# WATER QUALITY ASSESSMENT FROM HAND WATER-PUMP IN BARANGAY NAVARRO, CITY OF GENERAL TRIAS, CAVITE

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## ABSTRACT

The study focused on the assessment of water quality from hand water-pump in Brgy. Navarro, General Trias City, Cavite. It aimed to determine the physicochemical and microbial qualities of the water from pump. It also aimed to identify the total number of installed hand water-pumps and its year of installation in the community as well as the common uses of water from it. With that, the researchers used a mixed method of quantitative and qualitative approach to the study. Categorization of water samples was also done depending on the beneficial usage to identify the standard values for comparison of the result as accordance to Department Environment and Natural Resources Administrative Order No. 2016-08: Water Quality Guidelines and Effluent Standards of 2016. Base on the document from barangay Navarro, the locality has a total of 122 installed hand water-pumps but the researchers chose only five (5) stations at different locations for assessment. The first three stations are classified as Class A water but the remaining two falls under the Class B. The primary parameters from the guideline were assessed on December 2019.


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According to the on-site and laboratory test result, the temperature, pH level, total suspended solids (TSS), chloride, nitrate, color, and phosphate content of the water samples conform to the standards set by the DENR. Also, majority of the samples did not exceed to the standard amount of fecal coliform. However, the third sampling site is considered contaminated with the coliform bacteria so it is not recommendable for potable use.

## INTRODUCTION

Water is important to sustain life and a sufficient supply must be available to all. According to the National Geographic, nearly 70% of Earth is covered by water but only 2.5 percent of it is fresh. On the other hand, only one percent of fresh water are accessible because majority are being trapped in glaciers and snowfields. The only way to conserve this percentage of water is to protect it from the contamination by human or even animal excretion of sewage and manure. According to World Health Organization (2014), it has been proven and tested that the usage of hand water-pump could provide household water supply because of fresh water that can be extracted underground.

The traditional way of withdrawing groundwater source is through hand-dug wells while the improved one is through drilled wells. Moreover, hand-dug wells can be classified into shallow and deep well which differs from the depth of excavation. Shallow well is installed with until seven meters depth from the ground surface while deep well has a depth of up to 100 meters (Bruni, M. & Spuhler, D., 2019).

According to Nkansah, M. A., Boadi, N. O., & Badu, M. (2010), experimental researchers must do an in-depth analysis about the physicochemical and microbial properties of water from the hand-dug water pump wells. Thus, the researchers aim to conduct an assessment on the quality of water coming from the hand water-pumps in Barangay Navarro, General Trias City, Cavite. The result of laboratory examination can also serve as a basis for identifying the groundwater quality in the area.

## OBJECTIVES OF THE STUDY

The general objective of the study is to test the water quality of the hand-water pumps in Navarro, General Trias City, Cavite:

Specifically, it aims to conduct the following:

1. To identify the locality of the hand water-pumps in terms of:
    a. number of hand water-pumps installed;
    b. year range of installed hand water-pumps; and
    c. common uses of water from hand water-pumps
2. to perform a laboratory analysis of sample from hand water-pumps in terms of the physicochemical and microbial parameters such as:
    a. pH level;
    b. temperature;
    c. color;
    d. total suspended solids;
    e. chloride;
    f. phosphate;
    g. nitrate; and
    h. fecal coliform.
3. It aims to compare the laboratory result of physicochemical and microbial assessment to the standard values set by the Department of Environment and Natural Resources (DENR).



## SIGNIFICANCE OF THE STUDY

This study will be beneficial to the following:

**For the community**, this study will be of great significance to the community of Brgy. Navarro because it may serve as the source of information regarding the groundwater quality in the area;

**For the people in the community**, this study will help them, particularly the owner of the selected hand water-pumps, to know the quality of water they are using;

**For the government sectors**, some government sectors such as Department of Environment and Natural Resources (DENR), Department of Health (DOH), Department of Science and Technology (DOST), Environmental Management Bureau (EMB), and the like will benefit to this study because this will provide them an information regarding the water quality from the particular place;

**For the future researcher/s**, this study will help them to have further knowledge, and in addition, this may serve as a reference.

## TIME AND PLACE OF THE STUDY

This research study was conducted from December 2019 to February 2020 in Brgy. Navarro, General Trias City, Cavite.

## SCOPE AND LIMITATION

This study assessed the quality of water from the five selected hand water-pumps in Brgy. Navarro using primary parameters from Water Quality Guidelines and General Effluent Standards of 2016 proposed by DENR. The parameters are limited only to Temperature, pH Level, Color, Chloride, Phosphate, Total Suspended Solid, Nitrate and Fecal Coliform as adapted from the section 6.2 Guidelines for Groundwater Quality. The researchers do not consider the kind of environment issues that is present on the selected place. In addition, this research determined the number of registered hand water-pumps in the selected barangays as well as the year range of installation and common uses of water from it. The results in conducting the study is only limited during the dry season (late November to May).

