy days at 255 rainy days between 1981 and 2019. This is in line with the study by Oyugi (2016) that showed that the long rain season in the study area commences in the month of April. The month of October has never recorded any form of precipitation over the same period. The months of March and May experienced 146 and 141 rainy days over the same period as shown in Figure 4.19.

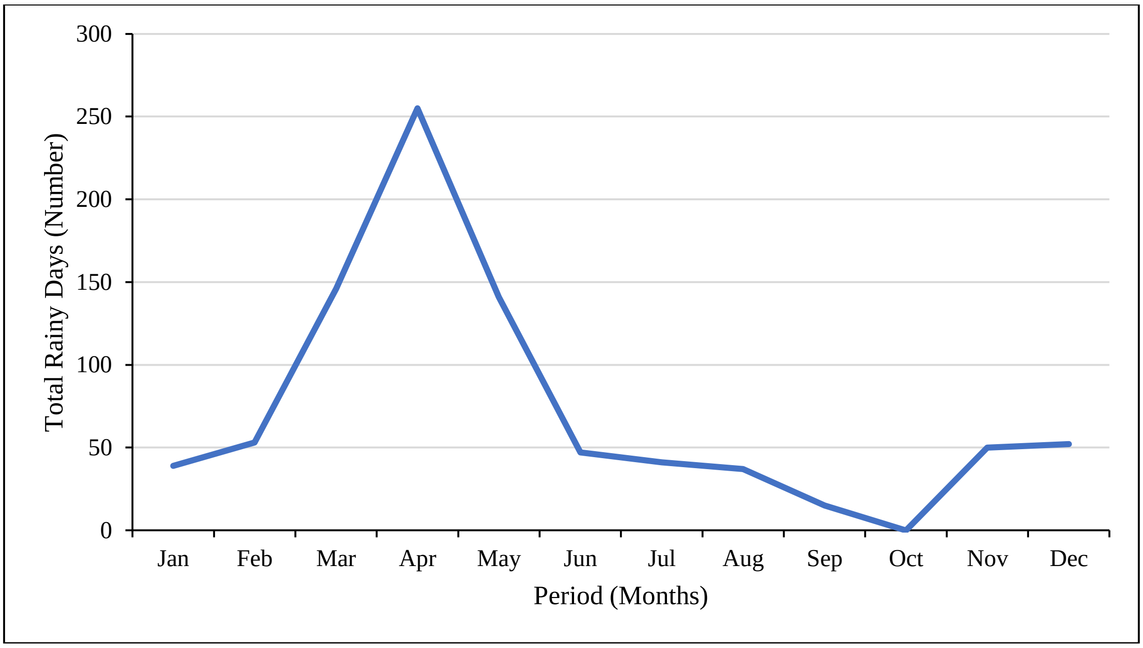

Figure 4.19: Monthly Distribution of Rainy Days

Source: Researcher (2021)

Analysis of rainfall trends shows that there have been no major changes in rainfall patterns between the year 1981 to 2019.

4.4.5 Groundwater Recharge

Groundwater in the study area has been estimated using the water budget equation. given by the following formula.

$$P+Q_{in}=ET+\Delta S+Q_{out}$$ Equation 4.5

Where: ΔS - Change in Water Storage
P - Precipitation
Q_{in} - Groundwater in
ET - Evapo-transpiration
Q_{out} - Groundwater out

According to Golder (2020) groundwater recharge in the study area occurs through direct rainfall. This is due to the absence of surface water sources such as rivers and lakes and the fact that no other form of precipitation is experienced in the study area apart from rainfall. The findings of a study by Radar Technologies International

(2013) on groundwater resources in Northern and Central Turkana show that recharge values in Northern and Central Turkana is approximately 30% of rainfall. The map of groundwater recharge for the entire Turkana County show that groundwater recharge in Lokichar Basin is between 10% to 20% of rainfall. Based on the study findings, an average of 15% of the rainfall has been adopted as the proportion of recharge in the current study. Figure 4.20 shows the annual groundwater recharge in the study area between 1981 to 2019.

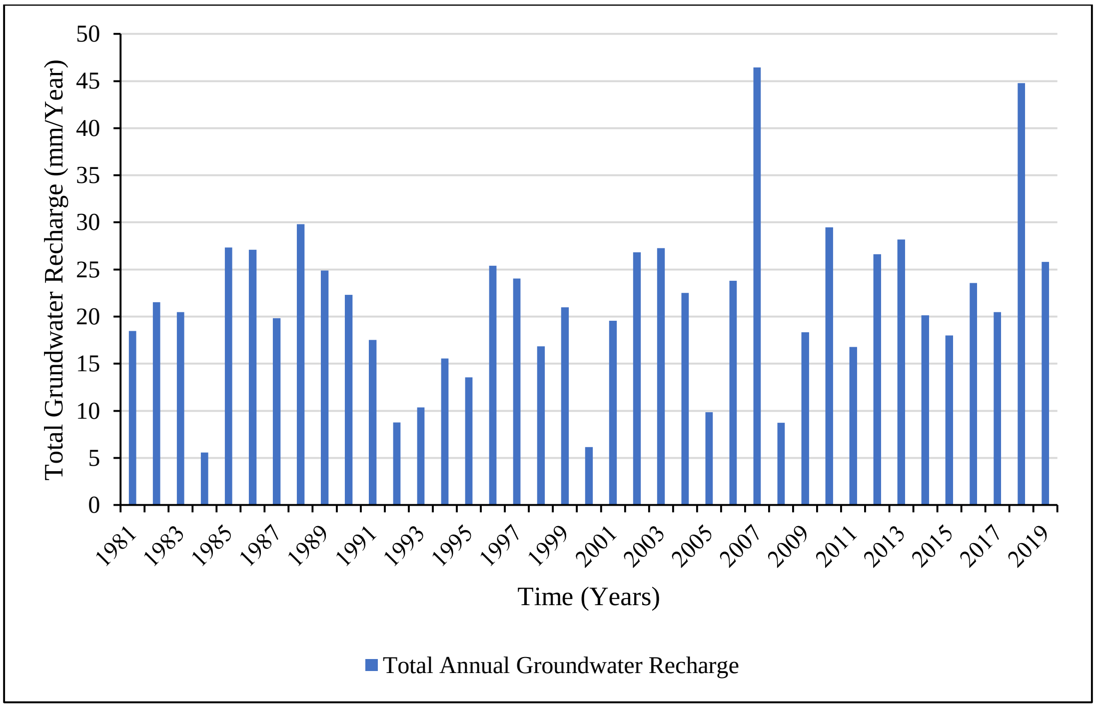

Figure 4.20: Annual Groundwater Recharge in Lokichar Basin

The average annual groundwater recharge in the study area is 21.373mm. The results are in line with the findings of Price (2016) which reported groundwater recharge in Turkana South (where Lokichar basin is located) to be less than 20%. From Figure 4-20, there has not been significant changes in groundwater recharge in the study area since 1981. The lowest recharge was recorded in 1984 at 5.56mm while the highest was recorded in 2007 at 46.43mm. There has not been significant changes in groundwater recharge in the study area since 1981. This implies that any significant change in groundwater levels is not as a result of varying groundwater Recharge.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summarized version of the study outcomes, the conclusions that have been arrived at based on the results and recommendations focusing on policy formulations and further research.

5.2 Summary of Findings

5.2.1 Groundwater Demand

Domestic, livestock, institutional and commercial groundwater demands have increased at a minimal rate between 2009 and 2019 (an average of 28%). The projected rate of increase in groundwater demand for the above four water sectors between year 2019 and 2022 is also minimal (an average of 4%). The rate of increase in water demand for the four sectors in the study area is lower than the rate given in the National Water Masterplan (2013) for the period 2010 to 2030 largely because of the low population growth rate. Water demand for the four sectors is therefore not expected to have a significant effect on the groundwater levels in the study area.

The industrial water demand increased significantly between 2009 and 2022 (from 0 litres per day to 2,862,000 litres per day). The industrial water demand is expected to undergo a further significance increase between 2019 to 2022 (4900% increase). Such huge increase in industrial water demand will exert pressure on the available groundwater resources which may lead to decline in groundwater levels and reallocation of groundwater resources from other sectors to oil production. The results of increased industrial water demand is in line with the study by Robert and Greg (2017) conducted in Karoo area in South Africa that showed that water for other sectors was reallocated to oil production that ended up causing conflicts between local residents and oil producing companies.

5.2.2 Borehole Water Levels

A sensitivity analysis of the radius of influence for boreholes within the study area show that all boreholes within Lokichar town share a common area of influence while 6 out of the 10 boreholes drilled by Tullow Oil Company also fall within a common area of influence. This implies that drawdown in one of the borehole in Lokichar town will result to a drawdown in all other boreholes within its area of influence. This equally applies to the six boreholes sharing the common area of influence near Nakukulas trading centre.

Hourly borehole water level fluctuations show that the levels are highest in the morning after which they start declining and achieves the lowest point at around 2pm. From 2pm, the water levels starts rising again. The rapid drop in the water levels during morning hours is due to high withdrawal of borehole water up to around 2pm when the withdrawal rates reduces and the boreholes gets time to recharge. This is in line with Buddemeier (2010) study that showed that withdrawal of high volume of water per minute from a borehole results to sudden lowering in levels. The average daily borehole water levels have been obtained as 18.12m and 19.5m for Chinese 1 and Nawoyatira boreholes respectively

A sensitivity analysis carried out by allocating a proportion of the 2019 oil production water demand to Chinese 1 and Nawoyatira boreholes show that the average daily groundwater levels drop by 54% for both Chinese 1 and Nawoyatira boreholes. Allocating a proportion of the 2022 oil production water demand to the two boreholes, the water levels drop by 193%. Such sudden changes in groundwater levels might lead to permanent level decline due to failure by the aquifers to recharge fully.

5.2.3 Rainfall Trends

A statistical significance trend analysis carried out using the Mann- Kendall test resulted to a p-value of 0.276 (27.6%) which is greater than alpha value of 0.05. No major variations were noticed on the average annual rainfall amounts between year 1981 to 2019. The lowest annual rainfall amount was recorded in 1984 at 37.07mm while the highest was recorded in 2007 at 309.56mm. The average rainfall amount over the 39 year period is 142.48mm. This is in line with Oyugi (2016) study that found that the average annual rainfall amount for Turkana County is 121mm. On the average monthly rainfall variations, the highest average monthly rainfall amount was recorded in April at 39.55mm while the lowest was recorded in October at 0mm.

On the number of rainy days, 2018 recorded the highest number of rainy days at 51 days while only 7 rainy days were recorded in 1984. On the monthly number of rainy days, April recorded the highest number of rainy days between 1981 to 2019 at 255 days while no rainy day was recorded for the month of October.

5.3 Conclusions

5.3.1 Changes in Groundwater Demand

There has been a significant increase in groundwater demand in the study area between the year 2009 to 2019 and is projected to increase significantly in 2022. The demand increased from 1,846,001.55 l/d in 2009 to 4,951,043.44 l/d in 2019 and is projected to increase to 145,235,374.23 l/d when full commercialization of the oil fields begins in 2022. This represents an increase in groundwater demand of 168% and 2833% for the periods 2009-2019 and 2019-2022 respectively. The increase in groundwater demand is attributed to the need for water required for oil production.

5.3.2 Borehole Water Level Changes

The study findings showed that daily groundwater levels in the basin remained fairly constant over the study period. This could have been brought about by the suspension of oil production at the time of field data collection after successful completion of the Early Oil Pilot Scheme. Analysis of hourly groundwater level fluctuations showed that when water pumping commences in the morning, groundwater decline commences up to around 2pm this implies that the abstraction is higher than the rate of replenishing. When pumping reduces from around 2pm, ground water starts rising again implying that the replenishing at this time is higher than groundwater abstraction.

The hourly changes in groundwater levels is attributed to supply of domestic, livestock, institutional and commercial water demands to the study area. When the industrial water demand for 2019 and 2022 was allocated to the study area, the decline in water levels was more significant with the levels getting to as low as 74m for Chinese 1 and 61m for Nawoyatira boreholes respectively. This is the expected groundwater level changes whenever water is being extracted for purposes of oil production.

5.3.3 Rainfall Trends

Analysis of rainfall data has shown no statistically significant change in the rainfall pattern in the study area. This by extension implies that the rate of groundwater recharge has not significantly changed between 1981 to 2019 with average annual groundwater recharge of 21.37mm. This implies that the decline in groundwater levels is not a result of changing rainfall patterns. Further, it implies that if the rainfall patterns remain unchanged in the future, groundwater decline will be more severe as more water is pumped out for purposes of oil production.

5.4 Recommendations

The study recommends that the next phase of oil production (full commercialization) should commence only once the construction of the water pipeline from Turkwel dam to the oil fields is completed. This will help in reducing the amount of water to be abstracted from the ground for purposes of oil production. Commencement of full commercialization of the oil fields before the water pipeline construction is completed will lead to significant changes in groundwater levels as this will entirely rely on groundwater.

Secondly, it is recommended that policies which are geared towards the protection of the Laggers to protect the riverbeds from sand harvesting. During the field data collection, it was noted that sand harvesting is taking place on the Laggers. The Laggers help in conserving the water below the sand layer and thus keeps recharging the aquifer beneath. Sand harvesting on these Laggers might lead to drying up of the aquifers resulting to decline in groundwater levels.

5.5 Areas for Further Research

The following areas could be considered for further research:

i. To establish groundwater level changes upon commencement of full oil commercialization.

ii. To establish the influence of Laggers on groundwater levels.

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APPENDICES

Appendix I: Human and Livestock Population

2019 Population Data for Turkana County

Table 2.4: Distribution of Population by Sex, Number of Households, Land Area, Population Density and Sub Locations

	Sex*			Households			Land Area	Density
	Total	Male	Female	Total	Conventional	Group Quarters	Sq. Km	Persons per Sq. Km
NGOINGWA	17,235	7,962	9,273	5,395	5,395	-	6.2	2,791
CHANIA	11,150	5,127	6,023	3,474	3,474	-	2.8	3,993
NGOINGWA	6,085	2,835	3,250	1,921	1,921	-	3.4	1,799
MAKONGENI	171,041	84,633	86,394	63,338	62,991	347	48.5	3,527
KAMENU	84,460	40,881	43,571	30,486	30,235	251	34.2	2,466
KAMENU	84,460	40,881	43,571	30,486	30,235	251	34.2	2,466
MAKONGENI	86,581	43,752	42,823	32,852	32,756	96	14.2	6,076
KIANJAU	23,385	12,229	11,154	9,282	9,197	85	7.8	3,010
KOMU	63,196	31,523	31,669	23,570	23,559	11	6.5	9,750
THIKA TOWNSHIP	54,264	26,440	27,820	19,629	19,624	5	16.6	3,261
BAHATI	23,333	11,230	12,102	8,714	8,714	-	11.0	2,123
KIMATHI	12,901	6,035	6,865	5,167	5,167	-	4.5	2,843
UMOJA	10,432	5,195	5,237	3,547	3,547	-	6.5	1,617
BIASHARA	30,931	15,210	15,718	10,915	10,910	5	5.6	5,476
STAREHE	18,482	9,653	8,826	6,688	6,688	-	3.4	5,495
TOWNSHIP	12,449	5,557	6,892	4,227	4,222	5	2.3	5,449
TURKANA	**926,976**	**478,087**	**448,868**	**164,519**	**162,627**	**1,892**	**68,233.1**	**14**
KIBISH	36,769	18,651	18,117	5,805	5,699	106	10,466.1	4
KAIKOR	16,150	8,151	7,998	2,516	2,502	14	3,204.1	5
KAIKOR	12,858	6,432	6,425	2,014	2,000	14	1,551.4	8
LOITANIT	3,261	1,650	1,611	554	554	-	672.2	5
LOKOLIO	6,633	3,286	3,347	1,040	1,026	14	548.8	12
NALITA	2,964	1,496	1,467	420	420	-	330.4	9
LORUTH	3,292	1,719	1,573	502	502	-	1,652.7	2
KARACH 2	1,370	718	652	201	201	-	20.8	66
KOTOME	884	469	415	135	135	-	643.2	1
LORUTH-ESEKON	1,038	532	506	166	166	-	988.6	1
KIBISH	11,394	5,623	5,771	1,908	1,816	92	5,300.4	2
KIBISH	4,591	2,288	2,303	889	797	92	3,551.9	1
KIBISH	1,750	865	885	403	311	92	1,384.8	1
LOKAMARINYANG	2,841	1,423	1,418	486	486	-	2,167.1	1
NAITA	2,265	1,090	1,175	343	343	-	94.7	24
NAITA	1,435	705	730	220	220	-	56.1	26
KOYASA	830	385	445	123	123	-	38.6	22
NATAPAR	4,538	2,245	2,293	676	676	-	1,653.8	3
KAITEDE	1,519	812	707	210	210	-	380.4	4
KARACH 1	1,611	758	853	272	272	-	1,074.0	2
NATAPAR	1,408	675	733	194	194	-	199.4	7
KOKURO	3,992	2,190	1,802	543	543	-	1,065.5	4
MEYAN	3,992	2,190	1,802	543	543	-	1,065.5	4
LIWAN	1,474	718	756	202	202	-	736.1	2
NAPEIKAR	2,518	1,472	1,046	341	341	-	329.4	8
LAPUR	5,233	2,687	2,546	838	838	-	896.1	6
KOKURO	5,233	2,687	2,546	838	838	-	896.1	6
KOKURO	3,909	2,000	1,909	613	613	-	746.1	5
SASAME	1,324	687	637	225	225	-	150.0	9
LOIMA	107,795	54,341	53,453	19,438	19,139	299	9,119.7	12
LOIMA	28,112	14,637	13,475	4,654	4,641	13	3,323.7	8
LOIMA	11,049	5,601	5,448	1,979	1,967	12	1,676.1	7
LOCHOR- EKUYEN	1,359	664	695	298	298	-	91.6	15
LOCHOR-EDOME	1,972	1,147	825	306	306	-	112.8	17
NAMORUPUTH	5,152	2,571	2,581	952	943	9	231.6	22
PUCH	2,566	1,219	1,347	423	420	3	1,240.1	2
LOKIRIAMA	3,712	1,957	1,755	576	575	1	360.6	10
ATA-LOKAMUSIO	871	497	374	140	140	-	130.6	7
LOKIRIAMA	2,841	1,460	1,381	436	435	1	230.0	12
LORENGIPPI	6,196	3,241	2,955	1,039	1,039	-	505.7	12
KAEMANIK	1,328	692	636	238	238	-	111.4	12
LODWAY	970	498	472	153	153	-	144.7	7
LORENGIPPI	2,033	1,045	988	358	358	-	85.5	24
LOYA	523	250	273	101	101	-	104.1	5
NAKURIO	1,342	756	586	189	189	-	60.0	22
URUM	7,155	3,838	3,317	1,060	1,060	-	781.3	9
LOCHOR-ALOMALA	1,276	653	623	194	194	-	171.9	7

*Intersex figures are too few to be distributed at sub national level. Totals may therefore differ slightly

Table 2.4: Distribution of Population by Sex, Number of Households, Land Area, Population Density and Sub Locations

	Sex*			Households			Land Area	Density
	Total	Male	Female	Total	Conventional	Group Quarters	Sq. Km	Persons per Sq. Km
NAKWAPUA	1,978	952	1,026	286	286	-	102.0	19
URUM	3,901	2,233	1,668	580	580	-	507.4	8
TURKWEL	79,683	39,704	39,978	14,784	14,498	286	5,796.0	14
KOTARUK	4,670	2,567	2,103	926	922	4	600.0	8
KOTARUK	1,422	856	566	263	263	-	327.8	4
NAIPA	3,248	1,711	1,537	663	659	4	272.1	12
LOBEI	5,450	2,721	2,729	1,015	808	207	484.9	11
LOBEI	5,450	2,721	2,729	1,015	808	207	484.9	11
LOKIPETOT ARENGAN	2,322	1,150	1,172	398	398	-	161.1	14
KAKALEL	1,089	517	572	228	228	-	72.8	15
LOKIPETOT ARENGAN	1,233	633	600	170	170	-	88.3	14
LOMEYAN	14,517	7,622	6,895	2,213	2,213	-	1,676.2	9
KAAPUS	7,408	3,950	3,458	1,097	1,097	-	643.3	12
LOMEYAN	3,277	1,774	1,503	545	545	-	384.8	9
NACHURO	3,832	1,898	1,934	571	571	-	648.1	6
LORUGUM	18,664	9,065	9,599	3,479	3,441	38	1,273.4	15
KALEMUNYANG	10,329	4,971	5,358	1,954	1,952	2	484.6	21
LORUGUM	8,335	4,094	4,241	1,525	1,489	36	788.7	11
NADAPAL	16,463	7,886	8,576	3,308	3,307	1	606.0	27
KAWALATHE	1,764	856	908	375	375	-	141.4	12
NADAPAL	4,810	2,305	2,505	952	952	-	80.6	60
NAPEIKAR	6,304	3,013	3,290	1,251	1,251	-	180.1	35
TIYA	3,585	1,712	1,873	730	729	1	203.9	18
NAPEILILIM	8,282	4,182	4,100	1,440	1,413	27	750.5	11
NAPEILILIM	5,371	2,708	2,663	876	872	4	353.7	15
NASIGER	2,911	1,474	1,437	564	541	23	396.8	7
TURKWEL	9,315	4,511	4,804	2,005	1,996	9	244.1	38
TURKWEL	9,315	4,511	4,804	2,005	1,996	9	244.1	38
TURKANA CENTRAL	185,305	93,145	92,160	38,173	37,917	256	6,415.2	29
CENTRAL	95,623	47,736	47,887	21,157	20,947	210	1,154.9	83
KANAMKEMER	46,603	22,858	23,745	10,063	10,032	31	594.6	78
KANAMKEMER	29,965	14,680	15,285	6,630	6,600	30	93.7	320
LOTUREREI	1,643	811	832	299	299	-	167.5	10
NAWOITORONG	14,995	7,367	7,628	3,134	3,133	1	333.4	45
LODWAR	30,612	15,793	14,819	7,080	7,007	73	536.7	57
LODWAR TOWNSHIP	16,931	9,025	7,906	4,301	4,228	73	335.8	50
NAPETET	13,681	6,768	6,913	2,779	2,779	-	200.9	68
NAKWAMEKWI	18,408	9,085	9,323	4,014	3,908	106	23.6	778
NAKWAMEKWI	18,408	9,085	9,323	4,014	3,908	106	23.6	778
KALOKOL	52,617	26,529	26,088	10,212	10,198	14	2,629.8	20
KALOKOL	20,698	10,505	10,193	4,208	4,202	6	699.6	30
KALOKOL	16,413	8,326	8,087	3,438	3,432	6	272.9	60
NAMADAK	4,285	2,179	2,106	770	770	-	426.7	10
KANGATOTHA	13,048	6,254	6,794	2,343	2,342	1	624.9	21
ILLE	5,236	2,494	2,742	986	985	1	342.8	15
LOMOPUS	3,101	1,493	1,608	610	610	-	154.7	20
NAOROS	4,711	2,267	2,444	747	747	-	127.5	37
KAPUA	5,028	2,459	2,569	1,021	1,021	-	812.4	6
KAPUA	5,028	2,459	2,569	1,021	1,021	-	812.4	6
NAMUKUSE	13,843	7,311	6,532	2,640	2,633	7	492.9	28
LOCHORAIKENY	4,738	2,324	2,414	888	881	7	411.3	12
NAMUKUSE	9,105	4,987	4,118	1,752	1,752	-	81.6	112
KERIO	37,065	18,880	18,185	6,804	6,772	32	2,630.5	14
KANGIRISAI	6,707	3,239	3,468	1,431	1,431	-	546.2	12
KANGIRISAI	3,434	1,724	1,710	739	739	-	306.6	11
NAKORET	3,273	1,515	1,758	692	692	-	239.6	14
KERIO	23,817	12,489	11,328	4,030	4,030	-	1,061.3	22
KERIO	4,596	2,183	2,413	905	905	-	199.5	23
NADOTO	10,052	5,447	4,605	1,463	1,463	-	70.9	142
NAKURIO	9,169	4,859	4,310	1,662	1,662	-	790.9	12
LORENGELUP	6,541	3,152	3,389	1,343	1,311	32	1,023.0	6
KAKIMAT	1,889	898	991	393	393	-	404.2	5
KANGAGETEI	1,568	743	825	349	323	26	158.8	10
LORENGELUP	3,084	1,511	1,573	601	595	6	459.9	7
TURKANA EAST	138,526	76,871	61,643	17,981	17,887	94	11,395.7	12

