VARIATION OF SURFACE WATER QUALITY IN AN URBAN VEGETATED CANAL

Submitted by

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A Thesis paper is submitted to the Department of Civil Engineering, Daffodil International University in Fulfillment of the Partial Requirements for the completion of **Bachelor of Science in Civil Engineering** Degree.

Department of Civil Engineering

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APPROVAL

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DECLARATION

It is hereby declared that except for the contents where specific reference have been made to the work of others, the design contained in this thesis report is the result of an detailed research work carried out by the authors under the supervision of Dr. Miah M. Hussainuzzaman, Associate Professor, Department of Civil Engineering, Daffodil International University.

No part of this report has been submitted to any other university or other educational establishments for a degree, diploma, or other qualification (except for publication).

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DEDICATION

Dedicated

To

Our Families & All Teacher

ABSTRACT

Water is one of the fundamental elements for living organisms, without water we cannot think of our life. As pure water can save the earth, on the contrary contaminated water is like a slow poison. It is poisoning the whole world slowly. Our surface water is contaminating day by day and industrial effluents are presenting a major role in it. In our country it's more conspicuous. This effluent contains carcinogenic matter and causes cancer on the living body. So, this matter should be highly focused on and decreased as much as possible. Again, it can meet the water demand by recycling and reusing this water. Constructed wetland process of wastewater treatment uses natural plants to take up the pollutants and thus treat the wastewater naturally. This canal with wastewater effluents has a lot of plants like a wetland and hence water samples were collected along this canal to test the pollution parameters to check whether the level of pollution reduces along the flow. Besides all the testing procedures, parameters collected and tested from different spots, and the results have been thoroughly mentioned in this report.

সারমর্ম

পানি জীবন্ত প্রাণীর জন্য মৌলিক উপাদানগুলির মধ্যে একটি। পানি ছাড়া জীবজগতে জীবনের কথা ভাবা যায় না। বিশুদ্ধ পানি যেমন পৃথিবীকে বাঁচাতে পারে, তার বিপরীতে দূষিত পানি ধীর বিষের মতো। এটি ধীরে ধীরে পুরো বিশ্বকে বিষিয়ে তুলছে। ভূপৃষ্ঠের পানি দিন দিন দূষিত হচ্ছে এবং শিল্পকারখানার বর্জ্য এতে প্রধান ভূমিকা পালন করছে। বাংলাদেশে এটি আরও স্পষ্ট। এই বর্জ্যে ক্যান্সার সৃষ্টিকারী দূষক পদার্থ থাকে যা ক্যান্সার সৃষ্টি করে। সুতরাং, এই বিষয়টির উপর খুব বেশি মনোযোগ দেওয়া উচিত এবং যতটা সম্ভব কমানো উচিত। আবার এই পানিকে পুনর্ব্যবহারের মাধ্যমে দৈনন্দিন নাগরিক পানির চাহিদা মেটানোর পাশাপাশি নান্দদিক স্থান হিসেবে উপস্থাপন করা যেতে পারে। বর্তমানে প্রাকৃতিক পদ্ধতিতে দূষণ নিয়ন্ত্রনের জন্য কন্সট্রাকটেড ওয়েটল্যান্ড পদ্ধতি ব্যাবহার করা হয়। শিল্প বর্জ্য দ্বারা দূষিত এই খালটিতে প্রচুর জলজ উদ্ভিদ থাকায় এটিও একটি প্রাকৃতিক ওয়েটল্যান্ডের মতো কাজ করে কি না, এবং এতে প্রবাহের সময় ধীরে ধীরে দূষণের মাত্রা কমে আসে কিনা সেটা বোঝার জন্য এই খাল বরাবর বেশ কয়েকটি স্থান থেকে পানি সংগ্রহ করে সেখানকার দূষণের মাত্রাগুলো পরিমাপ করা হয়েছে। সমস্ত পরীক্ষার পদ্ধতি ছাড়াও, ফলাফলগুলি এই প্রতিবেদনটিতে পুঙ্খানুপুঙ্খভাবে উল্লেখ করা হয়েছে

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Chapter 1: Introduction

1.1 General

Water pollution is a global problem that poses significant risks to human health and the environment. Industrial effluents are one of the major sources of water pollution. These effluents contain various pollutants that can cause significant changes in the physical, chemical, and biological properties of surface water bodies. The aim of this study is to assess the effects of industrial effluent on surface water quality, focusing on the parameters of pH, electro conductivity, and turbidity.