## DEFINITION OF TERMS

The following key terms used in the study are operationally defined for the clearer understanding on the terminologies that is used.

***Assessment.*** It is the evaluation before making conclusions.

***Hand Water-Pump.*** It is a modification to reciprocating water lift. It is operated by the up and down reciprocating movement of the handle.

***Parameter.*** It is the boundary that defines the scope of particular process. It is also the numerical characteristic of population as distinct from statistics of sample.

***Physicochemical.*** It is a study to get exact idea about the quality of water. The results from different physicochemical parameter values will be compared with standard values.

***Microbial.*** It is parameter used to assess the microorganisms in the sample water.

## CONCEPTUAL FRAMEWORK

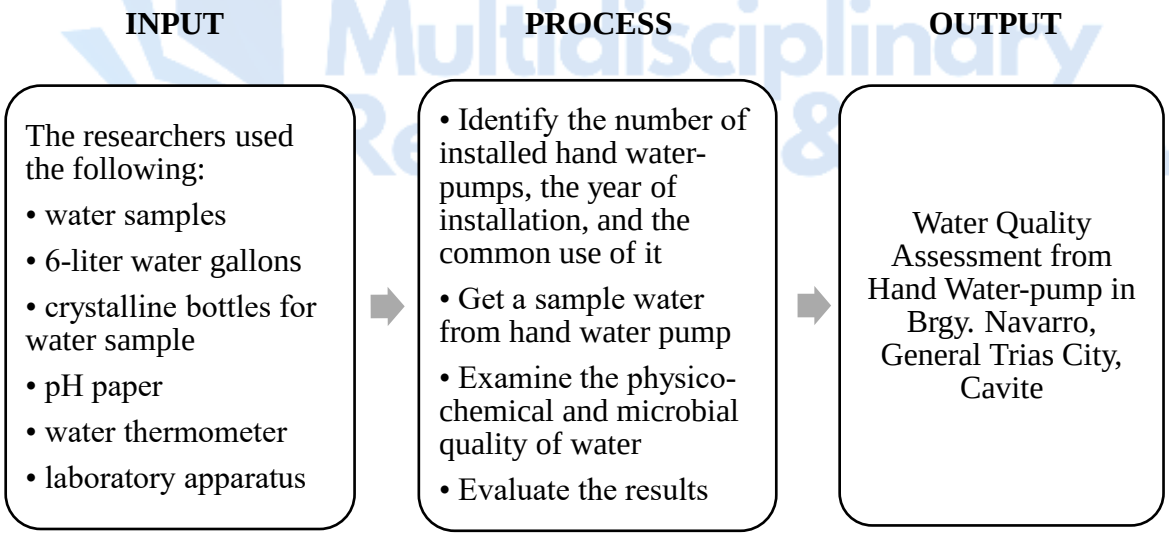


Figure 1: *Conceptual Framework*

# REVIEW OF RELATED LITERATURE

## Water Quality Assessment

Water quality measurements are being conducted by monitoring every station at various locations along the waterbodies. This is to assure the availability of water resources along the area. The Government of the Philippines is planning an integrated structure along with the independent economic development and planning agency of the country, the National Economic and Development Agency (NEDA). However, according to Asian Development Bank (2013), "planning and monitoring of sector activities are hampered by a lack of reliable data and the absence of systematic and regular monitoring of sector activities" (Core Sector Issues, para. 4). Due to this conundrum, the National Water Resources Board [NWRB] legally mandates and oversees water governance with an adequette planning among the administrative function. According to the data of World Resources Administration, the surface and groundwater resources of the Philippines has now a total of 479 billion cubic meters ($m^3$) leading to a six times global scarcity. The report of NWRB (2013) have estimated the total value of 20,200 $m^3$/year available groundwater source (Water Resources, para. 1).

The study entitled "Integration of Physico-chemical Assessment of Water Quality with Remote Sensing Techniques for the Dikgathong Dam in Botswana" shown that the water quality in the sampling area is polluted due to high levels of COD, TSS, and turbidity. Additionally, the current land-use paterns for the Dikgathong Catchment were also identified in this study and shows an increase in settlements due to urbanization and polution growth. Thus, increasing population and developmental activities that contributes pollution are the main reasons of global concern in water quality (Mosimanegape, 2016). According to Asoy A., et al. (2015), the quality of groundwater are examined from seven municipalities in Western Misamis Oriental using physico-chemical treatment based on the Philippine National Standards for Drinking Water (PNSDW)/US-EPA. This study revealed that addressing the pathogens are necessary to convert well waters into potable water.