*Intersex figures are too few to be distributed at sub national level. Totals may therefore differ slightly

Table 2.4: Distribution of Population by Sex, Number of Households, Land Area, Population Density and Sub Locations

	Sex*			Households			Land Area	Density
	Total	Male	Female	Total	Conventional	Group Quarters	Sq. Km	Persons per Sq. Km
LOKORI	114,522	63,525	50,985	14,318	14,285	33	7,797.3	15
KATILIA	39,423	20,040	19,371	5,253	5,253	-	4,934.4	8
ELELEA	9,892	4,809	5,082	1,160	1,160	-	1,268.4	8
KATILIA	29,088	15,034	14,043	4,038	4,038	-	1,845.4	16
NGILUKIA	443	197	246	55	55	-	399.2	1
PARKATI	-	-	-	-	-	-	1,421.4	-
KOCHODIN	21,315	13,055	8,260	2,352	2,351	1	973.6	22
KOCHODIN	12,184	7,840	4,344	1,308	1,307	1	389.1	31
LOPII	9,131	5,215	3,916	1,044	1,044	-	584.5	16
LOCHAKULA	10,750	6,692	4,058	863	863	-	919.5	12
LOKWAMOSING	7,098	4,517	2,581	571	571	-	155.4	46
LOCHAKULA	2,784	1,715	1,069	199	199	-	455.2	6
KAKULIT	868	460	408	93	93	-	308.9	3
LOKORI	43,034	23,738	19,296	5,850	5,818	32	969.7	44
KANGITIT	18,609	11,023	7,586	2,026	2,026	-	223.3	83
LOKORI	9,634	5,026	4,608	1,550	1,518	32	640.3	15
LOTUBAE	14,791	7,689	7,102	2,274	2,274	-	106.1	139
LOMELO	24,004	13,346	10,658	3,663	3,602	61	3,598.4	7
KAMUGE	1,476	815	661	250	250	-	327.3	5
KAMUGE	1,476	815	661	250	250	-	327.3	5
NAPEITOM	2,900	1,770	1,130	400	400	-	1,191.3	2
NAPEITOM	2,900	1,770	1,130	400	400	-	1,191.3	2
LOMELO	3,147	2,035	1,112	371	371	-	637.6	5
LOMELO	2,277	1,453	824	272	272	-	347.8	7
KATIR	870	582	288	99	99	-	289.8	3
KAPEDO	6,886	3,783	3,103	981	940	41	511.4	13
KAPEDO/PATIPAT	3,531	1,901	1,630	559	518	41	156.6	23
SILALE	3,355	1,882	1,473	422	422	-	354.8	9
NADOME	9,595	4,943	4,652	1,661	1,641	20	930.8	10
EKIPOR/NASOROT	8,211	4,157	4,054	1,475	1,455	20	477.5	17
NADOME/NAKUPUT	1,384	786	598	186	186	-	453.3	3
TURKANA NORTH	65,218	32,810	32,408	13,119	12,964	155	7,012.2	9
KAALENG	24,997	12,385	12,612	4,776	4,771	5	4,450.3	6
KAERIS	12,553	6,305	6,248	2,318	2,316	2	2,157.4	6
KAERIS	3,953	1,944	2,009	737	735	2	521.5	8
KANAKURUDIO	4,534	2,354	2,180	814	814	-	745.1	6
KANGAKIPIR	1,409	707	702	257	257	-	104.5	13
NADUNGA	2,657	1,300	1,357	510	510	-	786.3	3
YAPAKUNO	12,444	6,080	6,364	2,458	2,455	3	2,292.8	5
KAALEM	1,196	617	579	221	221	-	155.0	8
KAALENG	5,817	2,852	2,965	1,158	1,155	3	552.1	11
KAKELAE	1,397	644	753	296	296	-	196.0	7
MILIMATATU	4,034	1,967	2,067	783	783	-	1,389.7	3
KATABOI	10,105	5,075	5,030	2,025	2,025	-	634.2	16
KATABOI	10,105	5,075	5,030	2,025	2,025	-	634.2	16
KATABOI	5,295	2,674	2,621	1,046	1,046	-	253.5	21
KATIKO	2,774	1,407	1,367	546	546	-	123.9	22
LOMEKWI	2,036	994	1,042	433	433	-	256.8	8
LAPUR	10,270	5,593	4,677	2,237	2,096	141	554.1	19
NGISSIGER	8,697	4,474	4,223	1,756	1,742	14	225.0	39
KANAMKUNY	2,897	1,588	1,309	648	648	-	51.3	56
LOWARENGAK	5,800	2,886	2,914	1,108	1,094	14	173.7	33
TODONYANG	1,573	1,119	454	481	354	127	329.0	5
TODONYANG	1,573	1,119	454	481	354	127	329.0	5
LOKITAUNG	19,846	9,757	10,089	4,081	4,072	9	1,373.7	14
KAREBUR	2,306	1,110	1,196	440	440	-	243.3	9
KAREBUR	1,495	705	790	295	295	-	170.9	9
NABULUKOOK	811	405	406	145	145	-	72.4	11
LOKITAUNG	7,959	3,949	4,010	1,695	1,695	-	443.7	18
KACHODA	2,605	1,291	1,314	492	492	-	197.2	13
NAKALALE	3,643	1,836	1,807	861	861	-	124.6	29
NATOO	1,711	822	889	342	342	-	121.8	14
NGISSIGER	5,516	2,654	2,862	1,148	1,139	9	266.4	21
NACHUKUI	5,516	2,654	2,862	1,148	1,139	9	266.4	21
RIOKOMOR	4,065	2,044	2,021	798	798	-	420.3	10

*Intersex figures are too few to be distributed at sub national level. Totals may therefore differ slightly

Table 2.4: Distribution of Population by Sex, Number of Households, Land Area, Population Density and Sub Locations

	Sex*			Households			Land Area	Density
	Total	Male	Female	Total	Conventional	Group Quarters	Sq. Km	Persons per Sq. Km
KOKISELEI	1,864	899	965	400	400	-	217.0	9
RIOKOMOR	2,201	1,145	1,056	398	398	-	203.4	11
TURKANA SOUTH	153,736	78,402	75,329	24,552	24,281	271	7,045.2	22
KAINUK	26,491	13,425	13,065	4,018	3,935	83	1,537.1	17
KAINUK	14,825	7,474	7,351	2,070	2,010	60	1,226.2	12
KAINUK	10,809	5,417	5,392	1,520	1,460	60	259.4	42
KAKONGU	2,521	1,258	1,263	352	352	-	892.9	3
LOYAPAT	1,495	799	696	198	198	-	74.0	20
KAPUTIR	11,666	5,951	5,714	1,948	1,925	23	310.9	38
KALOMWAE	2,732	1,418	1,314	536	536	-	89.7	30
LOROGON	1,319	696	622	220	206	14	60.0	22
NAKWAMORU	7,615	3,837	3,778	1,192	1,183	9	161.3	47
KATILU	50,308	24,886	25,422	8,055	8,036	19	951.6	53
KATILU	50,308	24,886	25,422	8,055	8,036	19	951.6	53
KALEMNGOROK	10,944	5,355	5,589	2,144	2,135	9	331.8	33
KANAODON	8,179	4,502	3,677	1,238	1,238	-	157.4	52
KATILU	20,589	9,971	10,618	3,247	3,237	10	351.9	59
LOKAPEL	10,596	5,058	5,538	1,426	1,426	-	110.5	96
LOKICHAR	76,937	40,091	36,842	12,479	12,310	169	4,556.4	17
KALAPATA	33,526	17,569	15,955	4,412	4,412	-	1,560.9	21
KALAPATA	6,666	3,742	2,924	1,077	1,077	-	433.0	15
LOPEROT	9,125	4,952	4,173	1,352	1,352	-	711.4	13
NAKAALEI	17,735	8,875	8,858	1,983	1,983	-	416.5	43
LOCHWAA	16,375	8,324	8,050	2,787	2,770	17	2,253.4	7
LOCHWAA	11,329	5,768	5,560	2,044	2,027	17	1,385.3	8
NAPUSIMORU	5,046	2,556	2,490	743	743	-	868.1	6
LOKICHAR	27,036	14,198	12,837	5,280	5,128	152	742.1	36
KAPESE	12,131	6,334	5,797	2,104	2,104	-	539.2	22
LOKICHAR	14,905	7,864	7,040	3,176	3,024	152	203.0	73
TURKANA WEST	239,627	123,867	115,758	45,451	44,740	711	16,779.0	14
KAKUMA	129,545	67,297	62,247	26,122	25,674	448	3,816.3	34
KAKUMA	103,632	54,111	49,520	21,034	20,586	448	690.7	150
LOPUR	67,420	35,399	32,021	13,397	12,980	417	209.5	322
MORUNGOLE	16,587	8,504	8,083	3,532	3,532	-	206.6	80
NADAPAL	17,720	9,258	8,461	3,681	3,650	31	61.2	290
TARACH	1,905	950	955	424	424	-	213.4	9
NAKALALE	10,444	5,402	5,042	2,030	2,030	-	1,444.6	7
KOBUIN	5,143	2,798	2,345	896	896	-	603.0	9
LOSAJAIT	1,241	546	695	315	315	-	467.7	3
NAKALALE	4,060	2,058	2,002	819	819	-	373.9	11
PELEKECH	15,469	7,784	7,685	3,058	3,058	-	1,681.0	9
LOKORE	5,649	2,835	2,814	1,216	1,216	-	707.0	8
LOPUSIKI	7,693	3,918	3,775	1,420	1,420	-	545.1	14
NAMON	2,127	1,031	1,096	422	422	-	428.9	5
LOKICHOGGIO	30,411	16,336	14,075	5,420	5,162	258	2,925.2	10
LOKICHOGGIO	13,727	6,989	6,738	3,023	2,765	258	70.8	194
LOKARIWON	5,799	3,026	2,773	1,410	1,152	258	13.9	418
LOKICHOGGIO	7,928	3,963	3,965	1,613	1,613	-	56.9	139
LOTETELEIT	4,645	2,783	1,862	700	700	-	2,006.5	2
LOREMIET	1,197	672	525	208	208	-	1,741.5	1
LOTETELEIT	3,448	2,111	1,337	492	492	-	265.1	13
SONGOT	12,039	6,564	5,475	1,697	1,697	-	847.8	14
LOKUDULE	2,407	1,257	1,150	458	458	-	476.0	5
LOPWARIN	3,955	1,991	1,964	557	557	-	197.5	20
SONGOT	5,677	3,316	2,361	682	682	-	174.4	33
NANAM	25,905	13,386	12,519	3,841	3,839	2	5,814.4	4
LORAU	10,198	4,975	5,223	1,612	1,612	-	1,675.0	6
LOKANGAE	8,143	3,925	4,218	1,306	1,306	-	739.4	11
LOTIKIPI	2,055	1,050	1,005	306	306	-	935.6	2
NANAM	5,283	3,078	2,205	772	772	-	3,168.6	2
LOMEYAN	2,433	1,352	1,081	320	320	-	2,618.8	1
NANAM	2,850	1,726	1,124	452	452	-	549.8	5
MOGILA	10,424	5,333	5,091	1,457	1,455	2	970.8	11
LOPIDING	4,411	2,205	2,206	656	654	2	3.5	1,243
MOGILA	6,013	3,128	2,885	801	801	-	967.3	6

*Intersex figures are too few to be distributed at sub national level. Totals may therefore differ slightly

Table 2.4: Distribution of Population by Sex, Number of Households, Land Area, Population Density and Sub Locations

	Sex*			Households			Land Area	Density
	Total	Male	Female	Total	Conventional	Group Quarters	Sq. Km	Persons per Sq. Km
OROPOI	53,766	26,848	26,917	10,068	10,065	3	4,223.1	13
KALOBEYEI	35,512	17,752	17,759	7,230	7,227	3	1,670.7	21
KALOBEYEI	27,009	13,420	13,588	5,708	5,708	-	484.0	56
LONYUDUK	600	275	325	103	103	-	92.5	6
NALAPATUI	1,298	679	619	221	221	-	312.1	4
NATIRA	2,193	1,114	1,079	440	440	-	250.9	9
OROPOI	3,399	1,748	1,651	594	591	3	435.5	8
SONGOT	1,013	516	497	164	164	-	95.7	11
LETEA	8,429	4,244	4,185	1,362	1,362	-	876.0	10
LOITO	1,052	542	510	209	209	-	99.0	11
LORITIT	5,892	2,900	2,992	945	945	-	480.5	12
TULABALANY	1,485	802	683	208	208	-	296.5	5
LOKIPOTO	6,254	3,188	3,066	814	814	-	509.5	12
KATELEMOT	1,803	968	835	274	274	-	269.4	7
LOKIPOTO	4,451	2,220	2,231	540	540	-	240.1	19
LORENG	3,571	1,664	1,907	662	662	-	1,166.9	3
LORENG	2,740	1,244	1,496	538	538	-	807.5	3
NAMORKIRIONOK	831	420	411	124	124	-	359.4	2
WEST POKOT	**621,241**	**307,013**	**314,213**	**116,182**	**115,761**	**421**	**9,123.3**	**68**
KIPKOMO	102,633	50,923	51,703	18,370	18,367	3	765.6	134
BATEI	44,846	22,255	22,588	8,103	8,101	2	266.3	168
BATEI	17,018	8,563	8,454	3,277	3,275	2	51.2	333
CHIPAGH	3,518	1,751	1,767	583	581	2	10.5	335
KERELWA	6,024	3,039	2,984	1,026	1,026	-	21.5	281
ORTUM	7,476	3,773	3,703	1,668	1,668	-	19.2	389
CHEPKORIONG	7,659	3,742	3,917	1,267	1,267	-	50.7	151
CHEPKORIONG	1,529	754	775	257	257	-	13.0	117
KAPKAREMBA	1,671	787	884	295	295	-	10.9	154
PSAMAR	2,201	1,071	1,130	341	341	-	12.4	177
PUSOL	2,258	1,130	1,128	374	374	-	14.4	157
MORPUS	7,719	3,802	3,916	1,326	1,326	-	68.3	113
CHEPTYA	2,192	1,072	1,120	357	357	-	20.6	106
MORPUS	3,637	1,772	1,864	644	644	-	27.7	131
SAMOR	1,890	958	932	325	325	-	20.0	95
PARUA	9,757	4,774	4,982	1,705	1,705	-	51.8	188
KOCHIY	1,342	649	693	214	214	-	10.7	125
PARUA	2,654	1,270	1,383	443	443	-	11.4	234
SEBIT	2,990	1,533	1,457	598	598	-	18.3	163
TOROKIT	2,771	1,322	1,449	450	450	-	11.4	243
SOBUKWO	2,693	1,374	1,319	528	528	-	44.2	61
KAPKEPOT	1,547	796	751	282	282	-	24.7	63
SOBUKWO	1,146	578	568	246	246	-	19.6	59
CHEPARERIA	35,771	17,748	18,020	6,472	6,471	1	163.9	218
KIPKOMO	13,839	6,806	7,031	2,846	2,845	1	42.0	330
CHEPARERIA	6,565	3,182	3,382	1,569	1,568	1	11.1	590
KOSULOL	2,711	1,364	1,346	471	471	-	5.2	521
TAMPALAL	2,332	1,147	1,185	402	402	-	15.6	150
TOLKAGHIN	2,231	1,113	1,118	404	404	-	10.1	221
SENETWO	8,041	4,066	3,974	1,327	1,327	-	54.9	146
CHEPTUNGUNY	1,399	704	695	245	245	-	12.9	108
KORELLACH	2,390	1,197	1,193	391	391	-	22.4	107
SENETWO	2,231	1,114	1,117	361	361	-	9.6	233
SLA	2,021	1,051	969	330	330	-	10.0	202
YWALATEKE	13,891	6,876	7,015	2,299	2,299	-	67.0	207
KAPCHEMOGEN	4,720	2,348	2,372	789	789	-	27.4	172
MONGORION	3,279	1,583	1,696	558	558	-	18.9	174
PROPOI	2,621	1,292	1,329	418	418	-	8.5	309
YWALATEKE	3,271	1,653	1,618	534	534	-	12.2	268
CHEPKOPEGH	22,016	10,920	11,095	3,795	3,795	-	335.5	66
CHEPKOPEGH	5,867	2,905	2,961	1,021	1,021	-	91.1	64
CHEPKOPEGH	1,133	548	585	208	208	-	15.7	72
CHEPTIANGWA	2,339	1,149	1,189	381	381	-	23.8	98
CHEPUKAT	760	382	378	140	140	-	17.8	43
KAPSEKERO	1,635	826	809	292	292	-	33.7	49

*Intersex figures are too few to be distributed at sub national level. Totals may therefore differ slightly

2009 Population Census for Turkana County

Table 2: Population Distribution by Sex, Number of Households, Area , Density and Administrative Units

	Male	Female	Total	Households	Area in Sq. Km.	Density
RIFT VALLEY	5,026,462	4,980,343	10,006,805	2,137,136	183,383.2	55
TURKANA CENTRAL*	126,539	128,067	254,606	41,120	14,590.7	17
CENTRAL	28,531	29,759	58,290	11,437	831.8	70
LODWER TOWNSHIP	17,690	17,816	35,506	7,072	544.4	65
LODWER TOWNSHIP	7,201	6,865	14,066	2,906	279.7	50
NAKWAMEKWI	4,965	5,320	10,285	1,985	24.5	420
NAPETET	5,524	5,631	11,155	2,181	240.2	46
KANAMKEMER	10,841	11,943	22,784	4,365	287.4	79
KANAMKEMER	6,764	7,639	14,403	2,758	82.3	175
NAWOITORONG	4,077	4,304	8,381	1,607	205.1	41
KERIO	17,213	16,999	34,212	4,962	2,704.2	13
KERIO	10,491	9,942	20,433	2,864	1,191.5	17
KERIO	2,169	2,085	4,254	692	266.0	16
NAKURIO	3,872	3,882	7,754	1,204	769.3	10
NADOTO	4,450	3,975	8,425	968	156.3	54
KANGIRISAYE	3,871	3,970	7,841	1,141	680.6	12
KANGIRISAYE	1,791	1,852	3,643	518	455.0	8
NAKORET	2,080	2,118	4,198	623	225.6	19
LORENGELUP	2,851	3,087	5,938	957	832.0	7
LORENGELUP	1,039	1,134	2,173	372	112.1	19
KANGAGETEI	916	970	1,886	290	286.4	7
KAKIMAT	896	983	1,879	295	433.4	4
LOIMA	21,003	19,901	40,904	5,288	3,429.0	12
LOIMA	9,875	9,973	19,848	2,550	2,119.1	9
LOCHOR EKUYEN	1,681	1,673	3,354	511	335.0	10
LOCHOR EDOME	1,144	1,098	2,242	299	166.9	13
PUCH	4,946	4,828	9,774	1,049	1,373.9	7
NAMORUPUTH	2,104	2,374	4,478	691	243.3	18
LORENGIPPI	4,110	3,511	7,621	974	617.7	12
LORENGIPPI	1,393	1,066	2,459	299	209.4	12
KAEMANIK	645	562	1,207	153	189.6	6
NAKURIO	594	476	1,070	141	91.1	12
LODWAT	671	713	1,384	201	58.8	24
LOYA	807	694	1,501	180	68.8	22
LOKIRIAMA	7,018	6,417	13,435	1,764	692.2	19
LOKIRIAMA	1,951	1,664	3,615	482	163.7	22
LOCHOR LOMALA	3,074	2,765	5,839	800	428.2	14
ATALA KAMUSIO	1,993	1,988	3,981	482	100.3	40
KALOKOL	20,715	21,457	42,172	7,282	2,139.9	20
KALOKOL	9,484	9,993	19,477	3,684	1,134.9	17
KALOKOL	5,654	5,826	11,480	2,311	384.2	30
KAPUA	1,899	2,073	3;972	711	516.4	8
NAMADAK	1,931	2,094	4,025	662	234.3	17
NAMUKUSE	5,459	5,403	10,862	1,629	139.7	78
NAMUKUSE	3,212	3,070	6,282	1,031	35.0	180
LOCHER EKENY	2,247	2,333	4,580	598	104.7	44
KANGATOTHA	5,772	6,061	11,833	1,969	865.3	14
ELIYE	2,277	2,515	4,792	804	493.7	10
NAWOROS	2,319	2,243	4,562	711	97.3	47
LOMOPUS	1,176	1,303	2,479	454	274.3	9
TURKWEL	39,077	39,951	79,028	12,151	5,485.8	14
LORUGUM	13,152	13,519	26,671	4,437	1,612.5	17
LORUGUM	2,172	2,565	4,737	914	582.6	8
TURKWEL	3,871	4,268	8,139	1,602	333.3	24
KALEMUNYANG	4,400	4,266	8,666	1,250	450.2	19
LOBEI	2,709	2,420	5,129	671	246.4	21
NADAPAL	5,724	6,484	12,208	2,391	1,250.3	10
NADAPAL	1,530	1,756	3,286	645	109.3	30
TIYA	1,367	1,556	2,923	536	447.9	7
NAPEIKAR	2,163	2,363	4,526	899	276.4	16
KAWALATHE	664	809	1,473	311	416.7	4
LOMEYAN	10,955	11,360	22,315	3,009	1,934.7	12
LOMEYAN	4,938	5,155	10,093	1,483	883.0	11
NACHURO	2,527	2,637	5,164	698	547.1	9
KAAPUS	3,490	3,568	7,058	828	504.5	14
KOTARUK	9,246	8,588	17,834	2,314	688.4	26
KOTARUK	5,304	4,574	9,878	1,142	225.3	44
NAIPA	1,860	1,746	3,606	493	199.2	18

ıomalies Observed

Table 2: Population Distribution by Sex, Number of Households, Area , Density and Administrative Units