Heavy metals, organic compounds, and nutrients are just a few of the hazardous pollutants that can be found in wastewater or effluent produced by industrial activities including manufacturing, mining, and chemical manufacture. These pollutants can harm aquatic life, deteriorate water quality, and endanger human health. Therefore, it is crucial to evaluate how industrial effluent affects surface water quality to choose the appropriate countermeasures.

For human consumption, agriculture, and industrial activities, surface water bodies including rivers, lakes, and streams are essential sources of water. These bodies of water are nevertheless prone to pollution from a variety of sources, including industrial waste. The wastewater produced by industrial activities, known as industrial effluent, contains a variety of contaminants that may adversely affect the physical, chemical, and biological properties of surface water. This can result in a reduction in water quality and pose a risk to both human health and the environment.

The release of industrial waste into surface water bodies has raised severe concerns throughout the world, particularly in developing nations where industrialization is expanding quickly. Heavy metals, organic compounds, and suspended particles are only a few of the pollutants in industrial wastewater that can harm water quality and aquatic life. To propose potential mitigating solutions, it is necessary to evaluate the effect of industrial effluent on surface water quality. In this work, we use pH, electrical conductivity, and turbidity as the main criteria to assess the effects of industrial effluent on surface water quality.

Industrial effluent is one of the main sources of surface water contamination, which has grown to be a serious environmental problem on a global scale. Industrial effluent comprises a variety of pollutants that can negatively impact surface water's physical, chemical, and biological properties, causing a reduction in water quality and posing a risk to both human and environmental health. Measuring physicochemical characteristics like pH, electrical conductivity, and turbidity might be helpful to determine how industrial effluent affects the quality of surface water. By evaluating these variables and comparing a river that is close to an industrial region to another river that is far from any industrial activity, this study seeks to assess the effects of industrial effluent on surface water quality. The findings will offer understanding. Investigation into the effects of industrial effluent on the quality of surface water and potential defenses.

1.2 Objectives

The main purpose of this research is to give specific ideas about the water condition and environment of the identified place. Based on the water condition and the number of pollutants, by taking necessary steps to develop the environment, to help the surrounding environment and people to have a beautiful and healthy life. Finally, an attempt has been made to make the thesis topic meaningful through the research. The main objectives are as follows:

1. To compare the water qualities in different locations of the canal.
2. To know about the water quality of the canal.

1.3 Study Area

This study has demonstrated the significant pH effect on surface water. Changing pH in surface water affects solubility and toxicity of pollutants and makes aquatic life more harmful. Electro conductivity means the number of ions present in surface water. In this report it has shown that the impact of electro conductivity on surface water is significant. Due to the high presence of ions in water, aquatic biota is facing adverse effects on their survival and metabolism. Turbidity means the measure of clarity of water where high turbidity indicates water is cloudy or murky. This parameter in surface water has an impact on how much light gets through to the water, which influences photosynthesis and the growth of aquatic plants. Finally, does the canal work as a wetland as the canal with wastewater effluents has a lot of plants like a wetland.

Chapter 2: Literature Review

2.1 General

Water pollution is one of the major environmental problems and it affects communities all over the world. Industrial effluent plays a vital role in polluting the surface water. Liquids produced and discharged by industries pollute surface water and degrade the water quality. Industrial wastewater contains both organic and inorganic compounds including nutrients. When this wastewater is discharged directly and meets the surface water bodies, it will have an enormous impact on aquatic ecosystems and human health.

Previous studies have established the impacts of industrial effluents on surface water quality. For instance, following the study of Hossain et. al (2009) shown that effluent can substantially reduce water quality parameters like pH, DO and TDS. Another study by Patil et. al (2018) showed that industrial effluents considerably raised the turbidity of the water.

2.2 pH

pH is the indicator if the water is neutral, acidic, or alkaline expressed in a scale from 0 to 14. Though 6-8 pH range is suitable for aquatic biota to sustain, the pH of the drinking water is 6.5-8.5 (WHO). Very low pH extracts calcium which may deform aquatic biota. Industrial effluent containing strong acid and alkaline cause's significant change in the pH of surface water.