One of the well known methods to represent gradation in water quality is the Water Quality Index (WQI) which was first proposed by Horten (Srinivas Rao & Nageswararao, 2013). It indicates a single number like a grade that expresses the overall water quality at a certain area and time based on several water quality parameters. It is also one of the most effective tools to express water quality that offers a simple, stable, reproducible unit of measure to easily communicate the information of water quality to the policy makers and concerned citizens.

**Groundwater**

According to Tayone (2015), the groundwater is the largest reservoir of unfrozen fresh water in the hydrologic cycle. It is essential not only for industrial processes and power generation, for livestock and irrigation but for domestic purposes as well. While groundwater supply is replenished and renews 1,400 years, its withdrawal from aquifers is faster than natural recharge. Urbanization had greatly affect the availability and quality of water because of the population. Excessive withdrawal can lead to surface subsidence, salt water intrusion, and decrease water supply that greatly affect groundwater quality (p. 95).

According to the 2018 review of Abbasnia, et al., it describes how stress on the natural resources is increasing due to rapid industrialization and population growth and their conservation is one of the major challenges of mankind. Groundwater is a most vital resource for millions of people for both drinking and irrigation uses (as cited in Ghalib, 2017, p.1). In addition, an imprudent extraction of the groundwater resources and consecutive droughts in recent years have also led to expedited descend of the groundwater level and deterioration. The quality of groundwater resources is as important as its quantity. Thus, it is also necessary that the quality of the groundwater resources should be essentially taken into the full consideration (as cited in Aghazadeh, et al., 2018, p. 2).

As mentioned by the Cavite Provincial Disaster Risk Reduction and Management Plan (CPDRRMP) for 2011-2016, the artesian wells and deepwells provide water supply for both irrigation and domestic purposes in the lowaland areas of Cavite such as Bacoor, Imus, General Trias, Dasmariñas, Naic, Tanza, and Ternate. The study made by Japan International Cooperation Agency (JICA) reveals that the groundwater in Cavite is depleting at a rate of 1 meter water level

decrease per year. Moreover, according to the geological studies in Cavite, most of groundwater is located at pyroclastic rock reservoir and little in the volcano and clastic rock. Potable water is also reported afar from shore because it has presence of alluvium deposits which may be brackish and saline and are not suitable for drinking and other domestic use. The infilterated rainfall is another source of groudwater that serves as the source of most near surface aquifiers (p. 5).

**Hand Water-Pump**

According to the Rural Water Supply (2012), water supplies in all the municipalities, irrigation, power generation, fisheries, livestock raising, industrial and recreational uses. In addition to that, it is generally classified that water sources are according to the relative location on the surface of the Earth. Having water shortage affects people every year and all they need is a clean and porfitable source of water. As of the current generation majority of the households are using improved water system rather than the traditional groundwater wells such as hand water-pump. A hand water-pump is an oscillating pump which has been dug, bored, driven or drilled beneath the ground for the purpose of extracting groundwater.

Likewise, the review of Bruni and Spuhler (2019) stated that hand pumps are manually operated water lifting devices that withraw surface water or groundwater sources into distribution systems. Its accessible operation and capability of supplying adequate amount is significant to the places where financial resource for investment are limited and domestic water consumption is not excessive. The maintenance and usual operation of device, however, is required to maintain its good condition. In terms of drinking water supply, usage of hand water-pump is safer compared to lifting devices with rope and bucket though distillation must be done properly to avoid any health complications.

Some of water that infiltrates deep into the ground and replenishes aquifers preserves freshwater underground for long period of time. Traditional water sources such as springs and groundwater wells are notably the frequent used and available sources of water among the rural areas. State of the Coasts of Cavite Province (2017) states that 95% of the households have now an access to the improved water system and the rest is either springs or groundwater wells (p. 90). On the area of General Trias, Cavite - including the locality of Barangay Navarro, the General

Trias Water Corporation (GTWC) is the major source of clean usable water. Otherwise, Barangay Navarro also uses private water tank, especially in subdivision areas. the water system, base year 2018 of the barangay revealed that many residents from it also use shallow well or hand water-pump and some are upgrading to well deep well or the modified water system. Well deep wells are usually generated by electricity to pump water from the ground, directly stored to the water tank and distributed in household faucets.

The 2011 study of Linke & Turak describe the practice of systematic conservation planning across freshwater realms, including data-poor regions and standing-water ecosystems. As well, Gulhane et al. (2009) found that wells and hand water-pumps showed medium water quality rating in all seasons where the quality was slightly differs in dry and wet season, so the reasons to import water quality change and measures to be taken up in terms of groundwater quality management are required. A 2011 study of Martinez, Mijares & Galera on Physical Sciences Department of De La Salle University–Dasmariñas campus monitored 9 water quality parameters once a month within 12 months. Parameters such as pH level, temperature, total suspended solids, chlorine, nitrate ($NO_3^-$), phosphate, and fecal coliform has been set by the standards of DENR (p.189).