	Male	Female	Total	Households	Area in Sq. Km.	Density
LOKIPETOT ARENGANI	2,082	2,268	4,350	679	263.9	16
TURKANA NORTH*	**197,508**	**176,906**	**374,414**	**53,634**	**35,418.8**	**11**
LOKITAUNG	20,029	18,713	38,742	6,166	1,857.8	21
LOKITAUNG	3,535	3,704	7,239	1,284	316.2	23
NAKALALE	1,683	1,844	3,527	665	194.9	18
KACHODA	1,205	1,182	2,387	373	34.8	69
NATOO	647	678	1,325	246	86.5	15
KATABOI	4,524	4,237	8,761	1,460	908.6	10
KATABOI	2,203	2,000	4,203	683	287.8	15
KATIKO	1,040	991	2,031	367	186.3	11
LOMEKWI	1,281	1,246	2,527	410	434.4	6
RIAKOMOR	4,771	4,171	8,942	1,212	235.5	38
RIAKOMOR	3,081	2,629	5,710	740	115.0	50
KOKISELEI	1,690	1,542	3,232	472	120.5	27
NGISSIGER	7,199	6,601	13,800	2,210	397.5	35
LOWARENGAK	2,743	2,738	5,481	883	172.7	32
KANAMUKUNY	1,248	983	2,231	339	36.3	61
NACHUKUI	3,208	2,880	6,088	988	188.5	32
LAPUR	9,777	7,702	17,479	2,352	2,436.0	7
KAREBUR	1,672	1,481	3,153	400	511.4	6
KAREBUR	1,011	971	1,982	266	278.4	7
NABULUKOK	661	510	1,171	134	232.9	5
MEYAN	3,177	2,409	5,586	693	684.6	8
LEWAN	1,624	1,174	2,798	327	414.6	7
NAPEIKAR	1,553	1,235	2,788	366	270.1	10
KOKURO	4,928	3,812	8,740	1,259	1,240.0	7
KOKURO	2,066	1,777	3,843	548	573.5	7
SASAME	1,137	974	2,111	273	139.5	15
TODONYANG	1,725	1,061	2,786	438	527.0	5
KIBISH	11,380	10,293	21,673	2,935	5,633.2	4
KIBISH	2,338	2,220	4,558	724	1,693.6	3
KIBISH	637	507	1,144	268	706.0	2
LOKOMARINYANG	1,701	1,713	3,414	456	987.6	3
NAITA	1,452	1,580	3,032	360	2,589.0	1
NAITA	1,316	1,418	2,734	323	2,027.4	1
KOYASA	136	162	298	37	561.6	1
NATAPAR	7,590	6,493	14,083	1,851	1,350.6	10
NATAPAR	2,340	2,105	4,445	651	740.1	6
KARACH (I)	2,415	2,066	4,481	540	404.0	11
KAITEDE	2,835	2,322	5,157	660	206.5	25
KAALENG	27,469	23,724	51,193	6,392	8,225.8	6
KAIKOR	7,758	7,013	14,771	1,853	1,600.1	9
LOITANIT	2,167	2,070	4,237	538	727.4	6
NALITA	1,972	1,703	3,675	398	388.2	9
LOKOLIO	3,619	3,240	6,859	917	484.5	14
YAPAKUNO	7,138	6,131	13,269	1,738	1,879.8	7
MILIMA TATU	2,496	2,126	4,622	491	860.0	5
KAALEM	3,231	2,908	6,139	919	805.4	8
KAKELAE	1,411	1,097	2,508	328	214.4	12
LORUTH	3,419	3,018	6,437	847	1,890.4	3
LORUTH ESEKON	1,414	1,261	2,675	315	655.2	4
KATOME	1,241	1,056	2,297	344	627.9	4
KARACH	764	701	1,465	188	607.3	2
KAERIS	9,154	7,562	16,716	1,954	2,855.5	6
KANAKURUDIO	2,550	1,941	4,491	545	1,113.5	4
KAERIS	2,994	2,550	5,544	620	526.4	11
NADUNGA	2,292	1,982	4,274	515	871.5	5
KANGAKIPUR	1,318	1,089	2,407	274	344.1	7
OROPOI	32,144	29,390	61,534	8,265	5,534.8	11
LETEA	19,994	17,567	37,561	4,957	2,435.2	15
LORITIT	4,337	4,190	8,527	1,185	576.9	15
TULABALANY	2,364	1,838	4,202	479	804.8	5
KATELEMOT	2,068	1,939	4,007	542	174.4	23
LOKIPOTO	8,286	7,151	15,437	2,065	646.1	24
LOITO	2,939	2,449	5,388	686	233.0	23
KALOBEYEI	9,442	8,830	18,272	2,577	2,625.4	7
NALAPATUI	2,162	1,854	4,016	469	211.3	19
NATIRA	942	1,062	2,004	368	306.1	7
OROPOI	2,651	2,176	4,827	648	559.1	9

* Anomalies Observed

Table 2: Population Distribution by Sex, Number of Households, Area , Density and Administrative Units

	Male	Female	Total	Households	Area in Sq. Km.	Density
LONYODUK	1,341	1,180	2,521	375	255.3	10
KALOBEYEI	1,462	1,548	3,010	529	267.9	11
SONGOT	884	1,010	1,894	188	1,025.7	2
LORENG	2,708	2,993	5,701	731	474.2	12
LORENG	1,570	1,640	3,210	376	308.5	10
NAMOR-KIRIONOK	1,138	1,353	2,491	355	165.6	15
KAKUMA	49,361	45,330	94,691	16,084	3,466.5	27
KAKUMA	37,624	34,126	71,750	12,787	636.0	113
LOPUR	20,374	17,837	38,211	7,508	184.5	207
TARACH	3,064	2,872	5,936	689	120.7	49
NADAPAL	8,199	7,671	15,870	2,516	41.5	382
NAMORUNGOLE	5,987	5,746	11,733	2,074	289.4	41
PELEKECH	6,769	6,647	13,416	1,863	1,154.0	12
LOKORE	3,078	2,885	5,963	859	191.0	31
LOPUSIKI	2,397	2,473	4,870	649	225.5	22
NAMON	1,294	1,289	2,583	355	737.5	4
NAKALALE	4,968	4,557	9,525	1,434	1,676.5	6
NAKALALE	1,945	1,941	3,886	629	652.6	6
LOSAJAIT	1,150	1,002	2,152	277	442.3	5
KOBWIN	1,873	1,614	3,487	528	581.6	6
LOKICHOGGIO	47,348	41,754	89,102	11,440	8,264.8	11
LOKICHOGGIO	11,575	10,385	21,960	3,489	1,023.9	21
LOKICHOGGIO	5,652	5,328	10,980	1,868	503.9	22
LOKARIWON	5,923	5,057	10,980	1,621	520.0	21
SONGOT	4,404	3,774	8,178	1,077	1,278.7	6
SONGOT	2,075	1,545	3,620	459	562.4	6
LOKUDULE	1,370	1,249	2,619	341	365.4	7
LOPWARIN	959	980	1,939	277	350.8	6
LORAO	8,890	7,962	16,852	1,985	2,725.7	6
LOKANGAE	4,982	4,464	9,446	1,074	1,086.4	9
LOTIKIPI	3,908	3,498	7,406	911	1,639.2	5
MOGILA	10,763	8,992	19,755	2,194	741.9	27
MOGILA	8,094	6,453	14,547	1,536	597.7	24
LOPIDING	2,669	2,539	5,208	658	144.2	36
NANAM	7,896	7,154	15,050	1,828	2,037.0	7
NANAM	2,943	2,660	5,603	748	781.0	7
LOMEYAN	4,953	4,494	9,447	1,080	1,256.1	8
LOTETELEIT	3,820	3,487	7,307	867	457.7	16
LOTETELEIT	2,447	2,160	4,607	572	358.0	13
LOREMIET	1,373	1,327	2,700	295	99.7	27
TURKANA SOUTH*	**121,022**	**105,357**	**226,379**	**28,437**	**18,670.8**	**12**
LOKORI	34,436	30,592	65,028	8,104	7,091.2	9
LOKORI	17,029	15,653	32,682	3,935	1,639.1	20
LOKORI	4,360	3,901	8,261	953	245.7	34
KANGITIT	3,347	3,053	6,400	791	385.4	17
LOTUBAE	9,322	8,699	18,021	2,191	1,008.0	18
KOCHODIN	2,471	2,378	4,849	593	1,094.5	4
LOCHODIN	1,013	1,026	2,039	246	771.0	3
LOPII	1,458	1,352	2,810	347	323.5	9
KATILIA	11,306	9,677	20,983	2,787	3,337.8	6
KATILIA	4,152	3,595	7,747	1,047	814.4	10
ELELEA	1,997	1,910	3,907	583	748.6	5
PARKATI	5,157	4,172	9,329	1,157	1,774.9	5
LOCHAKULA	3,630	2,884	6,514	789	1,019.7	6
LOCHAKULA	871	695	1,566	184	232.6	7
KAKULIT	1,165	864	2,029	264	632.3	3
LOKWAMOSING	1,594	1,325	2,919	341	154.8	19
LOMELO	13,995	11,443	25,438	3,060	4,215.9	6
LOMELO	1,582	1,318	2,900	386	857.1	3
LOMELO	611	533	1,144	153	560.4	2
KATIR	971	785	1,756	233	296.7	6
NAPEITOM	3,314	2,991	6,305	717	883.4	7
NAPEITOM	3,314	2,991	6,305	717	883.4	7
NADOME	2,510	2,062	4,572	654	824.1	6
NADOME	1,559	1,416	2,975	378	282.5	11
EKIPOR	951	646	1,597	276	541.6	3
KAMUGE	4,721	3,930	8,651	928	1,143.6	8
KAMUGA	2,762	2,342	5,104	568	797.2	6
NGILUKIA	1,959	1,588	3,547	360	346.3	10

* Anomalies Observed

Table 2: Population Distribution by Sex, Number of Households, Area , Density and Administrative Units

	Male	Female	Total	Households	Area in Sq. Km.	Density
KAPEDO	1,868	1,142	3,010	375	507.7	6
KAPEDO	887	528	1,415	172	203.2	7
SILALE	981	614	1,595	203	304.5	5
LOKICHAR	35,756	31,986	67,742	8,175	4,536.6	15
LOKICHAR	12,240	11,212	23,452	3,308	878.0	27
LOKICHAR	5,630	5,190	10,820	1,644	187.8	58
KAPESE	6,610	6,022	12,632	1,664	690.2	18
KALAPATA	12,379	11,130	23,509	2,521	1,984.3	12
KALAPATA	4,612	4,329	8,941	907	617.5	14
LOPEROT	3,952	3,432	7,384	827	898.6	8
NAKALALE	3,815	3,369	7,184	787	468.2	15
LOCHWANGI KAMATAK	11,137	9,644	20,781	2,346	1,674.3	12
LOCHWANGI KAMATAK	7,915	6,646	14,561	1,636	1,071.6	14
NAPOSUMURU	3,222	2,998	6,220	710	602.8	10
KAINUK	14,470	11,777	26,247	3,684	1,684.1	16
KAINUK	6,243	4,885	11,128	1,412	1,002.1	11
KAINUK	3,936	3,215	7,151	900	186.5	38
KAKONGU	1,114	769	1,883	268	615.2	3
LOYAPAT	1,193	901	2,094	244	200.4	10
KAPUTIR	8,227	6,892	15,119	2,272	682.0	22
KALOMWAE	2,008	1,626	3,634	547	361.8	10
NAKWAMORU	4,815	4,265	9,080	1,353	247.7	37
LOROGON	1,404	1,001	2,405	372	72.5	33
KATILU	22,365	19,559	41,924	5,414	1,143.1	37
KATILU	22,365	19,559	41,924	5,414	1,143.1	37
KATILU	9,120	8,566	17,686	2,334	366.4	48
LOKAPEL	4,163	3,312	7,475	964	229.6	33
KALEMGOROK	4,455	4,076	8,531	1,241	453.7	19
KANAODON	4,627	3,605	8,232	875	93.4	88
WEST POKOT	**89,669**	**91,394**	**181,063**	**35,263**	**2,317.5**	**78**
KAPENGURIA	40,862	41,195	82,057	16,131	335.6	245
CHEMWOCHOI	1,913	2,104	4,017	775	60.3	67
CHEPKECHIR	367	388	755	159	11.2	67
KOMOL	706	746	1,452	264	16.7	87
NARAMAM	450	528	978	185	16.8	58
NGOLEYO	390	442	832	167	15.7	53
KAIBOS	1,910	1,898	3,808	732	18.2	209
KAIBOS	945	1,001	1,946	379	5.9	331
KAPKATET	479	466	945	188	9.0	105
KIPKORINYA	486	431	917	165	3.3	278
KAISAKAT	4,352	4,252	8,604	1,576	43.5	198
KAPCHILLA	1,085	1,088	2,173	391	13.2	165
PARAYWA	687	627	1,314	226	8.8	149
SIYOI	2,580	2,537	5,117	959	21.6	237
KAPENGURIA	7,138	7,231	14,369	3,179	24.3	592
CHEWOYET	2,056	1,891	3,947	920	8.1	485
KAMATIRA	1,640	1,610	3,250	546	10.9	299
MWOTOT	3,442	3,730	7,172	1,713	5.3	1,363
KAPKORIS	5,666	5,707	11,373	2,323	38.3	297
CHEMWOCHOI	2,432	2,543	4,975	923	9.7	514
KAPROM	1,423	1,394	2,817	513	21.1	134
TILAK	1,811	1,770	3,581	887	7.6	472
KERINGET	1,634	1,654	3,288	674	34.7	95
CHEPTUYA	1,209	1,216	2,425	495	24.1	101
LORKORNOI	228	224	452	103	4.8	94
MORTOME	197	214	411	76	5.8	71
KISHAUNET	7,588	7,713	15,301	3,008	55.4	276
KISHAUNET	2,883	2,951	5,834	1,132	28.2	207
LITYEI	3,671	3,718	7,389	1,498	13.5	546
SUKUT	1,034	1,044	2,078	378	13.7	151
MNAGEI	8,185	8,192	16,377	2,942	48.1	341
KERINGET	2,233	2,231	4,464	749	14.3	312
PSIGERIO	4,529	4,529	9,058	1,725	19.9	455
TARTAR	1,423	1,432	2,855	468	13.9	206
TALAU	2,476	2,444	4,920	922	12.7	387
CHEPKOTI	1,103	1,117	2,220	409	3.7	603
KAPSURUM	886	860	1,746	336	4.5	388
TALAU	487	467	954	177	4.5	210
KONGELAI	13,533	13,994	27,527	5,596	736.4	37

Appendix II: Borehole Level Records

Chinese 1 borehole water levels

CHINESE 1 BOREHOLE WATER LEVEL RECORDS

Day	Time											
	7:00 a.m	8:00 a.m	9:00 a.m	10:00 a.m	11:00 a.m	12:00 noon	1:00 p.m	2:00 p.m	3:00 p.m	4:00 p.m	5:00 p.m	6:00 p.m
12 Aug 2020	5.5	6.0	16.2	18.1	25.8	25.8	24.6	25.9	25.8	25.8	4.0	3.9
13 Aug 2020	4.3	5.7	12.0	22.4	17.8	23.0	26.8	26.9	27.2	26.1	25.3	4.0
14 Aug 2020	5.6	6.2	16.9	24.9	23.9	27.2	27.5	27.2	12.0	11.7	6.8	5.0
15 Aug 2020	3.5	5.4	12.3	18.1	25.0	22.4	22.4	21.8	21.8	20.0	15.1	6.0
16 Aug 2020	5.1	6.3	18.6	26.1	24.0	27.1	26.0	25.9	26.6	23.7	19.8	6.2
17 Aug 2020	4.7	6.4	18.5	21.7	24.3	28.5	27.6	26.5	25.2	23.1	17.2	5.3
18 Aug 2020	5.0	6.6	16.2	20.3	24.0	21.9	20.1	27.7	23.2	16.7	15.1	5.4
19 Aug 2020	5.1	6.2	16.0	21.0	23.7	21.3	26.7	25.9	24.7	23.1	15.4	5.6
20 Aug 2020	5.1	5.6	18.0	21.0	25.5	26.8	26.1	26.6	24.0	22.0	10.2	5.7
21 Aug 2020	5.0	5.1	17.2	22.8	26.0	26.6	22.3	26.7	22.7	22.0	15.1	6.7
22 Aug 2020	5.1	5.4	17.2	22.0	26.5	26.5	25.6	24.0	21.0	24.5	19.1	6.0
23 Aug 2020	4.8	5.1	15.0	22.0	25.6	26.3	22.7	26.1	21.7	23.0	19.2	6.0
24 Aug 2020	5.5	6.4	13.8	22.0	25.9	26.4	25.3	26.9	22.0	23.1	8.0	5.5
25 Aug 2020	5.1	5.0	17.7	22.2	26.1	21.4	23.2	25.2	22.9	11.0	16.0	5.8
26 Aug 2020	5.1	5.3	18.0	22.1	26.7	26.3	26.3	16.9	24.7	24.0	20.0	6.1
27 Aug 2020	5.0	5.1	17.0	22.6	27.1	26.5	26.5	26.5	16.0	24.2	7.0	5.4
28 Aug 2020	5.3	5.3	17.9	22.5	26.1	27.0	26.7	24.9	26.6	22.0	19.2	6.1
29 Aug 2020	5.1	5.1	17.9	22.5	26.3	26.9	26.7	27.0	26.8	22.3	20.1	6.5
30 Aug 2020	5.4	5.4	15.3	23.7	26.5	26.1	26.3	21.0	22.6	15.2	17.5	6.0
31 Aug 2020	5.1	6.0	11.7	23.3	21.5	26.1	26.1	26.1	23.0	18.0	6.5	6.0
1 Sep 2020	4.9	5.2	18.9	23.7	27.2	22.5	22.5	23.3	28.2	16.4	15.5	5.9
2 Sep 2020	4.9	4.9	15.6	22.1	26.0	28.5	26.9	27.2	27.9	19.8	19.4	6.2
3 Sep 2020	5.0	4.9	18.5	23.5	25.9	27.9	27.7	27.2	23.2	27.2	23.9	9.1
4 Sep 2020	4.8	4.8	19.0	24.0	26.9	28.9	27.3	23.9	25.2	23.4	19.5	6.2
5 Sep 2020	5.1	5.7	18.7	23.9	24.7	26.3	28.9	29.0	17.6	15.9	12.7	6.0
6 Sep 2020	4.9	4.9	18.9	24.0	18.7	23.5	17.2	22.3	19.1	23.0	15.8	5.9
7 Sep 2020	5.0	5.0	17.6	22.9	23.7	24.7	27.6	26.2	20.9	14.7	9.2	5.9
8 Sep 2020	5.0	5.0	19.1	24.4	24.4	27.0	27.5	27.1	26.7	25.5	19.1	6.2
9 Sep 2020	5.2	5.1	19.2	25.3	27.3	23.9	27.9	27.1	25.9	17.0	10.9	7.2
10 Sep 2020	5.4	6.5	19.3	24.6	27.2	27.5	25.9	26.6	26.3	22.7	17.2	7.1

Nawoyatira Borehole Levelogger Data

NAWOYATIIRA BOREHOLE LEVELOGGER RECORDS

Serial_number:	1073313	Level	Unit: m
Project ID:	Lokichar Project	Temperature	Unit: °C
Location:	Nawoyatiira Borehole	Conductivity	Unit: µS/cm

Date	Time	ms	Level	Temperature	Conductivity
12 Aug 2020	7:00:00 AM	0.00	28.09	31.52	0.00
12 Aug 2020	8:00:00 AM	0.00	28.11	31.55	600.20
12 Aug 2020	9:00:00 AM	0.00	21.70	31.54	627.50
12 Aug 2020	10:00:00 AM	0.00	21.11	31.54	650.80
12 Aug 2020	11:00:00 AM	0.00	18.82	31.56	694.70
12 Aug 2020	12:00:00 PM	0.00	19.49	31.55	682.80
12 Aug 2020	1:00:00 PM	0.00	27.84	31.44	600.90
12 Aug 2020	2:00:00 PM	0.00	18.03	31.55	704.10
12 Aug 2020	3:00:00 PM	0.00	14.80	31.53	651.10
12 Aug 2020	4:00:00 PM	0.00	15.18	31.56	721.70
12 Aug 2020	5:00:00 PM	0.00	15.37	31.54	690.10
12 Aug 2020	6:00:00 PM	0.00	27.17	31.36	567.20
12 Aug 2020	7:00:00 PM	0.00	27.64	31.39	573.80
12 Aug 2020	8:00:00 PM	0.00	27.80	31.45	565.30
12 Aug 2020	9:00:00 PM	0.00	27.89	31.46	576.90
12 Aug 2020	10:00:00 PM	0.00	27.95	31.49	579.80
12 Aug 2020	11:00:00 PM	0.00	28.00	31.51	583.80
13 Aug 2020	12:00:00 AM	0.00	28.04	31.54	586.40
13 Aug 2020	1:00:00 AM	0.00	28.06	31.54	589.20
13 Aug 2020	2:00:00 AM	0.00	28.08	31.53	590.50
13 Aug 2020	3:00:00 AM	0.00	28.10	31.55	592.20
13 Aug 2020	4:00:00 AM	0.00	28.12	31.57	594.20
13 Aug 2020	5:00:00 AM	0.00	28.13	31.56	595.20
13 Aug 2020	6:00:00 AM	0.00	28.14	31.57	596.50
13 Aug 2020	7:00:00 AM	0.00	28.15	31.58	597.50
13 Aug 2020	8:00:00 AM	0.00	28.16	31.58	598.10
13 Aug 2020	9:00:00 AM	0.00	22.85	31.54	664.20
13 Aug 2020	10:00:00 AM	0.00	14.00	31.55	681.00
13 Aug 2020	11:00:00 AM	0.00	16.25	31.54	671.90
13 Aug 2020	12:00:00 PM	0.00	13.34	31.55	629.20
13 Aug 2020	1:00:00 PM	0.00	9.46	31.60	847.30
13 Aug 2020	2:00:00 PM	0.00	15.31	31.57	640.60
13 Aug 2020	3:00:00 PM	0.00	16.85	31.57	650.30
13 Aug 2020	4:00:00 PM	0.00	15.24	31.53	695.10
13 Aug 2020	5:00:00 PM	0.00	15.94	31.56	671.40
13 Aug 2020	6:00:00 PM	0.00	27.08	31.38	590.70
13 Aug 2020	7:00:00 PM	0.00	27.54	31.40	580.40
13 Aug 2020	8:00:00 PM	0.00	27.71	31.45	572.50
13 Aug 2020	9:00:00 PM	0.00	27.81	31.48	577.20
13 Aug 2020	10:00:00 PM	0.00	27.89	31.50	578.70
13 Aug 2020	11:00:00 PM	0.00	27.94	31.52	580.60
14 Aug 2020	12:00:00 AM	0.00	27.98	31.53	582.70
14 Aug 2020	1:00:00 AM	0.00	28.01	31.52	584.20
14 Aug 2020	2:00:00 AM	0.00	28.04	31.55	586.50
14 Aug 2020	3:00:00 AM	0.00	28.06	31.56	588.20
14 Aug 2020	4:00:00 AM	0.00	28.08	31.55	589.50
14 Aug 2020	5:00:00 AM	0.00	28.10	31.57	591.50
14 Aug 2020	6:00:00 AM	0.00	28.11	31.57	592.50
14 Aug 2020	7:00:00 AM	0.00	28.13	31.56	593.30
14 Aug 2020	8:00:00 AM	0.00	28.14	31.58	594.80
14 Aug 2020	9:00:00 AM	0.00	18.10	31.55	679.00
14 Aug 2020	10:00:00 AM	0.00	12.99	31.55	673.10
14 Aug 2020	11:00:00 AM	0.00	17.43	31.56	665.80
14 Aug 2020	12:00:00 PM	0.00	13.23	31.55	659.50
14 Aug 2020	1:00:00 PM	0.00	9.44	31.58	839.80
14 Aug 2020	2:00:00 PM	0.00	15.80	31.53	662.50
14 Aug 2020	3:00:00 PM	0.00	16.88	31.55	660.30
14 Aug 2020	4:00:00 PM	0.00	17.18	31.55	654.80
14 Aug 2020	5:00:00 PM	0.00	26.83	31.42	560.40
14 Aug 2020	6:00:00 PM	0.00	27.45	31.47	639.60
14 Aug 2020	7:00:00 PM	0.00	27.68	31.47	584.40
14 Aug 2020	8:00:00 PM	0.00	27.79	31.46	596.20
14 Aug 2020	9:00:00 PM	0.00	27.86	31.49	595.50
14 Aug 2020	10:00:00 PM	0.00	27.92	31.55	593.40
14 Aug 2020	11:00:00 PM	0.00	27.96	31.47	591.40
15 Aug 2020	12:00:00 AM	0.00	28.00	31.50	594.50
15 Aug 2020	1:00:00 AM	0.00	28.02	31.50	597.00
15 Aug 2020	2:00:00 AM	0.00	28.04	31.49	598.20
15 Aug 2020	3:00:00 AM	0.00	28.07	31.52	600.10
15 Aug 2020	4:00:00 AM	0.00	28.08	31.51	602.10
15 Aug 2020	5:00:00 AM	0.00	28.10	31.52	603.00
15 Aug 2020	6:00:00 AM	0.00	28.11	31.51	596.70