Many studies have demonstrated the significant pH effect on surface water. A study took place in Dhaka city of Bangladesh revealed that the pH is lower 500 meters away from industrial areas. (Islam et al. 2011). The authors attributed industrial effluents to be responsible for this change. Additionally, changing pH in surface water affects solubility and toxicity of pollutants and makes aquatic life more harmful.

2.3 Electro conductivity

The ability of a solution to conduct electricity is referred to as electro conductivity. The number of ions present in surface water is directly related to electro conductivity. The presence of ions in water acts as an indicator of contamination. Discharge of industrial effluents substantially increases the ions of the surface water.

Different studies have shown that the impact of electro conductivity on surface water is significant. Research undertaking Vrishabhavathi River Bangalore in India reported that electro conductivity is comparatively higher in industrial regions than non-industrial regions. (Balakrishna et al., 2011). Due to the high presence of ions in water aquatic biota are facing adverse effects on their survival and metabolism.

2.4 Turbidity

The degree of light dispersion resulting from a solution's particulates can be referred to as turbidity. It is the measure of clarity of water where high turbidity indicates water is cloudy or murky. Turbidity is an important parameter in surface water as it has an impact on how much light gets through to the water, which influences photosynthesis and the growth of aquatic plants. Industrial effluents sometimes contain high levels of suspended solids that increase the turbidity of surface water.

According to studies, industrial effluents have significant effects on surface water. A study carried out in the River Tunga in the Shimoga district of Karnataka, India, found that the turbidity of the river increased substantially due to industrial effluent (Sudhir et al. 2014). It is difficult to treat surface water for use as drinking water and other purposes while turbidity levels are high.

Chapter 3: Methodology

3.1 General

The quality of Wastewater varies depending on their geographical location and time. So, collecting samples from one point will not fulfill the requirement of this research so that samples were collected from several locations along the canal. Factors affecting the water quality like selection of sampling points, locations, velocity of water, methods of sample collection, processing and storing procedures were considered while collecting the water samples. Sampling points were selected to get the best outcome of this research work.

3.2 Location:

Samples are collected from the canal flowing through Daffodil International University, Ashulia, Savar, Dhaka. These samples are collected from 5 different points of the stream. And for each point two different samples are collected, one for upstream and another for downstream. The key difference is that upstream bioprocessing involves screening and identification of microorganisms, media preparation, multiplication of microbes inside bioreactors, while downstream bioprocessing deals with extraction, purification, and filtration of the resulting product. Identified locations are below:

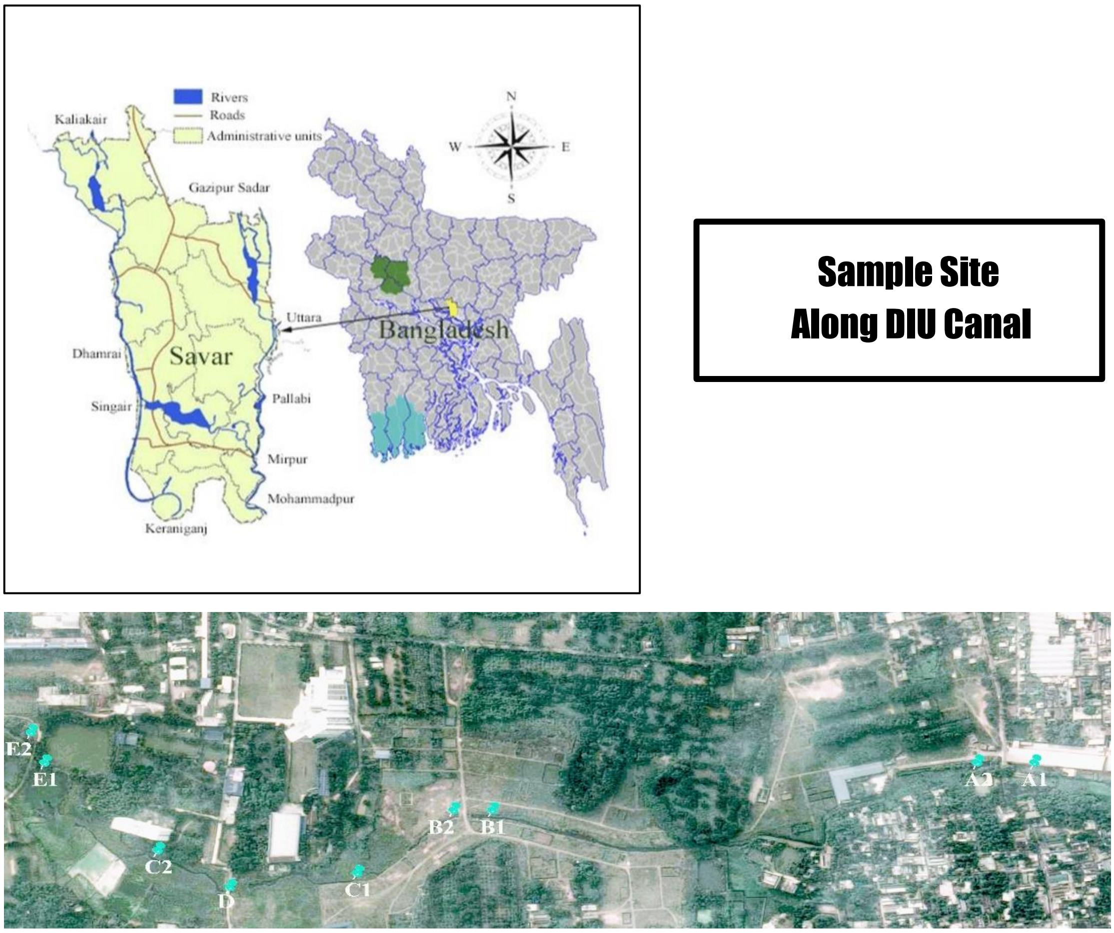

Figure 3-1: Map of Sampling Sites

Table 3-1: Location Details of Sampling Sites

Location Name	Description	Stream
Location-1(A)	Beside Manarat International University	Upstream(A1)
		Downstream(A2)
Location-2 (B)	Amin Mohammad Model Town	Upstream(B1)
		Downstream(B2)
Location-3 (C)	Beside DIU Power Plant & Rowshan Ara Scholar's Garden	Upstream(C1)
		Downstream(C2)
Location-4 (D)	DIU Bridge	Sewage line
Location-5 (E)	Nolkadi Bridge	Upstream(E1)
		Downstream(E2)

3.3 Sampling Points:

The number of sampling points takes many considerations. Because water quality varies from time to place. To find the peak values samples were collected from 9 different points. These points are:

Figure 3-2: Sampling Sites

3.4 Method of Collecting water Sample

Grab sampling method is used for collecting the water sample. Water samples are collected on spot at a specific location and time without taking any considerations for variations that may occur over time. The water is collected using a bottle and a stick, by submerging it directly into the water body at the desired location. As there was a lot of vegetation along the canal, water samples were collected from suitable locations, but it was taken in account that it fulfills the requirements of this research.

Due to the velocity of water pollutants moving, the density of waste varies from place to place. It was seen with bare eyes that the density of pollutants and dirt is relatively greater where the velocity is higher than less velocity. To prevent this measure, samples were collected from both upstream and downstream of a physical barrier like a bridge.

After collecting a water sample, it was poured into a clean labeled bottle. It was also ensured that there were no bubbles inside the bottle.

Safety precautions like using hand gloves, boots, keeping marginal distance from the major sources of pollution and storing samples were strictly followed.