**Physicochemical**

Most of the physico-chemical parameters are being determined by standard methods prescribed by different sources. In assessing the physico-chemical quality of groundwater from hand water-pump, the following parameters have been used as set by the standards of DENR.

**pH Level**

According to the 2018 study by Magdaraog, pH (acidity: log $1/[H^+]$) is the term used to refer the degree of acitivity of an acid or base in the water and is most important chemical factor in hand water pump (as cited in Puetz, J., 2013). The power of Hydrogen (pH) is measured on a scale from 0 to 14 with 7 being neutral. A pH value between 0 to 7 is considered acidic with 0 being the greatest acid activity and getting weaker as it approaches a value of 7. A value of 7 to 8.5 is considered basic with 14 being the greatest base activity. A hand water-pump is best kept in

the range of 7 to 8.5. When pH remains below 6.5, the water is considered to be corrosive which results to the chemical process.

There might also be a production of plaster and metals in equipment resulting on heat transaction that would make water weak. There are various chemical components that is being affected in the chemical quality of a water such as its pH level, alkalinity, and salinity. Based on Fondriest (2019), pH levels will increase with salinity until the water reaches calcium carbonate ($CaCO_3$) saturation.

**Temperature**

Temperature is measured with help of digital thermometer on the site of sample collection. It is a significant parameter because this measure the changes occurring on the water. It is a measure of the intensity (not the amount) of heat stored in a volume of water measured in temperature ($^oC$).

**Total Suspended Solid (TSS)**

Total suspended solids are those solids which are retained by the filter of 1 micro meter pore and they are called as non-filterable solids. Their quantity can be determined by passing a known volume of water sample through a glass fiber filter apparatus and weighing the dry residue left.

**Chloride**

It is measured by titrating a known volume of sample with standardized silver nitrate solution using potassium chromate solution in water or eosin/fluorescein solution in alcohol as indicator. The latter indicator is an adsorption indicator while the former makes a red colored compound with silver as soon as the chlorides are precipitated from solution.

**Phosphate**

Yellow color is developed from the action of phosphates on molybdate ion under strong acidic conditions. The intensity of color is directly proportional to the concentration of phosphate in the sample. Phosphate complexes are reduced by weak reducing agents such as ascorbic acid or

tartaric acid (potassium antimony tartrate) whereas silica complexes require strong reducing conditions of hydrazine or bisulfite.

**Nitrate**

Nitrate is a compound of nitrogen and oxygen and it is being formed when the nitrogen in the form of ammonia is combined with oxygen in water. Nitrate is a contamination in groundwater that is due to leaching of nitrate ($NO_3^-N$) coming from the animal waste and other agricultural activities. The report of Bourke et. Al (2019) states that in able to reduce the nitrate concetration in water, it must have the presence of denitrification.

**Color**

The color of water indicates its quality. The higher the value of this parameter, the lesser its quality.

**Microbial Parameter**

Assessing the microbial property of water is also necessary to determine whether the water is still suitable for human consumption, particularly for potable usage. Fecal coliform is the only microbial parameter in the primary parameters from Water Quality Guidelines and General Effluent Standards of 2016.

**Fecal Coliform**

Fecal Coliform in well water may indicate recent contamination of the groundwater by human sewage or animal droppings which could contain other bacteria, viruses, or disease-causing organisms. According to the Chilean Journal of Agricultural Research (2009), fecal coliform from groundwater resources in well water is due to the bacteria from the manure entering directly through local surface runoff.

## METHODOLOGY

**Materials**

The researchers used the following materials for data gathering:

**300 mL Crystaline Bottles**

**6L Gallons**


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**pH Paper**

**Water Thermometer**


**Cotton**


**Alcohol**

**Ice Box**

**Methods**

In this study, the researchers conducted a survey-interview in Brgy. Navarro, General Trias City, Cavite to determine the number of installed hand water-pumps as well as the common uses of the residents to the water from it and its year of installation. Moreover, the water samples undergo on-site and laboratory examination using physico-chemical and microbial parameters inclined to the standard set by the Department of Environment and Natural Resources (DENR) such as Temperature, pH Level, Color, Chloride, Phosphate, Total Suspended Solid, Nitrate and Fecal Coliform to determine the water quality from the hand water-pumps. The following parameters also have particular methods: total susupended solids uses Gravimetric, SMEWW 2540 D., Color, Phosphorus and Nitrate uses Photometric while Chloride undergoes Argentometric, SMEWW 2500-Cl-B. On the other hand, Multiple-Tube Fermentation, SMEWW 9221 E. is done for identification of Fecal Coliform. From the total number of 122 hand water-pump installed in barangay Navarro, researchers assess five hand water-pumps at scattered locations.

**Experimental Units**

The researchers gathered a water sample from the hand water-pumps. Therefore, the experimental unit is the water sample from hand water-pump since it will be the one to receive the treatment.