Date	Time	ms	Level	Temperature	Conductivity
15 Aug 2020	7:00:00 AM	0.00	28.12	31.52	602.30
15 Aug 2020	8:00:00 AM	0.00	28.13	31.53	601.30
15 Aug 2020	9:00:00 AM	0.00	21.77	31.53	644.80
15 Aug 2020	10:00:00 AM	0.00	16.30	31.54	710.00
15 Aug 2020	11:00:00 AM	0.00	11.22	31.55	671.20
15 Aug 2020	12:00:00 PM	0.00	12.71	31.57	673.40
15 Aug 2020	1:00:00 PM	0.00	12.88	31.58	706.30
15 Aug 2020	2:00:00 PM	0.00	12.59	31.56	678.20
15 Aug 2020	3:00:00 PM	0.00	13.51	31.57	636.80
15 Aug 2020	4:00:00 PM	0.00	15.74	31.58	665.20
15 Aug 2020	5:00:00 PM	0.00	19.36	31.56	655.00
15 Aug 2020	6:00:00 PM	0.00	26.97	31.47	669.70
15 Aug 2020	7:00:00 PM	0.00	27.57	31.45	613.10
15 Aug 2020	8:00:00 PM	0.00	27.72	31.45	597.60
15 Aug 2020	9:00:00 PM	0.00	27.82	31.52	600.40
15 Aug 2020	10:00:00 PM	0.00	27.89	31.48	601.40
15 Aug 2020	11:00:00 PM	0.00	27.94	31.50	602.10
16 Aug 2020	12:00:00 AM	0.00	27.97	31.53	605.20
16 Aug 2020	1:00:00 AM	0.00	28.00	31.52	596.40
16 Aug 2020	2:00:00 AM	0.00	28.03	31.53	600.70
16 Aug 2020	3:00:00 AM	0.00	28.05	31.51	605.90
16 Aug 2020	4:00:00 AM	0.00	28.07	31.49	603.50
16 Aug 2020	5:00:00 AM	0.00	28.08	31.53	603.60
16 Aug 2020	6:00:00 AM	0.00	28.10	31.52	603.40
16 Aug 2020	7:00:00 AM	0.00	28.11	31.51	604.80
16 Aug 2020	8:00:00 AM	0.00	28.12	31.53	604.20
16 Aug 2020	9:00:00 AM	0.00	17.28	31.54	665.60
16 Aug 2020	10:00:00 AM	0.00	16.21	31.55	680.30
16 Aug 2020	11:00:00 AM	0.00	9.81	31.56	671.90
16 Aug 2020	12:00:00 PM	0.00	11.29	31.55	673.10
16 Aug 2020	1:00:00 PM	0.00	9.44	31.59	858.10
16 Aug 2020	2:00:00 PM	0.00	9.43	31.56	859.30
16 Aug 2020	3:00:00 PM	0.00	9.42	31.59	856.10
16 Aug 2020	4:00:00 PM	0.00	12.12	31.56	634.00
16 Aug 2020	5:00:00 PM	0.00	15.18	31.58	659.20
16 Aug 2020	6:00:00 PM	0.00	26.88	31.43	625.10
16 Aug 2020	7:00:00 PM	0.00	27.47	31.44	599.00
16 Aug 2020	8:00:00 PM	0.00	27.64	31.47	586.10
16 Aug 2020	9:00:00 PM	0.00	27.75	31.46	591.10
16 Aug 2020	10:00:00 PM	0.00	27.83	31.51	597.20
16 Aug 2020	11:00:00 PM	0.00	27.89	31.55	590.60
17 Aug 2020	12:00:00 AM	0.00	27.93	31.48	592.40
17 Aug 2020	1:00:00 AM	0.00	27.97	31.51	596.10
17 Aug 2020	2:00:00 AM	0.00	28.00	31.59	594.90
17 Aug 2020	3:00:00 AM	0.00	28.02	31.50	595.60
17 Aug 2020	4:00:00 AM	0.00	28.04	31.53	599.00
17 Aug 2020	5:00:00 AM	0.00	28.06	31.61	598.00
17 Aug 2020	6:00:00 AM	0.00	28.08	31.51	597.80
17 Aug 2020	7:00:00 AM	0.00	28.09	31.54	601.50
17 Aug 2020	8:00:00 AM	0.00	28.10	31.55	601.80
17 Aug 2020	9:00:00 AM	0.00	18.47	31.55	689.70
17 Aug 2020	10:00:00 AM	0.00	13.53	31.55	666.50
17 Aug 2020	11:00:00 AM	0.00	10.01	31.57	665.50
17 Aug 2020	12:00:00 PM	0.00	9.45	31.58	860.90
17 Aug 2020	1:00:00 PM	0.00	9.99	31.57	679.70
17 Aug 2020	2:00:00 PM	0.00	9.43	31.57	863.20
17 Aug 2020	3:00:00 PM	0.00	9.42	31.59	851.80
17 Aug 2020	4:00:00 PM	0.00	12.39	31.56	636.40
17 Aug 2020	5:00:00 PM	0.00	16.65	31.56	667.60
17 Aug 2020	6:00:00 PM	0.00	27.07	31.37	569.10
17 Aug 2020	7:00:00 PM	0.00	27.47	31.40	560.60
17 Aug 2020	8:00:00 PM	0.00	27.63	31.46	569.00
17 Aug 2020	9:00:00 PM	0.00	27.74	31.48	577.50
17 Aug 2020	10:00:00 PM	0.00	27.82	31.49	579.60
17 Aug 2020	11:00:00 PM	0.00	27.87	31.51	580.60
18 Aug 2020	12:00:00 AM	0.00	27.92	31.53	583.50
18 Aug 2020	1:00:00 AM	0.00	27.95	31.54	585.80
18 Aug 2020	2:00:00 AM	0.00	27.98	31.54	587.10
18 Aug 2020	3:00:00 AM	0.00	28.01	31.55	589.00
18 Aug 2020	4:00:00 AM	0.00	28.03	31.56	591.30
18 Aug 2020	5:00:00 AM	0.00	28.05	31.57	592.60
18 Aug 2020	6:00:00 AM	0.00	28.07	31.57	593.80

Date	Time	ms	Level	Temperature	Conductivity
18 Aug 2020	7:00:00 AM	0.00	28.08	31.57	595.20
18 Aug 2020	8:00:00 AM	0.00	28.09	31.58	596.00
18 Aug 2020	9:00:00 AM	0.00	17.68	31.54	682.30
18 Aug 2020	10:00:00 AM	0.00	15.02	31.56	641.30
18 Aug 2020	11:00:00 AM	0.00	12.08	31.57	636.30
18 Aug 2020	12:00:00 PM	0.00	14.82	31.56	640.70
18 Aug 2020	1:00:00 PM	0.00	15.76	31.54	679.40
18 Aug 2020	2:00:00 PM	0.00	9.44	31.57	852.40
18 Aug 2020	3:00:00 PM	0.00	14.78	31.58	675.60
18 Aug 2020	4:00:00 PM	0.00	17.81	31.58	656.70
18 Aug 2020	5:00:00 PM	0.00	19.21	31.58	651.40
18 Aug 2020	6:00:00 PM	0.00	27.40	31.43	602.40
18 Aug 2020	7:00:00 PM	0.00	27.62	31.45	591.90
18 Aug 2020	8:00:00 PM	0.00	27.74	31.52	582.40
18 Aug 2020	9:00:00 PM	0.00	27.82	31.46	589.90
18 Aug 2020	10:00:00 PM	0.00	27.88	31.49	587.90
18 Aug 2020	11:00:00 PM	0.00	27.92	31.52	591.50
19 Aug 2020	12:00:00 AM	0.00	27.96	31.49	591.70
19 Aug 2020	1:00:00 AM	0.00	27.98	31.50	594.30
19 Aug 2020	2:00:00 AM	0.00	28.01	31.50	593.50
19 Aug 2020	3:00:00 AM	0.00	28.03	31.52	589.90
19 Aug 2020	4:00:00 AM	0.00	28.05	31.53	596.00
19 Aug 2020	5:00:00 AM	0.00	28.06	31.50	597.40
19 Aug 2020	6:00:00 AM	0.00	28.07	31.53	599.20
19 Aug 2020	7:00:00 AM	0.00	28.09	31.62	598.00
19 Aug 2020	8:00:00 AM	0.00	28.10	31.51	596.70
19 Aug 2020	9:00:00 AM	0.00	19.04	31.55	709.00
19 Aug 2020	10:00:00 AM	0.00	13.63	31.56	668.80
19 Aug 2020	11:00:00 AM	0.00	11.60	31.56	677.40
19 Aug 2020	12:00:00 PM	0.00	14.30	31.58	648.20
19 Aug 2020	1:00:00 PM	0.00	9.43	31.58	859.10
19 Aug 2020	2:00:00 PM	0.00	11.48	31.56	696.80
19 Aug 2020	3:00:00 PM	0.00	9.41	31.57	876.40
19 Aug 2020	4:00:00 PM	0.00	12.26	31.58	665.00
19 Aug 2020	5:00:00 PM	0.00	19.16	31.58	643.20
19 Aug 2020	6:00:00 PM	0.00	27.20	31.45	651.30
19 Aug 2020	7:00:00 PM	0.00	27.54	31.44	597.50
19 Aug 2020	8:00:00 PM	0.00	27.68	31.49	596.80
19 Aug 2020	9:00:00 PM	0.00	27.77	31.46	602.90
19 Aug 2020	10:00:00 PM	0.00	27.83	31.50	603.60
19 Aug 2020	11:00:00 PM	0.00	27.88	31.56	601.50
20 Aug 2020	12:00:00 AM	0.00	27.92	31.50	595.10
20 Aug 2020	1:00:00 AM	0.00	27.95	31.50	604.10
20 Aug 2020	2:00:00 AM	0.00	27.98	31.50	600.70
20 Aug 2020	3:00:00 AM	0.00	28.00	31.50	600.20
20 Aug 2020	4:00:00 AM	0.00	28.02	31.52	600.00
20 Aug 2020	5:00:00 AM	0.00	28.03	31.53	604.90
20 Aug 2020	6:00:00 AM	0.00	28.05	31.61	607.50
20 Aug 2020	7:00:00 AM	0.00	28.06	31.51	603.80
20 Aug 2020	8:00:00 AM	0.00	28.07	31.54	603.00
20 Aug 2020	9:00:00 AM	0.00	17.28	31.54	658.60
20 Aug 2020	10:00:00 AM	0.00	14.11	31.55	647.20
20 Aug 2020	11:00:00 AM	0.00	10.34	31.56	669.30
20 Aug 2020	12:00:00 PM	0.00	9.43	31.59	852.20
20 Aug 2020	1:00:00 PM	0.00	9.42	31.57	843.10
20 Aug 2020	2:00:00 PM	0.00	9.42	31.60	862.50
20 Aug 2020	3:00:00 PM	0.00	11.56	31.57	662.70
20 Aug 2020	4:00:00 PM	0.00	13.45	31.57	655.90
20 Aug 2020	5:00:00 PM	0.00	23.34	31.39	531.20
20 Aug 2020	6:00:00 PM	0.00	27.14	31.48	668.10
20 Aug 2020	7:00:00 PM	0.00	27.53	31.43	587.00
20 Aug 2020	8:00:00 PM	0.00	27.67	31.45	599.00
20 Aug 2020	9:00:00 PM	0.00	27.76	31.50	605.80
20 Aug 2020	10:00:00 PM	0.00	27.82	31.53	605.40
20 Aug 2020	11:00:00 PM	0.00	27.87	31.49	603.90
21 Aug 2020	12:00:00 AM	0.00	27.91	31.50	604.80
21 Aug 2020	1:00:00 AM	0.00	27.94	31.49	604.70
21 Aug 2020	2:00:00 AM	0.00	27.97	31.52	610.70
21 Aug 2020	3:00:00 AM	0.00	27.99	31.51	605.80
21 Aug 2020	4:00:00 AM	0.00	28.01	31.50	607.80
21 Aug 2020	5:00:00 AM	0.00	28.03	31.51	604.70
21 Aug 2020	6:00:00 AM	0.00	28.04	31.54	606.00
21 Aug 2020	7:00:00 AM	0.00	28.06	31.51	608.40
21 Aug 2020	8:00:00 AM	0.00	28.07	31.53	609.80
21 Aug 2020	9:00:00 AM	0.00	16.70	31.54	660.60
21 Aug 2020	10:00:00 AM	0.00	12.55	31.55	669.70
21 Aug 2020	11:00:00 AM	0.00	9.85	31.56	685.50
21 Aug 2020	12:00:00 PM	0.00	9.45	31.59	861.70
21 Aug 2020	1:00:00 PM	0.00	10.82	31.57	682.50

Date	Time	ms	Level	Temperature	Conductivity
21 Aug 2020	2:00:00 PM	0.00	9.76	31.57	745.00
21 Aug 2020	3:00:00 PM	0.00	12.50	31.57	687.90
21 Aug 2020	4:00:00 PM	0.00	13.26	31.58	642.30
21 Aug 2020	5:00:00 PM	0.00	19.20	31.58	643.70
21 Aug 2020	6:00:00 PM	0.00	26.34	31.48	641.30
21 Aug 2020	7:00:00 PM	0.00	27.50	31.43	597.80
21 Aug 2020	8:00:00 PM	0.00	27.65	31.46	588.90
21 Aug 2020	9:00:00 PM	0.00	27.74	31.50	589.10
21 Aug 2020	10:00:00 PM	0.00	27.81	31.53	591.40
21 Aug 2020	11:00:00 PM	0.00	27.86	31.48	589.50
22 Aug 2020	12:00:00 AM	0.00	27.90	31.52	597.10
22 Aug 2020	1:00:00 AM	0.00	27.93	31.50	593.30
22 Aug 2020	2:00:00 AM	0.00	27.96	31.49	590.90
22 Aug 2020	3:00:00 AM	0.00	27.98	31.51	596.10
22 Aug 2020	4:00:00 AM	0.00	28.00	31.51	597.70
22 Aug 2020	5:00:00 AM	0.00	28.01	31.51	597.20
22 Aug 2020	6:00:00 AM	0.00	28.03	31.55	603.80
22 Aug 2020	7:00:00 AM	0.00	28.05	31.51	600.10
22 Aug 2020	8:00:00 AM	0.00	28.06	31.56	604.10
22 Aug 2020	9:00:00 AM	0.00	17.30	31.54	650.70
22 Aug 2020	10:00:00 AM	0.00	13.27	31.56	668.10
22 Aug 2020	11:00:00 AM	0.00	9.46	31.56	847.80
22 Aug 2020	12:00:00 PM	0.00	9.45	31.58	869.20
22 Aug 2020	1:00:00 PM	0.00	10.20	31.57	668.00
22 Aug 2020	2:00:00 PM	0.00	11.58	31.57	640.00
22 Aug 2020	3:00:00 PM	0.00	14.17	31.57	636.00
22 Aug 2020	4:00:00 PM	0.00	11.18	31.57	641.00
22 Aug 2020	5:00:00 PM	0.00	15.78	31.57	668.60
22 Aug 2020	6:00:00 PM	0.00	26.91	31.38	584.30
22 Aug 2020	7:00:00 PM	0.00	27.40	31.42	571.30
22 Aug 2020	8:00:00 PM	0.00	27.57	31.44	579.60
22 Aug 2020	9:00:00 PM	0.00	27.68	31.48	590.10
22 Aug 2020	10:00:00 PM	0.00	27.75	31.53	581.40
22 Aug 2020	11:00:00 PM	0.00	27.81	31.47	580.10
23 Aug 2020	12:00:00 AM	0.00	27.86	31.50	584.00
23 Aug 2020	1:00:00 AM	0.00	27.89	31.49	589.60
23 Aug 2020	2:00:00 AM	0.00	27.92	31.49	591.20
23 Aug 2020	3:00:00 AM	0.00	27.95	31.52	594.10
23 Aug 2020	4:00:00 AM	0.00	27.97	31.59	591.20
23 Aug 2020	5:00:00 AM	0.00	27.99	31.51	591.30
23 Aug 2020	6:00:00 AM	0.00	28.00	31.53	594.40
23 Aug 2020	7:00:00 AM	0.00	28.02	31.61	595.70
23 Aug 2020	8:00:00 AM	0.00	28.03	31.55	595.10
23 Aug 2020	9:00:00 AM	0.00	17.27	31.54	646.30
23 Aug 2020	10:00:00 AM	0.00	13.34	31.56	672.60
23 Aug 2020	11:00:00 AM	0.00	10.21	31.57	670.80
23 Aug 2020	12:00:00 PM	0.00	9.62	31.56	683.20
23 Aug 2020	1:00:00 PM	0.00	12.71	31.59	650.40
23 Aug 2020	2:00:00 PM	0.00	9.42	31.58	908.70
23 Aug 2020	3:00:00 PM	0.00	13.86	31.56	662.50
23 Aug 2020	4:00:00 PM	0.00	12.40	31.58	654.60
23 Aug 2020	5:00:00 PM	0.00	15.69	31.58	672.60
23 Aug 2020	6:00:00 PM	0.00	26.93	31.37	588.90
23 Aug 2020	7:00:00 PM	0.00	27.38	31.40	558.90
23 Aug 2020	8:00:00 PM	0.00	27.55	31.45	571.70
23 Aug 2020	9:00:00 PM	0.00	27.66	31.48	579.30
23 Aug 2020	10:00:00 PM	0.00	27.74	31.49	582.50
23 Aug 2020	11:00:00 PM	0.00	27.79	31.51	583.10
24 Aug 2020	12:00:00 AM	0.00	27.84	31.53	585.10
24 Aug 2020	1:00:00 AM	0.00	27.88	31.55	588.20
24 Aug 2020	2:00:00 AM	0.00	27.90	31.54	589.50
24 Aug 2020	3:00:00 AM	0.00	27.93	31.54	591.40
24 Aug 2020	4:00:00 AM	0.00	27.95	31.56	593.60
24 Aug 2020	5:00:00 AM	0.00	27.96	31.57	595.30
24 Aug 2020	6:00:00 AM	0.00	27.98	31.56	595.70
24 Aug 2020	7:00:00 AM	0.00	28.00	31.58	597.30
24 Aug 2020	8:00:00 AM	0.00	28.01	31.58	598.50
24 Aug 2020	9:00:00 AM	0.00	20.26	31.54	679.50
24 Aug 2020	10:00:00 AM	0.00	13.20	31.56	677.90
24 Aug 2020	11:00:00 AM	0.00	10.32	31.56	674.20
24 Aug 2020	12:00:00 PM	0.00	9.76	31.60	689.80
24 Aug 2020	1:00:00 PM	0.00	10.73	31.58	679.10
24 Aug 2020	2:00:00 PM	0.00	9.43	31.57	860.70
24 Aug 2020	3:00:00 PM	0.00	12.95	31.57	687.80
24 Aug 2020	4:00:00 PM	0.00	11.90	31.59	645.40
24 Aug 2020	5:00:00 PM	0.00	25.14	31.36	541.80
24 Aug 2020	6:00:00 PM	0.00	27.10	31.44	640.70
24 Aug 2020	7:00:00 PM	0.00	27.43	31.44	597.80
24 Aug 2020	8:00:00 PM	0.00	27.58	31.44	599.20