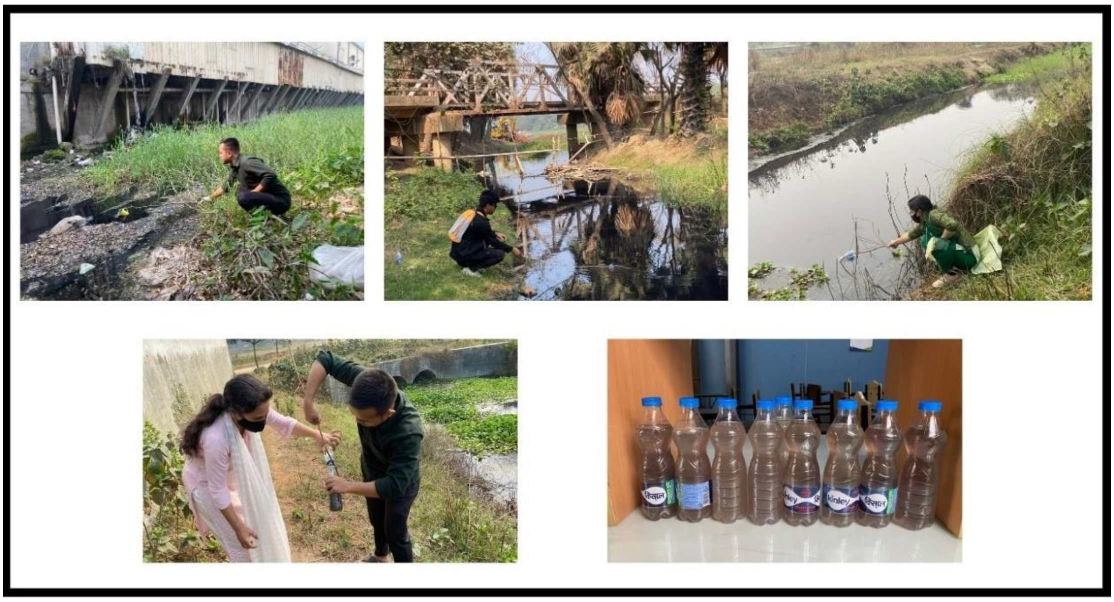

Figure 3-3: Sample Collection

Samples were collected in a pre-labeled 0.5-liter bottle from each point on and taken directly into the laboratory for testing.

3.5 Determination of pH value

Collected samples were directly taken to the laboratory for testing to get the peak result. Samples are tested in CE laboratory, DIU. The pH value of the collected sample is determined by using digital pH meter. For solution container beaker is used. Distilled water is used for rinsing the pH meter and the beaker. And fresh napkins were also used to mop the apparatus and the table.

3.5.1 Test Procedure

1. pH meter is calibrated properly before using it. Rinsed the pH meter with distilled water to remove any kind of contamination from the previous measurements.

2. For sample preparation a beaker was rinsed with distilled water and the collected sample water is poured into the beaker very carefully according to the required quantity.

3. Turned on the pH meter and waited for it to stabilize. While dipping into the beaker it was considered that the water level is in between the minimum and maximum mark of the pH meter. Observe the pH value displayed on the digital screen after allowing a few seconds for the reading to stabilize.

4. The electrode of pH meter is rinsed perfectly each time with distilled water to avoid cross contamination of samples.

5. Repeated step 2 and 3 twice for each sample to get accurate pH value and record the mean. Steps 2,3 and 4 were followed to find the pH level of all the selected locations.

Figure 3-4: Determination of pH

6. After determining the pH of all the locations electrode of the pH meter is rinsed with distilled water, kept it clean and stored properly.

7. While handling samples and equipment, the appropriate safety measures were taken to prevent contamination or accidents.

3.6 Determination of Electro- Conductivity

The Conductivity value of the collected sample is determined by using the Conductivity meter. The same apparatus of the pH determination was used to determine the electro-conductivity value.

Figure 3-5: Determination of Electro-Conductivity

3.6.1 Test Procedure

Steps are followed as 3.5.1 for determining the electro-conductivity value.

The obtained value is in Parts per Thousands (ppt). Then it is converted into Micro Simens/cm ((µS/cm) unit by multiplying 2000.

3.7 Determination of Turbidity:

At each station, a water sample is collected from 0.5 m below the surface to determine the turbidity (NTU) using an optical meter. The sample was taken directly in the lab for analysis.