**Experimental Design**

The researchers used a mixed method of quantitative and qualitative approach to research because the experimental unit received experimental treatment and related information was gathered through qualitative method.

**Experimental Treatment**

The researchers conducted a laboratory analysis of five water sample per parameter in the Cavite Water & Wastewater Testing Laboratory of the Department of Science and Technology-Trece Martires and JEFCOR Laboraties, Inc. in terms of primary parameters based on the Water Quality Guidelines and General Effluent Standards of 2016 proposed by DENR. The section five

of the stated guidelines emphasised the classification of water bodies for purpose of maintaining water quality according to its intended beneficial usage. Thus, the water sample was categorized by the researchers into class A, B, or C depending on its uses to determine what are the parameters and standard values to adopt for the assessment of water quality, as stated in section 6.2 Groundwater Quality Guidelines.

Table 1 Primary parameters for assessing water quality

| **Parameter** | **Unit** |
|---|---|
| BOD | mg/L |
| Temperature | ºC |
| Dissolved Oxygen | mg/L |
| Color | PCU |
| pH Level | - |
| Total Suspended Solids (TSS) | mg/L |
| Chloride | mg/L |
| Phosphate | mg/L |
| Nitrate as $NO_3^-N$ | mg/L |
| Fecal Coliform | MPN/100mL |

Table 2 Water body classification and uses of fresh water

| Classification | Intended Use |
|---|---|
| Class A | Public Water Supply Class II<br>Intended as source of water supply requiring conventional treatment (coagulation, sedimentation, filtration, and disinfection) to meet the latest PNSDW |
| Class B | Recreational Water Class I<br>Intended for primary contact recreation (bathing, swimming, etc.) |

| | |
|---|---|
| Class C | 1. Fishery Water - for the propagation and growth of fish and other aquatic resources;<br>2. Recreational Water Class I – intended for boating, fishing and other similar activities;<br>3. Agricultural, Irrigation, Livestock Raising |

Table 3 Groundwater quality guidelines

| Intended Beneficial Use | Groundwater Quality Guidelines |
|---|---|
| Sources of Potable Water and Other Domestic Use | Adopt Class A WQG (except BOD and Dissolved Oxygen) |
| Bathing and Other Primary Contact Recreation | Adopt Class B WQG (except BOD and Dissolved Oxygen) |
| Irrigation, Fish Culture, Livestock Watering | Adopt Class C WQG (except BOD, Dissolved Oxygen, and Total Suspended Solids) |

## FIELD LAYOUT OF THE EXPERIMEN

The sampling site for the five (5) water samples is in the locality of Navarro, General Trias City, Cavite. The researchers used scattered sampling method to assess the water quality in different areas.

Figure 2: *Sampling Sites*


**Data to be Gathered**

The researchers gathered five 300 mL water samples for Fecal Coliform and five 6-liter water samples for physico-chemical parameters from the selected hand water-pumps in Barangay Navarro, General Trias City, Cavite. The total of five hand water-pumps in various locations were examined to determine the physico-chemical and microbial quality of water then the post-tests result are interpreted after. The researchers also conducted survey-interview to gather the related information and evaluated in the results and discussion. The following questions were asked to the respondents who are using the selected hand water-pumps.

1. How long have you been living here in Barangay Navarro?
   (Gaano katagal na po kayong naninirahan dito sa barangay Navarro?)

2. In what year have you installed your hand water-pump? Is it still usable?
   (Anong taon ipinagawa ang inyong poso? Gumagana pa ba ito?)

3. How many family/ies are using this hand water-pump?
   (Ilang pamilya ang gumagamit ng poso?)

4. How frequent in a day you were using the hand water-pump?
   (Gaano kadalas gamitin ang poso sa isang araw?)

5. What are the uses of water from hand water-pump?
   (Saan niyo ginagamit ang tubig mula sa poso?) *Please refer to the choices below.*
   *a.* Drinking *(Panginom)*
   b. Cooking *(Panluto)*
   *c.* Bathing *(Panligo)*
   d. Laundry *(Panlaba)*
   *e.* Defecation *(Panlinis ng dumi)*
   f. Livestock Watering *(Inaalagaang Hayop)*
   g. Fishery *(Isdaan)*
   h. Irrigation *(Pananim)*

## DATA GATHERING PROCEDURES

The researchers requested the list of total registered hand water-pumps in the barangay hall of Navarro, General Trias City, Cavite. Furthermore, the researchers conducted a survey-interview to the residents to determine the uses of water from hand water-pumps as well as the year of installation. After the identification of intended beneficial usage, categorization of water sample, in accordance to section 5.0 of DENR Administrative Order No. 2016-08, is necessary because the basis of normal values of parameter is depending on its uses. Otherwise, the researchers collected water samples from selected hand water-pumps and were examined using physico-

chemical and microbial parameters particularly Temperature, pH Level, Color, Chloride, Phosphate, Total Suspended Solid, Nitrate and Fecal Coliform to assess the water quality. Significant parameters like temperature and pH level undergo an on-site examination because the results might change if it is exposed to external factors while the rest of parameters were examined in the laboratory. Also, as stated in the Water Quality Guidelines, the sample collection must only be conducted from 9:00 a.m. to 4:00 p.m.