Date	Time	ms	Level	Temperature	Conductivity
24 Aug 2020	9:00:00 PM	0.00	27.67	31.53	602.30
24 Aug 2020	10:00:00 PM	0.00	27.74	31.47	601.00
24 Aug 2020	11:00:00 PM	0.00	27.80	31.52	605.90
25 Aug 2020	12:00:00 AM	0.00	27.84	31.57	603.50
25 Aug 2020	1:00:00 AM	0.00	27.87	31.50	603.70
25 Aug 2020	2:00:00 AM	0.00	27.90	31.50	598.90
25 Aug 2020	3:00:00 AM	0.00	27.92	31.50	603.90
25 Aug 2020	4:00:00 AM	0.00	27.94	31.52	603.60
25 Aug 2020	5:00:00 AM	0.00	27.96	31.52	608.20
25 Aug 2020	6:00:00 AM	0.00	27.98	31.56	608.00
25 Aug 2020	7:00:00 AM	0.00	27.99	31.60	609.00
25 Aug 2020	8:00:00 AM	0.00	28.01	31.54	609.50
25 Aug 2020	9:00:00 AM	0.00	16.96	31.54	670.30
25 Aug 2020	10:00:00 AM	0.00	13.12	31.56	674.70
25 Aug 2020	11:00:00 AM	0.00	9.47	31.53	770.40
25 Aug 2020	12:00:00 PM	0.00	14.15	31.56	634.90
25 Aug 2020	1:00:00 PM	0.00	11.78	31.57	645.10
25 Aug 2020	2:00:00 PM	0.00	10.55	31.57	707.50
25 Aug 2020	3:00:00 PM	0.00	12.71	31.58	689.30
25 Aug 2020	4:00:00 PM	0.00	22.54	31.43	571.70
25 Aug 2020	5:00:00 PM	0.00	18.42	31.56	666.70
25 Aug 2020	6:00:00 PM	0.00	27.20	31.48	636.90
25 Aug 2020	7:00:00 PM	0.00	27.49	31.44	591.30
25 Aug 2020	8:00:00 PM	0.00	27.62	31.46	598.90
25 Aug 2020	9:00:00 PM	0.00	27.71	31.45	600.30
25 Aug 2020	10:00:00 PM	0.00	27.77	31.49	605.80
25 Aug 2020	11:00:00 PM	0.00	27.82	31.51	604.20
26 Aug 2020	12:00:00 AM	0.00	27.85	31.49	603.20
26 Aug 2020	1:00:00 AM	0.00	27.88	31.48	600.10
26 Aug 2020	2:00:00 AM	0.00	27.91	31.51	607.70
26 Aug 2020	3:00:00 AM	0.00	27.93	31.51	604.60
26 Aug 2020	4:00:00 AM	0.00	27.95	31.58	608.20
26 Aug 2020	5:00:00 AM	0.00	27.96	31.53	605.30
26 Aug 2020	6:00:00 AM	0.00	27.98	31.54	606.60
26 Aug 2020	7:00:00 AM	0.00	27.99	31.51	606.90
26 Aug 2020	8:00:00 AM	0.00	28.00	31.53	609.30
26 Aug 2020	9:00:00 AM	0.00	16.67	31.54	676.20
26 Aug 2020	10:00:00 AM	0.00	13.03	31.56	675.20
26 Aug 2020	11:00:00 AM	0.00	9.55	31.51	787.00
26 Aug 2020	12:00:00 PM	0.00	9.47	31.55	834.70
26 Aug 2020	1:00:00 PM	0.00	9.46	31.55	835.60
26 Aug 2020	2:00:00 PM	0.00	17.95	31.58	641.20
26 Aug 2020	3:00:00 PM	0.00	10.97	31.58	675.70
26 Aug 2020	4:00:00 PM	0.00	11.41	31.57	641.70
26 Aug 2020	5:00:00 PM	0.00	14.97	31.57	647.10
26 Aug 2020	6:00:00 PM	0.00	26.86	31.40	573.30
26 Aug 2020	7:00:00 PM	0.00	27.32	31.43	586.30
26 Aug 2020	8:00:00 PM	0.00	27.51	31.49	581.70
26 Aug 2020	9:00:00 PM	0.00	27.62	31.50	587.20
26 Aug 2020	10:00:00 PM	0.00	27.70	31.49	587.90
26 Aug 2020	11:00:00 PM	0.00	27.75	31.52	589.40
27 Aug 2020	12:00:00 AM	0.00	27.80	31.51	588.70
27 Aug 2020	1:00:00 AM	0.00	27.83	31.52	587.10
27 Aug 2020	2:00:00 AM	0.00	27.86	31.48	587.20
27 Aug 2020	3:00:00 AM	0.00	27.89	31.50	587.00
27 Aug 2020	4:00:00 AM	0.00	27.91	31.52	593.00
27 Aug 2020	5:00:00 AM	0.00	27.93	31.53	594.70
27 Aug 2020	6:00:00 AM	0.00	27.95	31.51	596.10
27 Aug 2020	7:00:00 AM	0.00	27.95	31.55	594.90
27 Aug 2020	8:00:00 AM	0.00	27.97	31.52	598.10
27 Aug 2020	9:00:00 AM	0.00	17.12	31.54	673.40
27 Aug 2020	10:00:00 AM	0.00	12.76	31.56	677.80
27 Aug 2020	11:00:00 AM	0.00	9.47	31.55	825.80
27 Aug 2020	12:00:00 PM	0.00	9.46	31.54	822.60
27 Aug 2020	1:00:00 PM	0.00	9.45	31.55	833.90
27 Aug 2020	2:00:00 PM	0.00	9.67	31.57	691.20
27 Aug 2020	3:00:00 PM	0.00	18.44	31.59	645.70
27 Aug 2020	4:00:00 PM	0.00	11.17	31.57	649.50
27 Aug 2020	5:00:00 PM	0.00	25.97	31.34	505.90
27 Aug 2020	6:00:00 PM	0.00	27.13	31.46	653.00
27 Aug 2020	7:00:00 PM	0.00	27.42	31.44	602.80
27 Aug 2020	8:00:00 PM	0.00	27.55	31.45	602.70
27 Aug 2020	9:00:00 PM	0.00	27.65	31.46	606.20
27 Aug 2020	10:00:00 PM	0.00	27.71	31.53	604.60
27 Aug 2020	11:00:00 PM	0.00	27.76	31.47	603.40
28 Aug 2020	12:00:00 AM	0.00	27.80	31.51	607.40
28 Aug 2020	1:00:00 AM	0.00	27.83	31.51	606.70
28 Aug 2020	2:00:00 AM	0.00	27.85	31.51	604.50
28 Aug 2020	3:00:00 AM	0.00	27.88	31.51	608.10

Date	Time	ms	Level	Temperature	Conductivity
28 Aug 2020	4:00:00 AM	0.00	27.90	31.52	610.90
28 Aug 2020	5:00:00 AM	0.00	27.91	31.51	609.70
28 Aug 2020	6:00:00 AM	0.00	27.93	31.52	612.00
28 Aug 2020	7:00:00 AM	0.00	27.94	31.53	607.20
28 Aug 2020	8:00:00 AM	0.00	27.95	31.52	612.40
28 Aug 2020	9:00:00 AM	0.00	16.86	31.54	680.00
28 Aug 2020	10:00:00 AM	0.00	12.88	31.56	681.70
28 Aug 2020	11:00:00 AM	0.00	9.49	31.55	771.80
28 Aug 2020	12:00:00 PM	0.00	9.45	31.55	828.50
28 Aug 2020	1:00:00 PM	0.00	9.43	31.54	831.70
28 Aug 2020	2:00:00 PM	0.00	11.24	31.57	695.10
28 Aug 2020	3:00:00 PM	0.00	9.40	31.54	843.50
28 Aug 2020	4:00:00 PM	0.00	13.25	31.56	684.30
28 Aug 2020	5:00:00 PM	0.00	15.66	31.56	671.50
28 Aug 2020	6:00:00 PM	0.00	26.82	31.40	599.10
28 Aug 2020	7:00:00 PM	0.00	27.29	31.41	592.90
28 Aug 2020	8:00:00 PM	0.00	27.46	31.46	572.70
28 Aug 2020	9:00:00 PM	0.00	27.57	31.48	578.20
28 Aug 2020	10:00:00 PM	0.00	27.65	31.50	581.70
28 Aug 2020	11:00:00 PM	0.00	27.70	31.51	579.90
29 Aug 2020	12:00:00 AM	0.00	27.74	31.52	585.40
29 Aug 2020	1:00:00 AM	0.00	27.78	31.54	588.20
29 Aug 2020	2:00:00 AM	0.00	27.81	31.55	590.00
29 Aug 2020	3:00:00 AM	0.00	27.83	31.55	592.40
29 Aug 2020	4:00:00 AM	0.00	27.85	31.55	593.20
29 Aug 2020	5:00:00 AM	0.00	27.87	31.56	594.90
29 Aug 2020	6:00:00 AM	0.00	27.89	31.57	596.80
29 Aug 2020	7:00:00 AM	0.00	27.90	31.57	598.00
29 Aug 2020	8:00:00 AM	0.00	27.92	31.58	599.00
29 Aug 2020	9:00:00 AM	0.00	16.81	31.55	685.80
29 Aug 2020	10:00:00 AM	0.00	12.71	31.56	681.00
29 Aug 2020	11:00:00 AM	0.00	9.45	31.55	824.80
29 Aug 2020	12:00:00 PM	0.00	9.44	31.55	850.10
29 Aug 2020	1:00:00 PM	0.00	9.43	31.58	841.60
29 Aug 2020	2:00:00 PM	0.00	9.85	31.55	725.00
29 Aug 2020	3:00:00 PM	0.00	9.40	31.55	853.60
29 Aug 2020	4:00:00 PM	0.00	13.36	31.56	680.70
29 Aug 2020	5:00:00 PM	0.00	14.90	31.58	647.30
29 Aug 2020	6:00:00 PM	0.00	26.53	31.39	584.60
29 Aug 2020	7:00:00 PM	0.00	27.22	31.41	583.40
29 Aug 2020	8:00:00 PM	0.00	27.41	31.45	581.00
29 Aug 2020	9:00:00 PM	0.00	27.52	31.52	586.40
29 Aug 2020	10:00:00 PM	0.00	27.60	31.47	589.70
29 Aug 2020	11:00:00 PM	0.00	27.67	31.49	591.90
30 Aug 2020	12:00:00 AM	0.00	27.71	31.51	592.10
30 Aug 2020	1:00:00 AM	0.00	27.75	31.49	589.10
30 Aug 2020	2:00:00 AM	0.00	27.78	31.49	592.00
30 Aug 2020	3:00:00 AM	0.00	27.81	31.53	594.30
30 Aug 2020	4:00:00 AM	0.00	27.83	31.54	597.60
30 Aug 2020	5:00:00 AM	0.00	27.85	31.51	594.00
30 Aug 2020	6:00:00 AM	0.00	27.87	31.54	598.90
30 Aug 2020	7:00:00 AM	0.00	27.89	31.53	600.40
30 Aug 2020	8:00:00 AM	0.00	23.84	31.52	601.80
30 Aug 2020	9:00:00 AM	0.00	18.66	31.55	699.70
30 Aug 2020	10:00:00 AM	0.00	11.56	31.56	677.70
30 Aug 2020	11:00:00 AM	0.00	9.46	31.53	813.90
30 Aug 2020	12:00:00 PM	0.00	9.46	31.57	841.20
30 Aug 2020	1:00:00 PM	0.00	9.45	31.58	827.90
30 Aug 2020	2:00:00 PM	0.00	13.85	31.56	654.40
30 Aug 2020	3:00:00 PM	0.00	12.69	31.57	693.70
30 Aug 2020	4:00:00 PM	0.00	19.10	31.56	664.50
30 Aug 2020	5:00:00 PM	0.00	17.03	31.57	640.40
30 Aug 2020	6:00:00 PM	0.00	26.99	31.43	624.10
30 Aug 2020	7:00:00 PM	0.00	27.37	31.43	602.70
30 Aug 2020	8:00:00 PM	0.00	27.51	31.46	599.10
30 Aug 2020	9:00:00 PM	0.00	27.60	31.51	597.50
30 Aug 2020	10:00:00 PM	0.00	27.67	31.54	595.70
30 Aug 2020	11:00:00 PM	0.00	27.72	31.49	595.80
31 Aug 2020	12:00:00 AM	0.00	27.75	31.48	596.70
31 Aug 2020	1:00:00 AM	0.00	27.79	31.49	604.50
31 Aug 2020	2:00:00 AM	0.00	27.81	31.52	598.00
31 Aug 2020	3:00:00 AM	0.00	27.83	31.51	601.20
31 Aug 2020	4:00:00 AM	0.00	27.85	31.50	597.50
31 Aug 2020	5:00:00 AM	0.00	27.87	31.52	603.90
31 Aug 2020	6:00:00 AM	0.00	27.88	31.53	599.70
31 Aug 2020	7:00:00 AM	0.00	27.89	31.52	605.50
31 Aug 2020	8:00:00 AM	0.00	22.12	31.54	642.40
31 Aug 2020	9:00:00 AM	0.00	22.02	31.53	672.00
31 Aug 2020	10:00:00 AM	0.00	12.51	31.56	676.80

Date	Time	ms	Level	Temperature	Conductivity
31 Aug 2020	11:00:00 AM	0.00	14.19	31.54	661.60
31 Aug 2020	12:00:00 PM	0.00	9.46	31.54	817.40
31 Aug 2020	1:00:00 PM	0.00	9.45	31.56	826.20
31 Aug 2020	2:00:00 PM	0.00	9.43	31.56	780.80
31 Aug 2020	3:00:00 PM	0.00	13.27	31.58	666.20
31 Aug 2020	4:00:00 PM	0.00	16.63	31.55	768.90
31 Aug 2020	5:00:00 PM	0.00	26.51	31.42	565.70
31 Aug 2020	6:00:00 PM	0.00	27.09	31.47	606.20
31 Aug 2020	7:00:00 PM	0.00	27.40	31.44	593.20
31 Aug 2020	8:00:00 PM	0.00	27.53	31.45	599.80
31 Aug 2020	9:00:00 PM	0.00	27.62	31.49	600.20
31 Aug 2020	10:00:00 PM	0.00	27.68	31.56	597.00
31 Aug 2020	11:00:00 PM	0.00	27.72	31.51	599.90
1 Sep 2020	12:00:00 AM	0.00	27.76	31.51	599.90
1 Sep 2020	1:00:00 AM	0.00	27.79	31.50	599.50
1 Sep 2020	2:00:00 AM	0.00	27.81	31.52	602.30
1 Sep 2020	3:00:00 AM	0.00	27.83	31.52	601.90
1 Sep 2020	4:00:00 AM	0.00	27.85	31.59	603.70
1 Sep 2020	5:00:00 AM	0.00	27.86	31.57	606.70
1 Sep 2020	6:00:00 AM	0.00	27.88	31.53	605.60
1 Sep 2020	7:00:00 AM	0.00	27.90	31.54	605.60
1 Sep 2020	8:00:00 AM	0.00	27.90	31.53	602.10
1 Sep 2020	9:00:00 AM	0.00	15.94	31.54	666.70
1 Sep 2020	10:00:00 AM	0.00	11.87	31.56	683.80
1 Sep 2020	11:00:00 AM	0.00	9.70	31.57	688.70
1 Sep 2020	12:00:00 PM	0.00	13.21	31.57	672.10
1 Sep 2020	1:00:00 PM	0.00	13.18	31.57	682.10
1 Sep 2020	2:00:00 PM	0.00	9.44	31.53	836.00
1 Sep 2020	3:00:00 PM	0.00	18.12	31.59	655.60
1 Sep 2020	4:00:00 PM	0.00	18.03	31.59	646.40
1 Sep 2020	5:00:00 PM	0.00	18.84	31.46	632.00
1 Sep 2020	6:00:00 PM	0.00	26.97	31.46	641.60
1 Sep 2020	7:00:00 PM	0.00	27.32	31.44	607.70
1 Sep 2020	8:00:00 PM	0.00	27.46	31.45	600.20
1 Sep 2020	9:00:00 PM	0.00	27.55	31.52	605.30
1 Sep 2020	10:00:00 PM	0.00	27.62	31.47	603.70
1 Sep 2020	11:00:00 PM	0.00	27.67	31.51	610.20
2 Sep 2020	12:00:00 AM	0.00	27.71	31.53	609.10
2 Sep 2020	1:00:00 AM	0.00	27.75	31.50	606.80
2 Sep 2020	2:00:00 AM	0.00	27.77	31.49	609.60
2 Sep 2020	3:00:00 AM	0.00	27.79	31.53	611.90
2 Sep 2020	4:00:00 AM	0.00	27.81	31.58	610.80
2 Sep 2020	5:00:00 AM	0.00	27.83	31.51	606.50
2 Sep 2020	6:00:00 AM	0.00	27.84	31.54	607.80
2 Sep 2020	7:00:00 AM	0.00	27.86	31.54	609.70
2 Sep 2020	8:00:00 AM	0.00	27.87	31.59	613.70
2 Sep 2020	9:00:00 AM	0.00	18.77	31.56	691.80
2 Sep 2020	10:00:00 AM	0.00	13.18	31.56	666.30
2 Sep 2020	11:00:00 AM	0.00	9.45	31.54	827.70
2 Sep 2020	12:00:00 PM	0.00	9.45	31.56	839.40
2 Sep 2020	1:00:00 PM	0.00	9.44	31.56	839.20
2 Sep 2020	2:00:00 PM	0.00	9.43	31.56	844.80
2 Sep 2020	3:00:00 PM	0.00	9.41	31.56	852.60
2 Sep 2020	4:00:00 PM	0.00	19.42	31.58	645.80
2 Sep 2020	5:00:00 PM	0.00	14.66	31.59	664.50
2 Sep 2020	6:00:00 PM	0.00	26.78	31.41	612.90
2 Sep 2020	7:00:00 PM	0.00	27.23	31.44	584.30
2 Sep 2020	8:00:00 PM	0.00	27.40	31.46	587.60
2 Sep 2020	9:00:00 PM	0.00	27.51	31.50	584.00
2 Sep 2020	10:00:00 PM	0.00	27.58	31.53	585.60
2 Sep 2020	11:00:00 PM	0.00	27.63	31.48	584.70
3 Sep 2020	12:00:00 AM	0.00	27.68	31.51	590.90
3 Sep 2020	1:00:00 AM	0.00	27.71	31.51	589.30
3 Sep 2020	2:00:00 AM	0.00	27.74	31.50	592.10
3 Sep 2020	3:00:00 AM	0.00	27.77	31.51	593.90
3 Sep 2020	4:00:00 AM	0.00	27.79	31.55	597.10
3 Sep 2020	5:00:00 AM	0.00	27.81	31.61	596.60
3 Sep 2020	6:00:00 AM	0.00	27.82	31.54	601.60
3 Sep 2020	7:00:00 AM	0.00	27.83	31.54	597.30
3 Sep 2020	8:00:00 AM	0.00	27.85	31.53	599.20
3 Sep 2020	9:00:00 AM	0.00	16.27	31.54	677.20
3 Sep 2020	10:00:00 AM	0.00	12.30	31.56	682.30
3 Sep 2020	11:00:00 AM	0.00	9.47	31.55	844.70
3 Sep 2020	12:00:00 PM	0.00	9.46	31.56	847.60
3 Sep 2020	1:00:00 PM	0.00	9.45	31.56	856.10
3 Sep 2020	2:00:00 PM	0.00	9.44	31.56	829.00
3 Sep 2020	3:00:00 PM	0.00	9.43	31.55	841.60
3 Sep 2020	4:00:00 PM	0.00	9.71	31.54	691.80
3 Sep 2020	5:00:00 PM	0.00	15.46	31.57	679.70

Date	Time	ms	Level	Temperature	Conductivity
3 Sep 2020	6:00:00 PM	0.00	26.69	31.42	615.40
3 Sep 2020	7:00:00 PM	0.00	27.16	31.42	590.40
3 Sep 2020	8:00:00 PM	0.00	27.34	31.48	581.90
3 Sep 2020	9:00:00 PM	0.00	27.45	31.50	582.70
3 Sep 2020	10:00:00 PM	0.00	27.53	31.51	583.40
3 Sep 2020	11:00:00 PM	0.00	27.59	31.52	585.10
4 Sep 2020	12:00:00 AM	0.00	27.64	31.53	585.40
4 Sep 2020	1:00:00 AM	0.00	27.68	31.53	588.00
4 Sep 2020	2:00:00 AM	0.00	27.71	31.54	590.30
4 Sep 2020	3:00:00 AM	0.00	27.74	31.56	592.40
4 Sep 2020	4:00:00 AM	0.00	27.76	31.56	593.60
4 Sep 2020	5:00:00 AM	0.00	27.78	31.57	595.40
4 Sep 2020	6:00:00 AM	0.00	27.80	31.56	596.50
4 Sep 2020	7:00:00 AM	0.00	27.81	31.57	597.80
4 Sep 2020	8:00:00 AM	0.00	27.82	31.59	598.90
4 Sep 2020	9:00:00 AM	0.00	16.04	31.55	675.30
4 Sep 2020	10:00:00 AM	0.00	11.56	31.58	675.80
4 Sep 2020	11:00:00 AM	0.00	9.46	31.54	824.00
4 Sep 2020	12:00:00 PM	0.00	9.45	31.54	846.60
4 Sep 2020	1:00:00 PM	0.00	12.70	31.59	679.50
4 Sep 2020	2:00:00 PM	0.00	9.43	31.54	836.90
4 Sep 2020	3:00:00 PM	0.00	11.10	31.58	685.20
4 Sep 2020	4:00:00 PM	0.00	10.02	31.58	687.30
4 Sep 2020	5:00:00 PM	0.00	15.37	31.58	706.80
4 Sep 2020	6:00:00 PM	0.00	26.70	31.39	605.80
4 Sep 2020	7:00:00 PM	0.00	27.17	31.44	571.70
4 Sep 2020	8:00:00 PM	0.00	27.34	31.46	585.50
4 Sep 2020	9:00:00 PM	0.00	27.45	31.49	582.40
4 Sep 2020	10:00:00 PM	0.00	27.52	31.50	585.00
4 Sep 2020	11:00:00 PM	0.00	27.58	31.52	586.40
5 Sep 2020	12:00:00 AM	0.00	27.63	31.54	587.80
5 Sep 2020	1:00:00 AM	0.00	27.66	31.54	589.50
5 Sep 2020	2:00:00 AM	0.00	27.69	31.54	591.00
5 Sep 2020	3:00:00 AM	0.00	27.72	31.54	593.30
5 Sep 2020	4:00:00 AM	0.00	27.74	31.56	595.00
5 Sep 2020	5:00:00 AM	0.00	27.76	31.57	596.60
5 Sep 2020	6:00:00 AM	0.00	27.77	31.57	597.60
5 Sep 2020	7:00:00 AM	0.00	27.78	31.56	598.30
5 Sep 2020	8:00:00 AM	0.00	21.57	31.55	645.40
5 Sep 2020	9:00:00 AM	0.00	16.14	31.55	677.30
5 Sep 2020	10:00:00 AM	0.00	27.13	31.42	608.30
5 Sep 2020	11:00:00 AM	0.00	11.96	31.55	689.20
5 Sep 2020	12:00:00 PM	0.00	12.91	31.58	653.30
5 Sep 2020	1:00:00 PM	0.00	9.43	31.52	790.20
5 Sep 2020	2:00:00 PM	0.00	9.41	31.54	847.70
5 Sep 2020	3:00:00 PM	0.00	19.64	31.57	676.90
5 Sep 2020	4:00:00 PM	0.00	27.08	31.37	547.20
5 Sep 2020	5:00:00 PM	0.00	27.35	31.41	573.90
5 Sep 2020	6:00:00 PM	0.00	27.47	31.46	573.40
5 Sep 2020	7:00:00 PM	0.00	27.55	31.48	584.80
5 Sep 2020	8:00:00 PM	0.00	27.61	31.50	585.80
5 Sep 2020	9:00:00 PM	0.00	27.65	31.52	588.20
5 Sep 2020	10:00:00 PM	0.00	27.68	31.53	592.60
5 Sep 2020	11:00:00 PM	0.00	27.71	31.56	594.60
6 Sep 2020	12:00:00 AM	0.00	27.73	31.54	596.00
6 Sep 2020	1:00:00 AM	0.00	27.75	31.54	597.70
6 Sep 2020	2:00:00 AM	0.00	27.77	31.57	599.60
6 Sep 2020	3:00:00 AM	0.00	27.78	31.57	600.10
6 Sep 2020	4:00:00 AM	0.00	27.79	31.56	601.20
6 Sep 2020	5:00:00 AM	0.00	27.80	31.58	603.30
6 Sep 2020	6:00:00 AM	0.00	27.81	31.58	603.70
6 Sep 2020	7:00:00 AM	0.00	27.82	31.57	604.70
6 Sep 2020	8:00:00 AM	0.00	27.83	31.60	605.80
6 Sep 2020	9:00:00 AM	0.00	16.23	31.54	678.80
6 Sep 2020	10:00:00 AM	0.00	11.59	31.57	685.30
6 Sep 2020	11:00:00 AM	0.00	16.16	31.56	680.50
6 Sep 2020	12:00:00 PM	0.00	10.67	31.57	674.00
6 Sep 2020	1:00:00 PM	0.00	17.57	31.58	712.20
6 Sep 2020	2:00:00 PM	0.00	14.07	31.57	671.10
6 Sep 2020	3:00:00 PM	0.00	15.77	31.57	672.20
6 Sep 2020	4:00:00 PM	0.00	12.45	31.56	672.30
6 Sep 2020	5:00:00 PM	0.00	18.58	31.57	665.70
6 Sep 2020	6:00:00 PM	0.00	26.98	31.43	624.60
6 Sep 2020	7:00:00 PM	0.00	27.29	31.45	569.30
6 Sep 2020	8:00:00 PM	0.00	27.42	31.48	584.60
6 Sep 2020	9:00:00 PM	0.00	27.50	31.50	586.40
6 Sep 2020	10:00:00 PM	0.00	27.57	31.51	586.10
6 Sep 2020	11:00:00 PM	0.00	27.61	31.52	588.90
7 Sep 2020	12:00:00 AM	0.00	27.66	31.53	591.40

Date	Time	ms	Level	Temperature	Conductivity
7 Sep 2020	1:00:00 AM	0.00	27.68	31.53	592.70
7 Sep 2020	2:00:00 AM	0.00	27.71	31.54	594.60
7 Sep 2020	3:00:00 AM	0.00	27.73	31.56	596.10
7 Sep 2020	4:00:00 AM	0.00	27.74	31.57	597.50
7 Sep 2020	5:00:00 AM	0.00	27.76	31.56	598.30
7 Sep 2020	6:00:00 AM	0.00	27.77	31.57	599.00
7 Sep 2020	7:00:00 AM	0.00	27.79	31.59	601.00
7 Sep 2020	8:00:00 AM	0.00	27.80	31.57	601.60
7 Sep 2020	9:00:00 AM	0.00	27.81	31.59	602.80
7 Sep 2020	10:00:00 AM	0.00	15.26	31.54	665.30
7 Sep 2020	11:00:00 AM	0.00	16.29	31.55	668.70
7 Sep 2020	12:00:00 PM	0.00	9.89	31.57	680.90
7 Sep 2020	1:00:00 PM	0.00	9.98	31.56	675.00
7 Sep 2020	2:00:00 PM	0.00	9.90	31.57	674.80
7 Sep 2020	3:00:00 PM	0.00	9.42	31.53	830.30
7 Sep 2020	4:00:00 PM	0.00	11.95	31.57	682.90
7 Sep 2020	5:00:00 PM	0.00	18.15	31.57	665.60
7 Sep 2020	6:00:00 PM	0.00	26.97	31.40	604.00
7 Sep 2020	7:00:00 PM	0.00	27.27	31.44	571.90
7 Sep 2020	8:00:00 PM	0.00	27.41	31.45	586.40
7 Sep 2020	9:00:00 PM	0.00	27.50	31.53	589.00
7 Sep 2020	10:00:00 PM	0.00	27.57	31.47	585.00
7 Sep 2020	11:00:00 PM	0.00	27.62	31.50	595.50
8 Sep 2020	12:00:00 AM	0.00	27.66	31.51	593.20
8 Sep 2020	1:00:00 AM	0.00	27.69	31.49	586.20
8 Sep 2020	2:00:00 AM	0.00	27.71	31.52	596.20
8 Sep 2020	3:00:00 AM	0.00	27.73	31.51	594.10
8 Sep 2020	4:00:00 AM	0.00	27.75	31.52	597.40
8 Sep 2020	5:00:00 AM	0.00	27.77	31.59	597.70
8 Sep 2020	6:00:00 AM	0.00	27.78	31.52	601.00
8 Sep 2020	7:00:00 AM	0.00	27.80	31.54	603.60
8 Sep 2020	8:00:00 AM	0.00	23.93	31.54	602.80
8 Sep 2020	9:00:00 AM	0.00	15.87	31.54	673.50
8 Sep 2020	10:00:00 AM	0.00	11.26	31.58	682.10
8 Sep 2020	11:00:00 AM	0.00	11.06	31.57	667.00
8 Sep 2020	12:00:00 PM	0.00	9.46	31.53	826.20
8 Sep 2020	1:00:00 PM	0.00	9.45	31.54	849.40
8 Sep 2020	2:00:00 PM	0.00	9.44	31.55	824.90
8 Sep 2020	3:00:00 PM	0.00	9.43	31.55	829.30
8 Sep 2020	4:00:00 PM	0.00	10.29	31.57	657.60
8 Sep 2020	5:00:00 PM	0.00	14.42	31.59	662.50
8 Sep 2020	6:00:00 PM	0.00	26.72	31.44	631.90
8 Sep 2020	7:00:00 PM	0.00	27.13	31.44	585.70
8 Sep 2020	8:00:00 PM	0.00	27.30	31.45	578.30
8 Sep 2020	9:00:00 PM	0.00	27.41	31.51	579.90
8 Sep 2020	10:00:00 PM	0.00	27.49	31.48	586.40
8 Sep 2020	11:00:00 PM	0.00	27.54	31.50	587.50
9 Sep 2020	12:00:00 AM	0.00	27.59	31.50	589.10
9 Sep 2020	1:00:00 AM	0.00	27.62	31.49	589.70
9 Sep 2020	2:00:00 AM	0.00	27.65	31.57	594.90
9 Sep 2020	3:00:00 AM	0.00	27.68	31.50	593.50
9 Sep 2020	4:00:00 AM	0.00	27.70	31.50	593.10
9 Sep 2020	5:00:00 AM	0.00	27.72	31.54	595.90
9 Sep 2020	6:00:00 AM	0.00	27.73	31.61	597.20
9 Sep 2020	7:00:00 AM	0.00	27.75	31.55	599.80
9 Sep 2020	8:00:00 AM	0.00	24.21	31.55	601.50
9 Sep 2020	9:00:00 AM	0.00	15.94	31.54	675.80
9 Sep 2020	10:00:00 AM	0.00	10.86	31.57	681.20
9 Sep 2020	11:00:00 AM	0.00	9.47	31.54	824.80
9 Sep 2020	12:00:00 PM	0.00	11.53	31.57	655.00
9 Sep 2020	1:00:00 PM	0.00	9.45	31.53	834.80
9 Sep 2020	2:00:00 PM	0.00	9.43	31.55	833.50
9 Sep 2020	3:00:00 PM	0.00	9.42	31.52	807.10
9 Sep 2020	4:00:00 PM	0.00	15.23	31.55	703.00
9 Sep 2020	5:00:00 PM	0.00	23.02	31.49	664.50
9 Sep 2020	6:00:00 PM	0.00	26.66	31.50	672.40
9 Sep 2020	7:00:00 PM	0.00	27.13	31.44	596.00
9 Sep 2020	8:00:00 PM	0.00	27.29	31.46	589.30
9 Sep 2020	9:00:00 PM	0.00	27.39	31.47	592.90
9 Sep 2020	10:00:00 PM	0.00	27.47	31.56	590.80
9 Sep 2020	11:00:00 PM	0.00	27.52	31.51	594.30
10 Sep 2020	12:00:00 AM	0.00	27.56	31.51	593.40
10 Sep 2020	1:00:00 AM	0.00	27.60	31.54	600.90
10 Sep 2020	2:00:00 AM	0.00	27.63	31.50	598.40
10 Sep 2020	3:00:00 AM	0.00	27.65	31.52	596.80
10 Sep 2020	4:00:00 AM	0.00	27.67	31.57	601.70
10 Sep 2020	5:00:00 AM	0.00	27.69	31.51	601.60
10 Sep 2020	6:00:00 AM	0.00	27.71	31.55	604.00
10 Sep 2020	7:00:00 AM	0.00	27.72	31.62	603.60
10 Sep 2020	8:00:00 AM	0.00	27.73	31.53	602.20
10 Sep 2020	9:00:00 AM	0.00	15.59	31.54	676.20
10 Sep 2020	10:00:00 AM	0.00	11.08	31.55	682.00
10 Sep 2020	11:00:00 AM	0.00	9.45	31.54	834.80
10 Sep 2020	12:00:00 PM	0.00	9.44	31.54	839.80
10 Sep 2020	1:00:00 PM	0.00	9.43	31.54	841.90
10 Sep 2020	2:00:00 PM	0.00	9.41	31.56	818.90
10 Sep 2020	3:00:00 PM	0.00	9.40	31.54	838.60
10 Sep 2020	4:00:00 PM	0.00	13.07	31.58	695.30
10 Sep 2020	5:00:00 PM	0.00	14.98	31.58	676.60
10 Sep 2020	6:00:00 PM	0.00	26.59	31.39	612.00
10 Sep 2020	7:00:00 PM	0.00	27.06	31.44	563.50
10 Sep 2020	8:00:00 PM	0.00	27.23	31.46	580.50
10 Sep 2020	9:00:00 PM	0.00	27.34	31.49	583.30
10 Sep 2020	10:00:00 PM	0.00	27.41	31.51	586.00
10 Sep 2020	11:00:00 PM	0.00	27.47	31.53	587.30

Nawoyatira Borehole Baralogger Data

NAWOYATIIRA BOREHOLE BARALOGGER RECORDS

Serial_number:	2072117	Level	Unit: psi
Project ID:	Lokichar Project	Temperature	Unit: °C
Location:	Nawoyatiira Borehole		

Date	Time	ms	Level	Temperature
12 Aug 2020	7:00:00 AM	0.00	30.06	31.88
12 Aug 2020	8:00:00 AM	0.00	30.08	31.87
12 Aug 2020	9:00:00 AM	0.00	21.02	31.91
12 Aug 2020	10:00:00 AM	0.00	20.17	31.88
12 Aug 2020	11:00:00 AM	0.00	16.93	31.89
12 Aug 2020	12:00:00 PM	0.00	17.89	31.88
12 Aug 2020	1:00:00 PM	0.00	29.71	31.79
12 Aug 2020	2:00:00 PM	0.00	15.82	31.89
12 Aug 2020	3:00:00 PM	0.00	13.43	31.99
12 Aug 2020	4:00:00 PM	0.00	13.43	31.98
12 Aug 2020	5:00:00 PM	0.00	13.43	31.98
12 Aug 2020	6:00:00 PM	0.00	28.75	31.84
12 Aug 2020	7:00:00 PM	0.00	29.42	31.78
12 Aug 2020	8:00:00 PM	0.00	29.64	31.76
12 Aug 2020	9:00:00 PM	0.00	29.77	31.79
12 Aug 2020	10:00:00 PM	0.00	29.86	31.84
12 Aug 2020	11:00:00 PM	0.00	29.92	31.85
13 Aug 2020	12:00:00 AM	0.00	29.97	31.86
13 Aug 2020	1:00:00 AM	0.00	30.01	31.87
13 Aug 2020	2:00:00 AM	0.00	30.04	31.89
13 Aug 2020	3:00:00 AM	0.00	30.07	31.89
13 Aug 2020	4:00:00 AM	0.00	30.09	31.89
13 Aug 2020	5:00:00 AM	0.00	30.11	31.90
13 Aug 2020	6:00:00 AM	0.00	30.13	31.91
13 Aug 2020	7:00:00 AM	0.00	30.14	31.91
13 Aug 2020	8:00:00 AM	0.00	30.16	31.91
13 Aug 2020	9:00:00 AM	0.00	22.63	31.91
13 Aug 2020	10:00:00 AM	0.00	13.47	32.01
13 Aug 2020	11:00:00 AM	0.00	13.47	31.99
13 Aug 2020	12:00:00 PM	0.00	13.48	32.02
13 Aug 2020	1:00:00 PM	0.00	13.46	32.04
13 Aug 2020	2:00:00 PM	0.00	13.43	32.00
13 Aug 2020	3:00:00 PM	0.00	14.17	31.93
13 Aug 2020	4:00:00 PM	0.00	13.39	31.90
13 Aug 2020	5:00:00 PM	0.00	13.39	31.97
13 Aug 2020	6:00:00 PM	0.00	28.62	31.84
13 Aug 2020	7:00:00 PM	0.00	29.27	31.78
13 Aug 2020	8:00:00 PM	0.00	29.51	31.78
13 Aug 2020	9:00:00 PM	0.00	29.66	31.81
13 Aug 2020	10:00:00 PM	0.00	29.76	31.83
13 Aug 2020	11:00:00 PM	0.00	29.84	31.84
14 Aug 2020	12:00:00 AM	0.00	29.90	31.85
14 Aug 2020	1:00:00 AM	0.00	29.94	31.88
14 Aug 2020	2:00:00 AM	0.00	29.98	31.88
14 Aug 2020	3:00:00 AM	0.00	30.01	31.88
14 Aug 2020	4:00:00 AM	0.00	30.04	31.90
14 Aug 2020	5:00:00 AM	0.00	30.06	31.90
14 Aug 2020	6:00:00 AM	0.00	30.08	31.90
14 Aug 2020	7:00:00 AM	0.00	30.10	31.91
14 Aug 2020	8:00:00 AM	0.00	30.12	31.91
14 Aug 2020	9:00:00 AM	0.00	15.92	31.91
14 Aug 2020	10:00:00 AM	0.00	13.45	31.99
14 Aug 2020	11:00:00 AM	0.00	14.93	31.93
14 Aug 2020	12:00:00 PM	0.00	13.43	31.97
14 Aug 2020	1:00:00 PM	0.00	13.41	32.00
14 Aug 2020	2:00:00 PM	0.00	13.39	31.89

Date	Time	ms	Level	Temperature
14 Aug 2020	3:00:00 PM	0.00	14.27	31.87
14 Aug 2020	4:00:00 PM	0.00	14.69	31.87
14 Aug 2020	5:00:00 PM	0.00	28.25	31.82
14 Aug 2020	6:00:00 PM	0.00	29.14	31.81
14 Aug 2020	7:00:00 PM	0.00	29.46	31.79
14 Aug 2020	8:00:00 PM	0.00	29.62	31.80
14 Aug 2020	9:00:00 PM	0.00	29.73	31.81
14 Aug 2020	10:00:00 PM	0.00	29.81	31.83
14 Aug 2020	11:00:00 PM	0.00	29.87	31.85
15 Aug 2020	12:00:00 AM	0.00	29.92	31.85
15 Aug 2020	1:00:00 AM	0.00	29.95	31.85
15 Aug 2020	2:00:00 AM	0.00	29.99	31.85
15 Aug 2020	3:00:00 AM	0.00	30.01	31.86
15 Aug 2020	4:00:00 AM	0.00	30.04	31.86
15 Aug 2020	5:00:00 AM	0.00	30.06	31.86
15 Aug 2020	6:00:00 AM	0.00	30.08	31.87
15 Aug 2020	7:00:00 AM	0.00	30.10	31.87
15 Aug 2020	8:00:00 AM	0.00	30.11	31.88
15 Aug 2020	9:00:00 AM	0.00	21.10	31.90
15 Aug 2020	10:00:00 AM	0.00	13.43	31.90
15 Aug 2020	11:00:00 AM	0.00	13.42	32.01
15 Aug 2020	12:00:00 PM	0.00	13.41	32.00
15 Aug 2020	1:00:00 PM	0.00	13.40	31.98
15 Aug 2020	2:00:00 PM	0.00	13.38	31.97
15 Aug 2020	3:00:00 PM	0.00	13.38	31.99
15 Aug 2020	4:00:00 PM	0.00	13.37	31.98
15 Aug 2020	5:00:00 PM	0.00	17.68	31.87
15 Aug 2020	6:00:00 PM	0.00	28.45	31.83
15 Aug 2020	7:00:00 PM	0.00	29.32	31.78
15 Aug 2020	8:00:00 PM	0.00	29.53	31.77
15 Aug 2020	9:00:00 PM	0.00	29.67	31.79
15 Aug 2020	10:00:00 PM	0.00	29.76	31.83
15 Aug 2020	11:00:00 PM	0.00	29.83	31.86
16 Aug 2020	12:00:00 AM	0.00	29.89	31.83
16 Aug 2020	1:00:00 AM	0.00	29.93	31.86
16 Aug 2020	2:00:00 AM	0.00	29.97	31.85
16 Aug 2020	3:00:00 AM	0.00	30.00	31.85
16 Aug 2020	4:00:00 AM	0.00	30.02	31.86
16 Aug 2020	5:00:00 AM	0.00	30.04	31.87
16 Aug 2020	6:00:00 AM	0.00	30.06	31.86
16 Aug 2020	7:00:00 AM	0.00	30.08	31.88
16 Aug 2020	8:00:00 AM	0.00	30.10	31.88
16 Aug 2020	9:00:00 AM	0.00	14.76	31.88
16 Aug 2020	10:00:00 AM	0.00	13.44	31.99
16 Aug 2020	11:00:00 AM	0.00	13.43	32.00
16 Aug 2020	12:00:00 PM	0.00	13.42	32.01
16 Aug 2020	1:00:00 PM	0.00	13.42	32.01
16 Aug 2020	2:00:00 PM	0.00	13.39	31.99
16 Aug 2020	3:00:00 PM	0.00	13.39	31.99
16 Aug 2020	4:00:00 PM	0.00	13.37	31.98
16 Aug 2020	5:00:00 PM	0.00	13.36	31.97
16 Aug 2020	6:00:00 PM	0.00	28.33	31.84
16 Aug 2020	7:00:00 PM	0.00	29.17	31.78
16 Aug 2020	8:00:00 PM	0.00	29.41	31.78
16 Aug 2020	9:00:00 PM	0.00	29.57	31.81
16 Aug 2020	10:00:00 PM	0.00	29.68	31.80

Date	Time	ms	Level	Temperature
16 Aug 2020	11:00:00 PM	0.00	29.76	31.83
17 Aug 2020	12:00:00 AM	0.00	29.83	31.86
17 Aug 2020	1:00:00 AM	0.00	29.88	31.86
17 Aug 2020	2:00:00 AM	0.00	29.92	31.86
17 Aug 2020	3:00:00 AM	0.00	29.96	31.88
17 Aug 2020	4:00:00 AM	0.00	29.98	31.87
17 Aug 2020	5:00:00 AM	0.00	30.01	31.88
17 Aug 2020	6:00:00 AM	0.00	30.03	31.90
17 Aug 2020	7:00:00 AM	0.00	30.05	31.90
17 Aug 2020	8:00:00 AM	0.00	30.07	31.88
17 Aug 2020	9:00:00 AM	0.00	16.44	31.91
17 Aug 2020	10:00:00 AM	0.00	13.43	32.00
17 Aug 2020	11:00:00 AM	0.00	13.44	32.03
17 Aug 2020	12:00:00 PM	0.00	13.44	32.04
17 Aug 2020	1:00:00 PM	0.00	13.41	32.01
17 Aug 2020	2:00:00 PM	0.00	13.39	32.00
17 Aug 2020	3:00:00 PM	0.00	13.38	31.99
17 Aug 2020	4:00:00 PM	0.00	13.37	31.98
17 Aug 2020	5:00:00 PM	0.00	13.84	31.93
17 Aug 2020	6:00:00 PM	0.00	28.61	31.83
17 Aug 2020	7:00:00 PM	0.00	29.17	31.78
17 Aug 2020	8:00:00 PM	0.00	29.40	31.79
17 Aug 2020	9:00:00 PM	0.00	29.56	31.81
17 Aug 2020	10:00:00 PM	0.00	29.67	31.83
17 Aug 2020	11:00:00 PM	0.00	29.75	31.85
18 Aug 2020	12:00:00 AM	0.00	29.81	31.86
18 Aug 2020	1:00:00 AM	0.00	29.86	31.86
18 Aug 2020	2:00:00 AM	0.00	29.90	31.88
18 Aug 2020	3:00:00 AM	0.00	29.94	31.89
18 Aug 2020	4:00:00 AM	0.00	29.97	31.89
18 Aug 2020	5:00:00 AM	0.00	29.99	31.89
18 Aug 2020	6:00:00 AM	0.00	30.02	31.90
18 Aug 2020	7:00:00 AM	0.00	30.04	31.91
18 Aug 2020	8:00:00 AM	0.00	30.06	31.91
18 Aug 2020	9:00:00 AM	0.00	15.34	31.90
18 Aug 2020	10:00:00 AM	0.00	13.46	32.00
18 Aug 2020	11:00:00 AM	0.00	13.45	32.00
18 Aug 2020	12:00:00 PM	0.00	13.44	31.97
18 Aug 2020	1:00:00 PM	0.00	13.43	31.94
18 Aug 2020	2:00:00 PM	0.00	13.41	32.08
18 Aug 2020	3:00:00 PM	0.00	13.40	31.98
18 Aug 2020	4:00:00 PM	0.00	15.49	31.87
18 Aug 2020	5:00:00 PM	0.00	17.45	31.86
18 Aug 2020	6:00:00 PM	0.00	29.07	31.80
18 Aug 2020	7:00:00 PM	0.00	29.39	31.78
18 Aug 2020	8:00:00 PM	0.00	29.56	31.78
18 Aug 2020	9:00:00 PM	0.00	29.67	31.82
18 Aug 2020	10:00:00 PM	0.00	29.75	31.84
18 Aug 2020	11:00:00 PM	0.00	29.82	31.83
19 Aug 2020	12:00:00 AM	0.00	29.86	31.85
19 Aug 2020	1:00:00 AM	0.00	29.90	31.85
19 Aug 2020	2:00:00 AM	0.00	29.94	31.85
19 Aug 2020	3:00:00 AM	0.00	29.97	31.86
19 Aug 2020	4:00:00 AM	0.00	29.99	31.85
19 Aug 2020	5:00:00 AM	0.00	30.01	31.86
19 Aug 2020	6:00:00 AM	0.00	30.03	31.87
19 Aug 2020	7:00:00 AM	0.00	30.05	31.87
19 Aug 2020	8:00:00 AM	0.00	30.06	31.90
19 Aug 2020	9:00:00 AM	0.00	17.29	31.92
19 Aug 2020	10:00:00 AM	0.00	13.43	31.99
19 Aug 2020	11:00:00 AM	0.00	13.42	31.96
19 Aug 2020	12:00:00 PM	0.00	13.42	32.00
19 Aug 2020	1:00:00 PM	0.00	13.40	32.02