For microbial analysis, five crystalline bottles provided by the laborotory with a capacity of 300 mL were cleaned and sterilized. Bottles were dried ready for the collection of water samples. For physico-chemical analysis, five 6-liter capacity of freshly emptied distilled water bottles with caps were used for collection of water samples. The following are the procedures done by the researchers in gathering water samples.

1. Check the hand water-pump if it is still useable. Pump for three minutes to ensure that the water sample represents the quality of groundwater that feeds the deep well.

**Propelling the Hand Water-Pump**

2. After three minutes of pumping, wipe the outlet or mouth of the hand water-pump to remove any adhering dirt using a clean cloth or tissue soaked in an alcohol. Pump again for a minute.

**Wiping the Outlet of Hand Water-Pump**

3. After pumping, an assistant will open the sterilized bottle and water gallon and fill it with the water sample. A small air space was left in the water sample bottles to facilitate shaking at the time of inoculation prior to analysis.

**Filling the Containers with Water Samples**

4. Sampling bottles were capped then labeled depending on the site where it was collected.


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**Labeling of Samples**

5. Immediately placed the samples inside an ice box (filled with ice) after collecting at low temperature so that bacterial action is reducewill be reduced.

**Putting the Samples inside the Icebox**

6. For the on-site examination, get the pH value and temperature of water sample by soaking the pH paper and water thermometer on the container with water.


**Getting the pH Value and Temperature**

7. Evaluate the color of pH paper by comparing it to the color scale as well as get the numerical result of temperature from the thermometer. Record the data.

**Evaluating the Color of pH Paper**

8. Collected water samples were immediately transported to the laboratory.

**Submitting Water Samples to the Laboratory**

## STATISTICAL ANALYSIS

The result of the laboratory examination in each physicochemical and microbial parameters are compared to the standard set by DENR. Thus, the identification of water class was done first to determine the basis of values for comparison. The normal values for each parameter depending on the class of water are listed below. The result that exceeds with the standard values are classified as contaminated.

Table 4 Standard values of parameters depending on class of water, generally employed in the physico-chemical and microbial examination of water samples

| Parameter | Unit | Water Body Classification | | |
|---|---|---|---|---|
| | | A | B | C |
| Temperature | ºC | 26-30 | 26 - 30 | 25 - 31 |
| Color | PCU | 50 | 50 | 75 |
| pH Level | - | 6.5 – 8.5 | 6.5 – 8.5 | 6.5 – 9.0 |
| Total Suspended Solids (TSS) | mg/L | 50 | 65 | 80 |
| Chloride | mg/L | 250 | 250 | 350 |
| Phosphate | mg/L | 0.5 | 0.5 | 0.5 |
| Nitrate as $NO_3^-N$ | mg/L | 7 | 7 | 7 |

| | | | | |
|---|---|---|---|---|
| Fecal Coliform | MPN/100mL | <1.1 | 100 | 200 |

## RESULTS AND DISCUSSIONS

The total of five hand water-pumps in different locations within the Brgy. Navarro, General Trias City, Cavite were selected for assessing its quality. To identify the total number of installed hand water-pumps in the barangay, the researchers requested for the record in the barangay hall. According to the Water System (2018), there are 122 hand water-pumps installed in the area. Otherwise, to identify the year of installation and the common uses of water from water pumps, an interview to the residents who use it was also conducted.

Table 5 shows the interview results from the respondents who are using the selected the hand water-pumps in Brgy. Navarro, General Trias City, Cavite. Those individuals are residents of the barangay since then the hand water-pump was installed. The year range of installation of selected hand water-pump is from 1953 to 2018. It implies that hand water-pumps are still one of their sources of water for their living since then until now. Other than that, there are only few families who are using each of the selected water pump and majority of them are frequently using it.

Table 6 Interview result from the respondents

| | Question 1 | Question 2 | Question 3 | Question 4 |
|---|---|---|---|---|
| **Respondent 1** | 20 Years | 2017 | 2 | Always |
| **Respondent 2** | 16 Years | 2018 | 2 | Always |
| **Respondent 3** | 30 Years | 2009 | 4 | Sometimes |

| | | | | |
|---|---|---|---|---|
| **Respondent 4** | 30 Years | 2014 | 3 | Always |
| **Respondent 5** | 66 Years | 1953 | 4 | Always |

For the question "What are the uses of water from hand water-pump?", the answer of the respondents relying on the table 6 shows that all of them use the water for primary contact recreation (bathing, laundry, houshold, and defecation). The result of the interview also shows that there are individuals who are still using water for cooking purposes and livestock watering, however, no one use the water for potable drinking. Thus, the water from hand water-pump in location 1, 2, and 3 were classified into Class A but location 4 and 5 falls under the category of Class B.