Date	Time	ms	Level	Temperature
19 Aug 2020	2:00:00 PM	0.00	13.38	31.98
19 Aug 2020	3:00:00 PM	0.00	13.37	32.02
19 Aug 2020	4:00:00 PM	0.00	13.35	31.99
19 Aug 2020	5:00:00 PM	0.00	17.38	31.85
19 Aug 2020	6:00:00 PM	0.00	28.79	31.80
19 Aug 2020	7:00:00 PM	0.00	29.28	31.77
19 Aug 2020	8:00:00 PM	0.00	29.47	31.78
19 Aug 2020	9:00:00 PM	0.00	29.60	31.81
19 Aug 2020	10:00:00 PM	0.00	29.69	31.81
19 Aug 2020	11:00:00 PM	0.00	29.76	31.83
20 Aug 2020	12:00:00 AM	0.00	29.81	31.86
20 Aug 2020	1:00:00 AM	0.00	29.86	31.85
20 Aug 2020	2:00:00 AM	0.00	29.89	31.83
20 Aug 2020	3:00:00 AM	0.00	29.92	31.86
20 Aug 2020	4:00:00 AM	0.00	29.95	31.86
20 Aug 2020	5:00:00 AM	0.00	29.97	31.86
20 Aug 2020	6:00:00 AM	0.00	30.00	31.86
20 Aug 2020	7:00:00 AM	0.00	30.01	31.89
20 Aug 2020	8:00:00 AM	0.00	30.03	31.88
20 Aug 2020	9:00:00 AM	0.00	14.77	31.89
20 Aug 2020	10:00:00 AM	0.00	13.42	31.96
20 Aug 2020	11:00:00 AM	0.00	13.42	32.02
20 Aug 2020	12:00:00 PM	0.00	13.41	32.03
20 Aug 2020	1:00:00 PM	0.00	13.39	32.04
20 Aug 2020	2:00:00 PM	0.00	13.39	32.01
20 Aug 2020	3:00:00 PM	0.00	13.36	32.00
20 Aug 2020	4:00:00 PM	0.00	13.35	31.99
20 Aug 2020	5:00:00 PM	0.00	22.97	31.88
20 Aug 2020	6:00:00 PM	0.00	28.70	31.80
20 Aug 2020	7:00:00 PM	0.00	29.26	31.77
20 Aug 2020	8:00:00 PM	0.00	29.46	31.78
20 Aug 2020	9:00:00 PM	0.00	29.58	31.78
20 Aug 2020	10:00:00 PM	0.00	29.67	31.82
20 Aug 2020	11:00:00 PM	0.00	29.74	31.86
21 Aug 2020	12:00:00 AM	0.00	29.80	31.82
21 Aug 2020	1:00:00 AM	0.00	29.84	31.84
21 Aug 2020	2:00:00 AM	0.00	29.88	31.86
21 Aug 2020	3:00:00 AM	0.00	29.91	31.86
21 Aug 2020	4:00:00 AM	0.00	29.94	31.86
21 Aug 2020	5:00:00 AM	0.00	29.97	31.87
21 Aug 2020	6:00:00 AM	0.00	29.99	31.87
21 Aug 2020	7:00:00 AM	0.00	30.01	31.87
21 Aug 2020	8:00:00 AM	0.00	30.03	31.87
21 Aug 2020	9:00:00 AM	0.00	13.99	31.89
21 Aug 2020	10:00:00 AM	0.00	13.44	32.00
21 Aug 2020	11:00:00 AM	0.00	13.44	32.02
21 Aug 2020	12:00:00 PM	0.00	13.45	32.03
21 Aug 2020	1:00:00 PM	0.00	13.42	31.98
21 Aug 2020	2:00:00 PM	0.00	13.41	32.00
21 Aug 2020	3:00:00 PM	0.00	13.39	31.94
21 Aug 2020	4:00:00 PM	0.00	13.38	31.99
21 Aug 2020	5:00:00 PM	0.00	17.06	31.85
21 Aug 2020	6:00:00 PM	0.00	27.48	31.85
21 Aug 2020	7:00:00 PM	0.00	29.22	31.78
21 Aug 2020	8:00:00 PM	0.00	29.43	31.79
21 Aug 2020	9:00:00 PM	0.00	29.56	31.79
21 Aug 2020	10:00:00 PM	0.00	29.66	31.82
21 Aug 2020	11:00:00 PM	0.00	29.73	31.85
22 Aug 2020	12:00:00 AM	0.00	29.78	31.84
22 Aug 2020	1:00:00 AM	0.00	29.83	31.84
22 Aug 2020	2:00:00 AM	0.00	29.86	31.85
22 Aug 2020	3:00:00 AM	0.00	29.90	31.85
22 Aug 2020	4:00:00 AM	0.00	29.92	31.85

Date	Time	ms	Level	Temperature
22 Aug 2020	5:00:00 AM	0.00	29.95	31.86
22 Aug 2020	6:00:00 AM	0.00	29.97	31.87
22 Aug 2020	7:00:00 AM	0.00	29.99	31.90
22 Aug 2020	8:00:00 AM	0.00	30.01	31.87
22 Aug 2020	9:00:00 AM	0.00	14.80	31.88
22 Aug 2020	10:00:00 AM	0.00	13.45	32.00
22 Aug 2020	11:00:00 AM	0.00	13.45	32.03
22 Aug 2020	12:00:00 PM	0.00	13.44	32.03
22 Aug 2020	1:00:00 PM	0.00	13.42	31.99
22 Aug 2020	2:00:00 PM	0.00	13.42	32.01
22 Aug 2020	3:00:00 PM	0.00	13.39	31.99
22 Aug 2020	4:00:00 PM	0.00	13.37	32.01
22 Aug 2020	5:00:00 PM	0.00	13.37	31.96
22 Aug 2020	6:00:00 PM	0.00	28.38	31.83
22 Aug 2020	7:00:00 PM	0.00	29.07	31.73
22 Aug 2020	8:00:00 PM	0.00	29.32	31.77
22 Aug 2020	9:00:00 PM	0.00	29.47	31.77
22 Aug 2020	10:00:00 PM	0.00	29.58	31.82
22 Aug 2020	11:00:00 PM	0.00	29.66	31.84
23 Aug 2020	12:00:00 AM	0.00	29.72	31.83
23 Aug 2020	1:00:00 AM	0.00	29.77	31.83
23 Aug 2020	2:00:00 AM	0.00	29.81	31.84
23 Aug 2020	3:00:00 AM	0.00	29.85	31.86
23 Aug 2020	4:00:00 AM	0.00	29.88	31.86
23 Aug 2020	5:00:00 AM	0.00	29.91	31.88
23 Aug 2020	6:00:00 AM	0.00	29.93	31.87
23 Aug 2020	7:00:00 AM	0.00	29.95	31.86
23 Aug 2020	8:00:00 AM	0.00	29.97	31.89
23 Aug 2020	9:00:00 AM	0.00	14.76	31.88
23 Aug 2020	10:00:00 AM	0.00	13.43	31.99
23 Aug 2020	11:00:00 AM	0.00	13.43	32.03
23 Aug 2020	12:00:00 PM	0.00	13.42	32.00
23 Aug 2020	1:00:00 PM	0.00	13.41	32.00
23 Aug 2020	2:00:00 PM	0.00	13.39	32.00
23 Aug 2020	3:00:00 PM	0.00	13.37	31.96
23 Aug 2020	4:00:00 PM	0.00	13.37	31.97
23 Aug 2020	5:00:00 PM	0.00	13.36	31.95
23 Aug 2020	6:00:00 PM	0.00	28.40	31.83
23 Aug 2020	7:00:00 PM	0.00	29.05	31.78
23 Aug 2020	8:00:00 PM	0.00	29.30	31.77
23 Aug 2020	9:00:00 PM	0.00	29.45	31.80
23 Aug 2020	10:00:00 PM	0.00	29.56	31.82
23 Aug 2020	11:00:00 PM	0.00	29.64	31.84
24 Aug 2020	12:00:00 AM	0.00	29.70	31.85
24 Aug 2020	1:00:00 AM	0.00	29.75	31.86
24 Aug 2020	2:00:00 AM	0.00	29.79	31.87
24 Aug 2020	3:00:00 AM	0.00	29.83	31.88
24 Aug 2020	4:00:00 AM	0.00	29.86	31.88
24 Aug 2020	5:00:00 AM	0.00	29.88	31.88
24 Aug 2020	6:00:00 AM	0.00	29.91	31.90
24 Aug 2020	7:00:00 AM	0.00	29.93	31.90
24 Aug 2020	8:00:00 AM	0.00	29.95	31.90
24 Aug 2020	9:00:00 AM	0.00	18.99	31.90
24 Aug 2020	10:00:00 AM	0.00	13.44	31.99
24 Aug 2020	11:00:00 AM	0.00	13.44	32.03
24 Aug 2020	12:00:00 PM	0.00	13.43	32.02
24 Aug 2020	1:00:00 PM	0.00	13.41	31.98
24 Aug 2020	2:00:00 PM	0.00	13.40	32.01
24 Aug 2020	3:00:00 PM	0.00	13.38	31.91
24 Aug 2020	4:00:00 PM	0.00	13.38	32.00
24 Aug 2020	5:00:00 PM	0.00	25.66	31.84
24 Aug 2020	6:00:00 PM	0.00	28.65	31.78
24 Aug 2020	7:00:00 PM	0.00	29.12	31.76

Date	Time	ms	Level	Temperature
24 Aug 2020	8:00:00 PM	0.00	29.33	31.76
24 Aug 2020	9:00:00 PM	0.00	29.47	31.78
24 Aug 2020	10:00:00 PM	0.00	29.57	31.83
24 Aug 2020	11:00:00 PM	0.00	29.64	31.81
25 Aug 2020	12:00:00 AM	0.00	29.70	31.84
25 Aug 2020	1:00:00 AM	0.00	29.75	31.87
25 Aug 2020	2:00:00 AM	0.00	29.79	31.85
25 Aug 2020	3:00:00 AM	0.00	29.82	31.85
25 Aug 2020	4:00:00 AM	0.00	29.85	31.86
25 Aug 2020	5:00:00 AM	0.00	29.88	31.86
25 Aug 2020	6:00:00 AM	0.00	29.90	31.85
25 Aug 2020	7:00:00 AM	0.00	29.92	31.88
25 Aug 2020	8:00:00 AM	0.00	29.94	31.91
25 Aug 2020	9:00:00 AM	0.00	14.34	31.91
25 Aug 2020	10:00:00 AM	0.00	13.47	32.01
25 Aug 2020	11:00:00 AM	0.00	13.46	32.02
25 Aug 2020	12:00:00 PM	0.00	13.47	32.00
25 Aug 2020	1:00:00 PM	0.00	13.45	32.00
25 Aug 2020	2:00:00 PM	0.00	13.43	32.00
25 Aug 2020	3:00:00 PM	0.00	13.40	31.98
25 Aug 2020	4:00:00 PM	0.00	22.49	31.85
25 Aug 2020	5:00:00 PM	0.00	16.36	31.87
25 Aug 2020	6:00:00 PM	0.00	28.79	31.77
25 Aug 2020	7:00:00 PM	0.00	29.21	31.77
25 Aug 2020	8:00:00 PM	0.00	29.39	31.78
25 Aug 2020	9:00:00 PM	0.00	29.52	31.78
25 Aug 2020	10:00:00 PM	0.00	29.60	31.79
25 Aug 2020	11:00:00 PM	0.00	29.67	31.83
26 Aug 2020	12:00:00 AM	0.00	29.72	31.83
26 Aug 2020	1:00:00 AM	0.00	29.77	31.84
26 Aug 2020	2:00:00 AM	0.00	29.80	31.87
26 Aug 2020	3:00:00 AM	0.00	29.83	31.85
26 Aug 2020	4:00:00 AM	0.00	29.86	31.85
26 Aug 2020	5:00:00 AM	0.00	29.88	31.88
26 Aug 2020	6:00:00 AM	0.00	29.90	31.86
26 Aug 2020	7:00:00 AM	0.00	29.92	31.86
26 Aug 2020	8:00:00 AM	0.00	29.94	31.87
26 Aug 2020	9:00:00 AM	0.00	13.93	31.91
26 Aug 2020	10:00:00 AM	0.00	13.47	32.00
26 Aug 2020	11:00:00 AM	0.00	13.47	32.03
26 Aug 2020	12:00:00 PM	0.00	13.47	32.02
26 Aug 2020	1:00:00 PM	0.00	13.44	32.01
26 Aug 2020	2:00:00 PM	0.00	15.42	31.92
26 Aug 2020	3:00:00 PM	0.00	13.41	31.97
26 Aug 2020	4:00:00 PM	0.00	13.40	31.98
26 Aug 2020	5:00:00 PM	0.00	13.40	31.96
26 Aug 2020	6:00:00 PM	0.00	28.30	31.82
26 Aug 2020	7:00:00 PM	0.00	28.97	31.73
26 Aug 2020	8:00:00 PM	0.00	29.23	31.75
26 Aug 2020	9:00:00 PM	0.00	29.39	31.80
26 Aug 2020	10:00:00 PM	0.00	29.50	31.83
26 Aug 2020	11:00:00 PM	0.00	29.58	31.81
27 Aug 2020	12:00:00 AM	0.00	29.64	31.84
27 Aug 2020	1:00:00 AM	0.00	29.69	31.84
27 Aug 2020	2:00:00 AM	0.00	29.74	31.84
27 Aug 2020	3:00:00 AM	0.00	29.77	31.84
27 Aug 2020	4:00:00 AM	0.00	29.80	31.85
27 Aug 2020	5:00:00 AM	0.00	29.83	31.85
27 Aug 2020	6:00:00 AM	0.00	29.85	31.86
27 Aug 2020	7:00:00 AM	0.00	29.87	31.86
27 Aug 2020	8:00:00 AM	0.00	29.89	31.86
27 Aug 2020	9:00:00 AM	0.00	14.56	31.91
27 Aug 2020	10:00:00 AM	0.00	13.46	32.00

Date	Time	ms	Level	Temperature
27 Aug 2020	11:00:00 AM	0.00	13.47	32.02
27 Aug 2020	12:00:00 PM	0.00	13.44	32.00
27 Aug 2020	1:00:00 PM	0.00	13.43	32.03
27 Aug 2020	2:00:00 PM	0.00	13.41	31.99
27 Aug 2020	3:00:00 PM	0.00	16.26	31.89
27 Aug 2020	4:00:00 PM	0.00	13.38	31.98
27 Aug 2020	5:00:00 PM	0.00	26.97	31.81
27 Aug 2020	6:00:00 PM	0.00	28.69	31.78
27 Aug 2020	7:00:00 PM	0.00	29.11	31.77
27 Aug 2020	8:00:00 PM	0.00	29.30	31.77
27 Aug 2020	9:00:00 PM	0.00	29.43	31.78
27 Aug 2020	10:00:00 PM	0.00	29.52	31.80
27 Aug 2020	11:00:00 PM	0.00	29.59	31.85
28 Aug 2020	12:00:00 AM	0.00	29.64	31.85
28 Aug 2020	1:00:00 AM	0.00	29.69	31.84
28 Aug 2020	2:00:00 AM	0.00	29.72	31.85
28 Aug 2020	3:00:00 AM	0.00	29.75	31.85
28 Aug 2020	4:00:00 AM	0.00	29.78	31.85
28 Aug 2020	5:00:00 AM	0.00	29.80	31.85
28 Aug 2020	6:00:00 AM	0.00	29.82	31.86
28 Aug 2020	7:00:00 AM	0.00	29.84	31.86
28 Aug 2020	8:00:00 AM	0.00	29.86	31.86
28 Aug 2020	9:00:00 AM	0.00	14.21	31.91
28 Aug 2020	10:00:00 AM	0.00	13.44	31.99
28 Aug 2020	11:00:00 AM	0.00	13.45	32.01
28 Aug 2020	12:00:00 PM	0.00	13.43	32.03
28 Aug 2020	1:00:00 PM	0.00	13.40	32.01
28 Aug 2020	2:00:00 PM	0.00	13.38	31.98
28 Aug 2020	3:00:00 PM	0.00	13.37	32.01
28 Aug 2020	4:00:00 PM	0.00	13.35	31.91
28 Aug 2020	5:00:00 PM	0.00	13.35	31.95
28 Aug 2020	6:00:00 PM	0.00	28.25	31.83
28 Aug 2020	7:00:00 PM	0.00	28.92	31.78
28 Aug 2020	8:00:00 PM	0.00	29.16	31.77
28 Aug 2020	9:00:00 PM	0.00	29.32	31.79
28 Aug 2020	10:00:00 PM	0.00	29.42	31.82
28 Aug 2020	11:00:00 PM	0.00	29.50	31.84
29 Aug 2020	12:00:00 AM	0.00	29.57	31.85
29 Aug 2020	1:00:00 AM	0.00	29.62	31.86
29 Aug 2020	2:00:00 AM	0.00	29.66	31.86
29 Aug 2020	3:00:00 AM	0.00	29.70	31.87
29 Aug 2020	4:00:00 AM	0.00	29.72	31.88
29 Aug 2020	5:00:00 AM	0.00	29.75	31.89
29 Aug 2020	6:00:00 AM	0.00	29.77	31.89
29 Aug 2020	7:00:00 AM	0.00	29.79	31.89
29 Aug 2020	8:00:00 AM	0.00	29.81	31.90
29 Aug 2020	9:00:00 AM	0.00	14.11	31.92
29 Aug 2020	10:00:00 AM	0.00	13.43	32.00
29 Aug 2020	11:00:00 AM	0.00	13.44	32.01
29 Aug 2020	12:00:00 PM	0.00	13.43	32.02
29 Aug 2020	1:00:00 PM	0.00	13.41	32.02
29 Aug 2020	2:00:00 PM	0.00	13.39	31.98
29 Aug 2020	3:00:00 PM	0.00	13.37	32.01
29 Aug 2020	4:00:00 PM	0.00	13.35	31.92
29 Aug 2020	5:00:00 PM	0.00	13.36	31.95
29 Aug 2020	6:00:00 PM	0.00	27.82	31.82
29 Aug 2020	7:00:00 PM	0.00	28.82	31.72
29 Aug 2020	8:00:00 PM	0.00	29.09	31.77
29 Aug 2020	9:00:00 PM	0.00	29.26	31.77
29 Aug 2020	10:00:00 PM	0.00	29.37	31.81
29 Aug 2020	11:00:00 PM	0.00	29.46	31.81
30 Aug 2020	12:00:00 AM	0.00	29.53	31.82
30 Aug 2020	1:00:00 AM	0.00	29.58	31.82

Date	Time	ms	Level	Temperature
30 Aug 2020	2:00:00 AM	0.00	29.62	31.83
30 Aug 2020	3:00:00 AM	0.00	29.66	31.84
30 Aug 2020	4:00:00 AM	0.00	29.69	31.84
30 Aug 2020	5:00:00 AM	0.00	29.72	31.84
30 Aug 2020	6:00:00 AM	0.00	29.75	31.86
30 Aug 2020	7:00:00 AM	0.00	29.77	31.86
30 Aug 2020	8:00:00 AM	0.00	24.38	31.86
30 Aug 2020	9:00:00 AM	0.00	16.80	31.90
30 Aug 2020	10:00:00 AM	0.00	13.46	31.98
30 Aug 2020	11:00:00 AM	0.00	13.45	32.02
30 Aug 2020	12:00:00 PM	0.00	13.45	32.00
30 Aug 2020	1:00:00 PM	0.00	13.43	32.01
30 Aug 2020	2:00:00 PM	0.00	13.41	31.95
30 Aug 2020	3:00:00 PM	0.00	13.39	31.99
30 Aug 2020	4:00:00 PM	0.00	16.58	31.88
30 Aug 2020	5:00:00 PM	0.00	14.20	31.94
30 Aug 2020	6:00:00 PM	0.00	28.50	31.79
30 Aug 2020	7:00:00 PM	0.00	29.04	31.77
30 Aug 2020	8:00:00 PM	0.00	29.24	31.77
30 Aug 2020	9:00:00 PM	0.00	29.37	31.78
30 Aug 2020	10:00:00 PM	0.00	29.46	31.82
30 Aug 2020	11:00:00 PM	0.00	29.53	31.84
31 Aug 2020	12:00:00 AM	0.00	29.58	31.83
31 Aug 2020	1:00:00 AM	0.00	29.63	31.84
31 Aug 2020	2:00:00 AM	0.00	29.66	31.84
31 Aug 2020	3:00:00 AM	0.00	29.70	31.83
31 Aug 2020	4:00:00 AM	0.00	29.72	31.85
31 Aug 2020	5:00:00 AM	0.00	29.74	31.85
31 Aug 2020	6:00:00 AM	0.00	29.76	31.86
31 Aug 2020	7:00:00 AM	0.00	29.78	31.85
31 Aug 2020	8:00:00 AM	0.00	21.64	31.88
31 Aug 2020	9:00:00 AM	0.00	21.55	31.87
31 Aug 2020	10:00:00 AM	0.00	13.47	32.00
31 Aug 2020	11:00:00 AM	0.00	13.46	31.91
31 Aug 2020	12:00:00 PM	0.00	13.45	32.02
31 Aug 2020	1:00:00 PM	0.00	13.44	32.00
31 Aug 2020	2:00:00 PM	0.00	13.42	32.00
31 Aug 2020	3:00:00 PM	0.00	13.39	31.96
31 Aug 2020	4:00:00 PM	0.00	14.27	31.89
31 Aug 2020	5:00:00 PM	0.00	27.79	31.77
31 Aug 2020	6:00:00 PM	0.00	28.63	31.78
31 Aug 2020	7:00:00 PM	0.00	29.08	31.76
31 Aug 2020	8:00:00 PM	0.00	29.26	31.77
31 Aug 2020	9:00:00 PM	0.00	29.39	31.79
31 Aug 2020	10:00:00 PM	0.00	29.47	31.81
31 Aug 2020	11:00:00 PM	0.00	29.54	31.84
1 Sep 2020	12:00:00 AM	0.00	29.59	31.86
1 Sep 2020	1:00:00 AM	0.00	29.63	31.84
1 Sep 2020	2:00:00 AM	0.00	29.67	31.84
1 Sep 2020	3:00:00 AM	0.00	29.70	31.84
1 Sep 2020	4:00:00 AM	0.00	29.72	31.84
1 Sep 2020	5:00:00 AM	0.00	29.74	31.87
1 Sep 2020	6:00:00 AM	0.00	29.76	31.90
1 Sep 2020	7:00:00 AM	0.00	29.78	31.86
1 Sep 2020	8:00:00 AM	0.00	29.80	31.87
1 Sep 2020	9:00:00 AM	0.00	13.45	31.94
1 Sep 2020	10:00:00 AM	0.00	13.46	32.00
1 Sep 2020	11:00:00 AM	0.00	13.46	32.00
1 Sep 2020	12:00:00 PM	0.00	13.45	31.91
1 Sep 2020	1:00:00 PM	0.00	13.43	32.02
1 Sep 2020	2:00:00 PM	0.00	13.42	32.13
1 Sep 2020	3:00:00 PM	0.00	15.86	31.85
1 Sep 2020	4:00:00 PM	0.00	15.55	31.88

Date	Time	ms	Level	Temperature
1 Sep 2020	5:00:00 PM	0.00	17.27	31.86
1 Sep 2020	6:00:00 PM	0.00	28.48	31.75
1 Sep 2020	7:00:00 PM	0.00	28.96	31.75
1 Sep 2020	8:00:00 PM	0.00	29.17	31.76
1 Sep 2020	9:00:00 PM	0.00	29.30	31.78
1 Sep 2020	10:00:00 PM	0.00	29.40	31.83
1 Sep 2020	11:00:00 PM	0.00	29.47	31.80
2 Sep 2020	12:00:00 AM	0.00	29.52	31.83
2 Sep 2020	1:00:00 AM	0.00	29.57	31.87
2 Sep 2020	2:00:00 AM	0.00	29.61	31.84
2 Sep 2020	3:00:00 AM	0.00	29.64	31.85
2 Sep 2020	4:00:00 AM	0.00	29.67	31.86
2 Sep 2020	5:00:00 AM	0.00	29.69	31.88
2 Sep 2020	6:00:00 AM	0.00	29.71	31.87
2 Sep 2020	7:00:00 AM	0.00	29.73	31.86
2 Sep 2020	8:00:00 AM	0.00	29.75	31.86
2 Sep 2020	9:00:00 AM	0.00	16.85	31.88
2 Sep 2020	10:00:00 AM	0.00	13.44	31.99
2 Sep 2020	11:00:00 AM	0.00	13.46	32.11
2 Sep 2020	12:00:00 PM	0.00	13.45	32.09
2 Sep 2020	1:00:00 PM	0.00	13.43	32.12
2 Sep 2020	2:00:00 PM	0.00	13.41	32.08
2 Sep 2020	3:00:00 PM	0.00	13.39	32.08
2 Sep 2020	4:00:00 PM	0.00	17.77	31.84
2 Sep 2020	5:00:00 PM	0.00	13.37	31.96
2 Sep 2020	6:00:00 PM	0.00	28.20	31.82
2 Sep 2020	7:00:00 PM	0.00	28.85	31.77
2 Sep 2020	8:00:00 PM	0.00	29.08	31.77
2 Sep 2020	9:00:00 PM	0.00	29.23	31.78
2 Sep 2020	10:00:00 PM	0.00	29.33	31.81
2 Sep 2020	11:00:00 PM	0.00	29.41	31.84
3 Sep 2020	12:00:00 AM	0.00	29.47	31.84
3 Sep 2020	1:00:00 AM	0.00	29.53	31.83
3 Sep 2020	2:00:00 AM	0.00	29.57	31.83
3 Sep 2020	3:00:00 AM	0.00	29.60	31.85
3 Sep 2020	4:00:00 AM	0.00	29.63	31.85
3 Sep 2020	5:00:00 AM	0.00	29.66	31.85
3 Sep 2020	6:00:00 AM	0.00	29.68	31.88
3 Sep 2020	7:00:00 AM	0.00	29.70	31.90
3 Sep 2020	8:00:00 AM	0.00	29.72	31.87
3 Sep 2020	9:00:00 AM	0.00	13.46	31.91
3 Sep 2020	10:00:00 AM	0.00	13.46	31.99
3 Sep 2020	11:00:00 AM	0.00	13.47	32.02
3 Sep 2020	12:00:00 PM	0.00	13.46	32.08
3 Sep 2020	1:00:00 PM	0.00	13.45	32.14
3 Sep 2020	2:00:00 PM	0.00	13.43	32.16
3 Sep 2020	3:00:00 PM	0.00	13.42	32.15
3 Sep 2020	4:00:00 PM	0.00	13.41	32.00
3 Sep 2020	5:00:00 PM	0.00	13.41	31.98
3 Sep 2020	6:00:00 PM	0.00	28.06	31.82
3 Sep 2020	7:00:00 PM	0.00	28.75	31.73
3 Sep 2020	8:00:00 PM	0.00	29.00	31.78
3 Sep 2020	9:00:00 PM	0.00	29.17	31.80
3 Sep 2020	10:00:00 PM	0.00	29.28	31.82
3 Sep 2020	11:00:00 PM	0.00	29.36	31.83
4 Sep 2020	12:00:00 AM	0.00	29.43	31.84
4 Sep 2020	1:00:00 AM	0.00	29.48	31.85
4 Sep 2020	2:00:00 AM	0.00	29.52	31.86
4 Sep 2020	3:00:00 AM	0.00	29.56	31.87
4 Sep 2020	4:00:00 AM	0.00	29.59	31.88
4 Sep 2020	5:00:00 AM	0.00	29.62	31.88
4 Sep 2020	6:00:00 AM	0.00	29.64	31.88
4 Sep 2020	7:00:00 AM	0.00	29.67	31.89

Date	Time	ms	Level	Temperature
4 Sep 2020	8:00:00 AM	0.00	29.69	31.90
4 Sep 2020	9:00:00 AM	0.00	13.46	31.92
4 Sep 2020	10:00:00 AM	0.00	13.47	31.99
4 Sep 2020	11:00:00 AM	0.00	13.46	32.04
4 Sep 2020	12:00:00 PM	0.00	13.46	32.20
4 Sep 2020	1:00:00 PM	0.00	13.44	32.02
4 Sep 2020	2:00:00 PM	0.00	13.42	32.10
4 Sep 2020	3:00:00 PM	0.00	13.43	32.06
4 Sep 2020	4:00:00 PM	0.00	13.39	32.07
4 Sep 2020	5:00:00 PM	0.00	13.39	31.98
4 Sep 2020	6:00:00 PM	0.00	28.09	31.82
4 Sep 2020	7:00:00 PM	0.00	28.76	31.73
4 Sep 2020	8:00:00 PM	0.00	29.01	31.77
4 Sep 2020	9:00:00 PM	0.00	29.15	31.80
4 Sep 2020	10:00:00 PM	0.00	29.26	31.82
4 Sep 2020	11:00:00 PM	0.00	29.34	31.83
5 Sep 2020	12:00:00 AM	0.00	29.41	31.84
5 Sep 2020	1:00:00 AM	0.00	29.46	31.85
5 Sep 2020	2:00:00 AM	0.00	29.50	31.86
5 Sep 2020	3:00:00 AM	0.00	29.54	31.87
5 Sep 2020	4:00:00 AM	0.00	29.56	31.87
5 Sep 2020	5:00:00 AM	0.00	29.59	31.88
5 Sep 2020	6:00:00 AM	0.00	29.61	31.88
5 Sep 2020	7:00:00 AM	0.00	29.64	31.89
5 Sep 2020	8:00:00 AM	0.00	20.94	31.89
5 Sep 2020	9:00:00 AM	0.00	13.45	31.89
5 Sep 2020	10:00:00 AM	0.00	28.69	31.83
5 Sep 2020	11:00:00 AM	0.00	13.44	32.06
5 Sep 2020	12:00:00 PM	0.00	13.43	32.06
5 Sep 2020	1:00:00 PM	0.00	13.41	32.09
5 Sep 2020	2:00:00 PM	0.00	13.39	32.12
5 Sep 2020	3:00:00 PM	0.00	18.11	31.86
5 Sep 2020	4:00:00 PM	0.00	28.63	31.78
5 Sep 2020	5:00:00 PM	0.00	29.02	31.77
5 Sep 2020	6:00:00 PM	0.00	29.19	31.77
5 Sep 2020	7:00:00 PM	0.00	29.30	31.80
5 Sep 2020	8:00:00 PM	0.00	29.38	31.82
5 Sep 2020	9:00:00 PM	0.00	29.44	31.84
5 Sep 2020	10:00:00 PM	0.00	29.49	31.85
5 Sep 2020	11:00:00 PM	0.00	29.52	31.85
6 Sep 2020	12:00:00 AM	0.00	29.55	31.86
6 Sep 2020	1:00:00 AM	0.00	29.58	31.88
6 Sep 2020	2:00:00 AM	0.00	29.60	31.88
6 Sep 2020	3:00:00 AM	0.00	29.62	31.88
6 Sep 2020	4:00:00 AM	0.00	29.64	31.89
6 Sep 2020	5:00:00 AM	0.00	29.65	31.89
6 Sep 2020	6:00:00 AM	0.00	29.67	31.89
6 Sep 2020	7:00:00 AM	0.00	29.68	31.90
6 Sep 2020	8:00:00 AM	0.00	29.70	31.90
6 Sep 2020	9:00:00 AM	0.00	13.43	31.93
6 Sep 2020	10:00:00 AM	0.00	13.43	32.04
6 Sep 2020	11:00:00 AM	0.00	13.42	31.96
6 Sep 2020	12:00:00 PM	0.00	13.41	32.03
6 Sep 2020	1:00:00 PM	0.00	15.33	31.87
6 Sep 2020	2:00:00 PM	0.00	13.37	31.98
6 Sep 2020	3:00:00 PM	0.00	13.38	31.98
6 Sep 2020	4:00:00 PM	0.00	13.36	32.00
6 Sep 2020	5:00:00 PM	0.00	16.62	31.85
6 Sep 2020	6:00:00 PM	0.00	28.49	31.74
6 Sep 2020	7:00:00 PM	0.00	28.93	31.73
6 Sep 2020	8:00:00 PM	0.00	29.11	31.76
6 Sep 2020	9:00:00 PM	0.00	29.24	31.80
6 Sep 2020	10:00:00 PM	0.00	29.33	31.81

Date	Time	ms	Level	Temperature
6 Sep 2020	11:00:00 PM	0.00	29.39	31.83
7 Sep 2020	12:00:00 AM	0.00	29.44	31.84
7 Sep 2020	1:00:00 AM	0.00	29.49	31.85
7 Sep 2020	2:00:00 AM	0.00	29.52	31.87
7 Sep 2020	3:00:00 AM	0.00	29.55	31.87
7 Sep 2020	4:00:00 AM	0.00	29.58	31.87
7 Sep 2020	5:00:00 AM	0.00	29.60	31.88
7 Sep 2020	6:00:00 AM	0.00	29.62	31.89
7 Sep 2020	7:00:00 AM	0.00	29.64	31.89
7 Sep 2020	8:00:00 AM	0.00	29.66	31.90
7 Sep 2020	9:00:00 AM	0.00	29.67	31.90
7 Sep 2020	10:00:00 AM	0.00	13.46	31.99
7 Sep 2020	11:00:00 AM	0.00	13.46	31.99
7 Sep 2020	12:00:00 PM	0.00	13.45	32.05
7 Sep 2020	1:00:00 PM	0.00	13.44	31.99
7 Sep 2020	2:00:00 PM	0.00	13.42	32.00
7 Sep 2020	3:00:00 PM	0.00	13.40	32.04
7 Sep 2020	4:00:00 PM	0.00	13.40	31.99
7 Sep 2020	5:00:00 PM	0.00	16.27	31.84
7 Sep 2020	6:00:00 PM	0.00	28.47	31.73
7 Sep 2020	7:00:00 PM	0.00	28.90	31.73
7 Sep 2020	8:00:00 PM	0.00	29.10	31.77
7 Sep 2020	9:00:00 PM	0.00	29.23	31.77
7 Sep 2020	10:00:00 PM	0.00	29.32	31.81
7 Sep 2020	11:00:00 PM	0.00	29.39	31.81
8 Sep 2020	12:00:00 AM	0.00	29.45	31.82
8 Sep 2020	1:00:00 AM	0.00	29.49	31.83
8 Sep 2020	2:00:00 AM	0.00	29.53	31.83
8 Sep 2020	3:00:00 AM	0.00	29.56	31.83
8 Sep 2020	4:00:00 AM	0.00	29.59	31.84
8 Sep 2020	5:00:00 AM	0.00	29.61	31.85
8 Sep 2020	6:00:00 AM	0.00	29.63	31.88
8 Sep 2020	7:00:00 AM	0.00	29.65	31.89
8 Sep 2020	8:00:00 AM	0.00	24.77	31.86
8 Sep 2020	9:00:00 AM	0.00	13.47	31.93
8 Sep 2020	10:00:00 AM	0.00	13.47	32.00
8 Sep 2020	11:00:00 AM	0.00	13.47	32.04
8 Sep 2020	12:00:00 PM	0.00	13.46	32.06
8 Sep 2020	1:00:00 PM	0.00	13.44	32.17
8 Sep 2020	2:00:00 PM	0.00	13.43	32.15
8 Sep 2020	3:00:00 PM	0.00	13.42	32.14
8 Sep 2020	4:00:00 PM	0.00	13.40	31.99
8 Sep 2020	5:00:00 PM	0.00	13.39	31.95
8 Sep 2020	6:00:00 PM	0.00	28.11	31.78
8 Sep 2020	7:00:00 PM	0.00	28.70	31.75
8 Sep 2020	8:00:00 PM	0.00	28.94	31.76
8 Sep 2020	9:00:00 PM	0.00	29.09	31.77
8 Sep 2020	10:00:00 PM	0.00	29.21	31.82
8 Sep 2020	11:00:00 PM	0.00	29.29	31.83
9 Sep 2020	12:00:00 AM	0.00	29.35	31.82
9 Sep 2020	1:00:00 AM	0.00	29.40	31.82
9 Sep 2020	2:00:00 AM	0.00	29.45	31.83
9 Sep 2020	3:00:00 AM	0.00	29.48	31.87
9 Sep 2020	4:00:00 AM	0.00	29.51	31.85
9 Sep 2020	5:00:00 AM	0.00	29.54	31.86
9 Sep 2020	6:00:00 AM	0.00	29.56	31.85
9 Sep 2020	7:00:00 AM	0.00	29.58	31.88
9 Sep 2020	8:00:00 AM	0.00	25.35	31.86
9 Sep 2020	9:00:00 AM	0.00	13.47	31.94
9 Sep 2020	10:00:00 AM	0.00	13.47	32.00
9 Sep 2020	11:00:00 AM	0.00	13.47	32.03
9 Sep 2020	12:00:00 PM	0.00	13.46	32.08
9 Sep 2020	1:00:00 PM	0.00	13.44	32.12

Date	Time	ms	Level	Temperature
9 Sep 2020	2:00:00 PM	0.00	13.43	32.15
9 Sep 2020	3:00:00 PM	0.00	13.41	32.15
9 Sep 2020	4:00:00 PM	0.00	13.39	31.86
9 Sep 2020	5:00:00 PM	0.00	24.85	31.85
9 Sep 2020	6:00:00 PM	0.00	28.02	31.78
9 Sep 2020	7:00:00 PM	0.00	28.70	31.76
9 Sep 2020	8:00:00 PM	0.00	28.93	31.76
9 Sep 2020	9:00:00 PM	0.00	29.08	31.77
9 Sep 2020	10:00:00 PM	0.00	29.18	31.78
9 Sep 2020	11:00:00 PM	0.00	29.26	31.82
10 Sep 2020	12:00:00 AM	0.00	29.32	31.85
10 Sep 2020	1:00:00 AM	0.00	29.37	31.82
10 Sep 2020	2:00:00 AM	0.00	29.41	31.83
10 Sep 2020	3:00:00 AM	0.00	29.44	31.83
10 Sep 2020	4:00:00 AM	0.00	29.47	31.84
10 Sep 2020	5:00:00 AM	0.00	29.50	31.87
10 Sep 2020	6:00:00 AM	0.00	29.52	31.86
10 Sep 2020	7:00:00 AM	0.00	29.54	31.87
10 Sep 2020	8:00:00 AM	0.00	29.56	31.89
10 Sep 2020	9:00:00 AM	0.00	13.45	31.94
10 Sep 2020	10:00:00 AM	0.00	13.46	31.99
10 Sep 2020	11:00:00 AM	0.00	13.45	32.01
10 Sep 2020	12:00:00 PM	0.00	13.44	32.13
10 Sep 2020	1:00:00 PM	0.00	13.42	32.15
10 Sep 2020	2:00:00 PM	0.00	13.40	32.14
10 Sep 2020	3:00:00 PM	0.00	13.38	32.12
10 Sep 2020	4:00:00 PM	0.00	13.37	31.95
10 Sep 2020	5:00:00 PM	0.00	13.36	31.94
10 Sep 2020	6:00:00 PM	0.00	27.93	31.81
10 Sep 2020	7:00:00 PM	0.00	28.60	31.72
10 Sep 2020	8:00:00 PM	0.00	28.85	31.77
10 Sep 2020	9:00:00 PM	0.00	29.00	31.80
10 Sep 2020	10:00:00 PM	0.00	29.11	31.81
10 Sep 2020	11:00:00 PM	0.00	29.19	31.82

Appendix III: Rainfall Data

Lodwar Weather Station Rainfall Data

RAINFALL OBSERVATIONS AT LODWAR MET STATION

TOTALS												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
2019	1.3	5.4	TR	25.9	TR	17.3	86.7	6.6	TR	79.8	34.6	53.9
2018	0.0	4.5	33.9	136.6	98.2	3.4	0.0	2.1	0.0	TR	0.5	34.0
2017	9.0	3.4	4.9	21.5	TR	0.0	0.0	1.9	8.4	64.9	29.9	0.0
2016	0.0	TR	67.7	129.8	1.8	11.9	0.9	10.0	0.0	TR	TR	TR
2015	0.0	0.0	0.0	95.4	31.0	2.6	0.0	0.0	TR	4.0	38.2	12.0
2014	0.0	TR	6.0	24.9	0.7	0.0	24.8	6.3	30.2	24.0	20.3	4.4
2013	7.7	TR	54.5	117.9	33.1	TR	21.6	29.6	TR	TR	22.6	1.2
2012	0.0	0.0	TR	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
2011	0.0	TR	58.3	16.5	5.7	3.5	20.1	TR	133.9	50.5	100.7	1.5
2010	62.6	6.6	96.4	22.4	27.0	NIL	2.1	37.4	0.6	12.0	0.0	TR
2009	4.6	TR	TR	1.4	30.0	TR	NIL	NIL	TR	18.2	2.8	106.1
2008	1.0	NIL	39.0	9.8	0.8	TR	TR	TR	5.1	42.2	31.2	NIL
2007	R	29.2	18.7	92.9	56.7	68.3	49.0	52.4	16.8	TR	3.5	0.5
2006	1.1	4.3	36.3	36.5	1.2	NIL	5.1	27.1	0.2	46.2	154.1	57.7
2005	0.6	TR	17.4	7.8	84.2	5.2	31.6	0.0	28.9	0.0	2.3	0.0
2004	19.3	0.0	4.0	46.2	13.2	NIL	TR	NIL	26.2	1.2	39.8	4.4

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
2003	NIL	TR	79.7	61.8	38.6	TR	NIL	13.4	NIL	TR	TR	4.8
2002	10.0	TR	87.6	56.6	130.6	1.6	0.0	0.0	TR	19.4	5.4	20.2
2001	23.5	2.6	34.4	6.6	NIL	TR	20.2	2.5	1.2	4.1	2.1	1.0
2000	NIL	NIL	TR	9.5	NIL	TR	3.7	NIL	TR	41.9	4.8	16.0
1999	TR	NIL	43.4	27.4	5.6	TR	13.3	TR	NIL	0.7	4.1	9.2
1998	13.1	05.3	02.3	13.4	20.8	41.6	1.2	26.6	NIL	0.6	0.6	TR
1997	NIL	NIL	2.0	123.3	0.4	TR	36.1	37.0	NIL	30.0	139.6	5.5
1996	6.1	1.9	35.9	22.7	19.6	52.7	45.5	TR	TR	NIL	13.5	NIL
1995	NIL	7.8	27.3	NIL	2.4	2.3	1.4	19.4	2.6	TR	3.1	8.1
1994	0.0	1.0	18.9	50.8	7.5	1.4	4.5	7.1	0.0	8.5	27.6	0.4
1993	9.0	8.9	2.6	5.6	77.3	10.9	TR	TR	NIL	TR	4.0	TR
1992	0.0	3.6	14.4	20.8	10.6	0.8	TR	0.4	0.0	2.9	6.1	2.0

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1991	16.2	0.4	46.2	8.3	38.5	TR	4.9	27.6	TR	8.6	1.1	1..0
1990	1.1	21.2	13.6	18.0	4.1	TR	TR	TR	TR	15.8	TR	6.2

CHIRPS Data for Lokichar Town

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	0.000	3.058	71.352	34.287	0.000	0.000	13.477	0.000	0.721	0.000	0.255	0.000
1982	0.000	7.705	34.682	43.955	8.158	0.000	18.597	0.000	0.000	0.000	3.303	27.126
1983	3.031	7.932	4.633	17.357	4.475	0.000	28.236	56.122	0.000	0.000	0.000	14.626
1984	1.151	0.000	0.000	20.248	0.000	0.000	0.000	0.000	2.110	0.000	0.000	13.564
1985	6.476	6.060	57.802	73.315	12.710	0.000	24.931	0.000	0.548	0.000	0.304	0.000
1986	1.259	0.000	94.206	52.747	5.218	27.149	0.000	0.000	0.000	0.000	0.000	0.000
1987	6.058	2.678	38.605	30.977	13.924	40.031	0.000	0.000	0.000	0.000	0.000	0.000
1988	3.683	10.127	22.485	71.138	0.000	0.000	60.494	23.295	0.000	0.000	0.000	7.411
1989	0.000	8.264	50.713	41.581	10.125	6.684	26.287	0.000	0.000	0.000	0.000	22.218
1990	0.000	22.287	74.071	33.175	3.730	0.000	0.000	0.000	0.000	0.000	0.000	15.415
1991	7.896	0.000	50.437	16.012	18.980	10.856	0.000	0.000	0.000	0.000	0.000	12.736
1992	0.000	3.247	23.030	9.040	4.609	0.000	0.000	0.000	0.000	0.000	0.405	18.101
1993	11.012	10.979	10.497	6.970	14.487	15.192	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	27.340	34.009	9.945	0.000	23.522	0.000	0.000	0.000	0.568	8.363
1995	0.000	5.172	28.499	11.289	5.260	0.000	22.562	0.000	3.484	0.000	0.000	14.121
1996	8.989	4.961	67.263	22.463	0.000	40.160	0.000	23.622	0.000	0.000	1.751	0.000
1997	0.000	0.000	27.026	73.549	3.676	0.000	35.784	0.000	0.000	0.000	0.000	20.138
1998	11.002	6.303	0.000	14.592	10.311	32.750	17.485	19.931	0.000	0.000	0.000	0.000
1999	2.826	0.000	58.303	38.034	0.000	0.000	28.619	0.000	0.000	0.000	1.012	11.054
2000	0.000	0.000	9.084	14.569	0.000	0.000	0.000	17.084	0.000	0.000	0.195	0.000
2001	11.989	3.238	59.553	34.911	0.000	20.809	0.000	0.000	0.000	0.000	0.000	0.000
2002	3.265	0.000	72.652	44.912	19.712	0.000	0.000	0.000	0.000	0.000	0.000	38.307
2003	0.000	3.378	58.060	66.889	11.544	0.000	0.000	25.725	0.000	0.000	0.694	15.477
2004	9.984	2.689	35.334	63.436	9.403	0.000	12.348	0.000	0.000	0.000	1.085	15.813
2005	5.640	0.000	0.000	18.924	21.279	19.930	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	9.296	40.391	36.658	2.528	0.000	0.000	39.862	0.000	0.000	3.725	26.233
2007	6.311	21.447	28.454	60.923	12.382	69.989	59.543	34.837	5.273	0.000	0.000	10.397
2008	3.845	2.344	37.974	14.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	6.497	0.000	7.845	52.495	7.039	0.000	0.000	0.000	0.000	0.000	0.000	48.351
2010	9.385	24.556	80.849	28.790	15.834	0.000	10.973	21.178	0.000	0.000	0.000	4.902
2011	3.489	0.000	53.504	15.809	5.425	18.509	0.000	0.000	3.453	0.000	4.612	6.981
2012	0.000	4.150	9.406	82.446	26.496	0.000	0.000	15.507	3.949	0.000	0.000	35.472
2013	6.099	0.000	46.012	72.555	14.290	12.047	12.552	24.378	0.000	0.000	0.000	0.000
2014	0.000	4.322	42.778	5.133	3.664	0.000	33.496	27.487	2.901	0.000	2.399	11.967
2015	0.000	0.000	6.415	64.260	7.213	7.199	10.541	8.606	0.000	0.000	0.000	15.661
2016	3.417	2.700	23.578	67.482	13.502	21.634	16.988	7.540	0.000	0.000	0.276	0.000
2017	0.000	17.142	16.632	14.375	7.932	6.052	47.937	17.538	3.745	0.000	0.000	5.092
2018	0.000	0.000	96.610	109.380	14.543	24.524	12.436	15.502	0.000	0.000	0.000	25.493
2019	0.000	0.000	26.328	29.778	0.000	33.908	24.398	15.012	3.895	0.000	1.053	37.571

Appendix IV: NACOSTI RESEARCH PERMIT

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Date of Issue: **15/January/2020**

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