Table 6 Common uses water form hand water-pump

| **Class** | **Uses of Water** | Respondent 1 | Respondent 2 | Respondent 3 | Respondent 4 | Respondent 5 |
|---|---|---|---|---|---|---|
| A | Drinking *(Panginom)* Cooking *(Panluto)* | ✓ | ✓ | ✓ | | |
| B | Bathing *(Panligo)* | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Household *(Panlinis ng Bahay)* | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Laundry *(Panlaba)* | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Defecation *(Panlinis ng dumi)* | ✓ | ✓ | ✓ | ✓ | ✓ |

| | | | |
|---|---|---|---|
| C | Livestock Watering *(Inaalagaang Hayop)* Fishery *(Isdaan)* Irrigation *(Pananim)* | ✓ | ✓ |

The physicochemical and microbial laboratory result that came from Cavite Water and Waste Water Testing Laboratory and Jefcor Laboratories Inc. are shown in the table 7. After determing the intended beneficial uses of water, it was categorized into different water class so that the laboratory result can be compared to the corresponding standard values. The numerical result of samples in location 1, 2, and 3 should not exceed to the standard for Class A. Meanwhile, the results of examination in location 4 and 5 should only fall within the range of values for Class B.

Table 7 Physicochemical and Microbial analysis in comparison with DENR Water Quality Guidelines

| **PARAMETERS** | **LOC 1** | **LOC 2** | **LOC 3** | **LOC 4** | **LOC 5** | **DENR STANDARD** | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | **A** | **B** | **C** |
| Temperature (ºC) | 29.8 | 28.8 | 28.8 | 29.8 | 28.8 | 26-30 | 26-30 | 25-31 |
| pH Level | 7 | 7 | 7 | 7 | 7 | 6.5-8.5 | 6.5-8.5 | 6.5-9.0 |
| TSS (mg/L) | < 3 | < 3 | < 3 | < 3 | < 3 | 50 | 65 | 80 |
| Chloride (mg/L) | 18.1 | 6.5 | 43.7 | 19.9 | 46.9 | 250 | 250 | 350 |
| Nitrate (mg/L) | < 0.9 | < 0.9 | < 0.9 | < 0.9 | 1.8 | 7 | 7 | 7 |
| Color (PCU) | 5 | < 1 | < 1 | 4 | 3 | 50 | 50 | 75 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Phosphate (mg/L) | < 0.06 | < 0.06 | < 0.06 | < 0.06 | 0.09 | 0.5 | 0.5 | 0.5 |
| Fecal Coliform (MPN/100mL) | < 1.1 | < 1.1 | 16 | < 1.1 | 1.1 | < 1.1 | 100 | 200 |

**Temperature**

The temperature of five hand water-pump stations was gathered using water thermometer and had a result of 28.8ºC to 29.8ºC that did not exceed to the standard values set by the DENR which is limited from 26ºC to 30ºC for Class A and B. This means that it is all suitable for potable, domestic, recreational, agricultural, industrial, and livestock raising.

**pH Level**

As shown in the table, the pH level of all the water samples passed the standard set by the DENR Administrative Order 2016 because all of the results got neutral value of 7 and fall within the standard values for water Class A, B, and C. Thus, the water from hand water-pumps are not corrosive and are healthy for human use. Factors such as different dissolved gases and solids affect the pH level of the sample as stated in the review of Physicochemical Parameters for Testing of Water (2012).

**Total Suspended Solids (TSS)**

The table reflects that all of the samples did not exceed to the required limit of 50mg/L (Class A water), and 65mg/L (Class B water) total suspended solids because all of the samples had a result of <3mg/L. Total solids are water insoluble materials including organic and inorganic that are suspended in water such as silt, plankton and industrial wastes (Kumar, et al., 2010). Therefore, the five water samples are not contominated with water insoluble materials.

**Chloride**

The chlorine content of the water sample in LOC 1 is 18.1mg/L while LOC 2 is 6.5mg/L. The third and fourth location, on the other hand, have a chlorine content of 43.7mg/L and 19.9mg/L

respectively. The last sampling station got the peak of 46.9mg/L. The result shows that chlorine of all water samples are below the limit set by the DENR which is 250mg/L(for class A and B) so it is safe for human usage. Too much exposure of the body with the chlorine might have negative effects in the health of oneself. Chloride is detrimental when comes in contact with some of the body parts each time one bathes, or swims in the river (Matinez, 2011).

**Nitrate**

When the rain or irrigation water travels across the land, it carries nitrate (and other contaminants) with it. High amount of nitrate in drinking water are associated with adverse health effects. An increased nitrate levels found in drinking water may also indicate the presence of other types of contaminants such as coliform bacteria, viruses, and other human pathogens as well as pesticides. Fortunately, the nitrate of five sampling stations that was measured using the photometric method have relatively low results. LOC 1 to LOC 4 only had < 0.09mg/L of Nitrate while LOC 5 had 1.8mg/L. Hence, all of the samples did not exceed to the DENR standard values which is 7mg/L and it means free from contamination.

**Color**

The values of color from the sample of the selected hand water-pump is lower than the expected 50-75 PCU because the results only ranged form <1 PCU to 5 PCU. The measurement of color was done using photometric method.

**Phosphate**

Phosphate level of all water samples implies that it passed the standard value of 0.5mg/L (for all water class) using the colorimetric ascorbic-acid method. Four out of five samples had a result of <0.06mg/L and the highest result among all had 0.09mg/L. The numerical results did not exceed to the limitation so the samples are not contaminated with too much phosphorus.

**Fecal Coliform**

The result of fecal coliform laboratory test shows that LOC 1 and LOC 2 have reached the standard value of <1.1 MPN/100mL. The water samples from these area fall into classification A

of the DENR Adminitrative Order 2016 which means, it is intended as a source of water supply required to have conventional treatment such as coagulation, sedimentation, filtration, and disinfection to meet the latest Philippine National Standard for Drinking Water. LOC 4, as well, it had a result of <1.1 MPN/100mL even though the water from it is considered as class B. Yet, it did not exceed to the standard value of 100MPN/100mL. Samples from LOC 5 also had a relatively low amount of fecal coliform and had passed into the standard values for water class B. Water from these stations could be use for primary contact such as bathing and also for agriculture, irrigation, and livestock watering. However, the result 16 MPN/100mL from LOC 3, which was considered to be class A water, shows that the source exceeded beyond the limit of <1.1 MPN/100mL. It means that there is contamination of fecal coliform in the water from this area.

## SUMMARY, CONCLUSION, AND RECOMMENDATION

### Summary

The purposes of this study are to assess the physicochemical and microbial quality of water from hand water-pump in Brgy. Navarro, General Trias City, Cavite and to compare the evaluated water in the groundwater quality standards set by the DENR. Moreover, it aims to determine the number of installed hand water-pump, the year of installation and the common uses of water from it.

The water samples were collected from the five (5) selected hand water-pumps in different locations and were contained into sterilized glass bottle containers and water gallons. Samples were brought in the JEFCOR Laboratory to assess the Fecal Coliform and to the Cavite Water and Wastewater Testing Laboratory to assess the physicochemical parameters.

The major conclusion of this study is, the result for physicochemical analysis of five water samples did not exceed to DENR standard values for water classification A, B, and C. The microbial analysis, on the other hand, resulted failure to water quality of one (1) sampling site because of high amount of Fecal Coliform that exceeded to the standard values for water Class A.

## CONCLUSION

The locality of Navarro, General Trias City, Cavite has a total of 122 installed hand water-pumps but only five (5) were chosen by the researchers for the assessment of physicochemical and microbial quality of water. According to the interview result, the evaluated hand water-pumps are installed from year 1953 to 2018 and are now still useable. The primary parameters and its standard values were adopted from DENR Administrative Order 2016-08: Water Quality Guidelines and General Effluent Standards. Based on the analysis, the physicochemical status of the water from hand water-pumps in Brgy. Navarro is in good condition since all of the physicochemical qualities of water samples under the study fall within the DENR standards.

As for microbial result, high fecal coliform counts were found in one sample and did not fall within the standard values for water Class A. The other three samples can be a source of water supply but it will require to have conventional treatment to meet the latest Philippine National Standard for Drinking Water. For location 1 and 2, it reached the standard value as a source of potable water. The third station, in contrast, is contaminated with fecal coliform and is not recommended to be use for body intake. Conversely, the last two locations which are intended for primary contact recreation are still suitable for human usage.

To sum it up, majority of water samples in terms microbial aspect – specifically fecal coliform and physicochemical qualities under the study falls within the standard stipulated by the Department of Environment and Natural Resources (DENR).

## RECOMMENDATIONS

After the assessment of quality of water from hand water-pumps in the locality of Navarro, General Trias City, Cavite, the researchers recommend the following:

1. Avoidance of using the water from the third sampling site for human intake since it is contaminated with fecal coliform;

2. Constant monitoring in microbial and physicochemical qualities of hand water-pumps in Barangay Navarro during wet and dry season since the result of this study is only limited on dry season;
3. Thorough analysis to other physicochemical parameters such as odor, taste, turbidity, total hardness and the like;
4. Further studies on the parameters included on the Philippine National Standard for drinking water;
5. Evaluation of other microbial parameters other than Fecal Coliform; and
6. Increase the number of sampling site.

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