3.7.1 Test Procedure

Testing procedure are as follows:

1. Switch on the turbidity meter at least 30 min before the test.

2. Calibrate the turbidity meter to 400 NTU using the standard solution by adjusting the calibration knob.

3. Calibrate the turbidity meter to 0 NTU using distilled water and by adjusting the calibration knob.

4. Pour the sample into the sample chamber then insert it on the turbidity meter.

Figure3-6: Determination of Turbidity

5. Press the power button and the meter will start to show values. Allowed few seconds to stabilize the reading.

6. Repeated Steps 3 & 4 twice for each sample to get accurate values.

Chapter 4: Results and Discussion

4.1 Result

After testing all the samples, the following results are recorded accordingly for day one and day two. Mean value is taken as every sample is tested twice. Water quality parameters results for Day-1 & Day-2 are as follows:

Table 4-1: Water Quality Parameter Results (Day-One)

Location	Date	Tested Parameters			
		pH	Electro Conductivity		Turbidity (NTU)
			ppt	(µS/cm)	
A-1	08/02/2023	6.7	0.43	860	109
A-2		6.7	0.4	800	98
B-1		6.9	0.71	1420	66
B-2		7	0.74	1480	58
C-1		7.1	0.6	1200	28.36
C-2		7	0.52	1040	36.18
D		6.9	0.19	380	98
E-1		7.1	0.58	1160	29.82
E-2		7.1	0.58	1160	28.73

Table 4-2: Water Quality Parameter Results (Day-two)

Location	Date	Tested Parameters			
		pH	Electro Conductivity		Turbidity (NTU)
			ppt	(µS/cm)	
A-1	18/02/2023	6.7	0.43	860	92
A-2		6.8	0.39	780	100
B-1		6.8	0.71	1420	104
B-2		6.9	0.49	980	106
C-1		7	0.48	960	28.24
C-2		6.9	0.59	1180	43.09
D		6.8	0.17	340	75
E-1		7.1	0.59	1180	31.52
E-2		7	0.59	1180	32.32

4.2 pH of Wastewater

pH of water determines the solubility and biological availability of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals. In addition to affecting how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. In the case of heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble. pH ranges from 0 to 14, with 7 being neutral. pH less than 7 are acidic while pHs greater than 7 are alkaline (basic). As per WHO standard pH level of water varies from 6.5-8.5. Normal rainfall has a pH of about 5.6—slightly acidic due to carbon dioxide gas from the atmosphere whether acid rain can be very acidic, and it can affect the environment in a negative way.

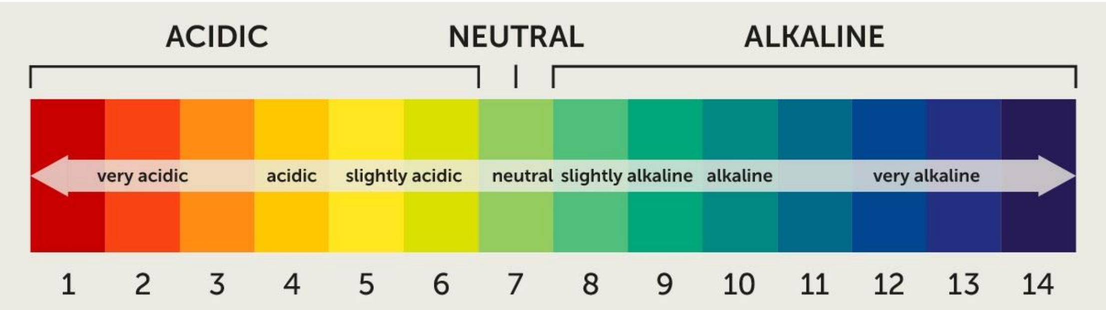

Figure 4-1: pH Meter

The purpose of this study is to find the pH of the canal is suitable for both terrestrial and aquatic life. The test results illustrate that the wastewater is changing from acidic to alkaline but does not cross the standard limit. In upstream that is point A1 & A2 pH value is 6.7 and 6.8 accordingly which is slightly acidic because of the discharge of acidic waste directly into the canal. Since the water is acidic it dissolves a numerous number of pollutants and heavy metals. The pollutant rates are much higher than the different points of the canal. Going downstream from point B1 to C2 pH value is close to the neutral value of pH, which is 7, because there is a lot of vegetation upstream which refines the wastewater and purifies it. But in point D it abruptly changed as there is a direct sewage line and industrial wastewater line to the canal. Which contained alkaline substances and turned the water into acidic water, which indicates the high number of pollutants. Going downstream from point D there is a lot of vegetation on the canal and for that the water is purified and pH value increases to 7.1 in points E1 and E2. It indicates that vegetation works as a wetland, and it decreases the number of pollutants.

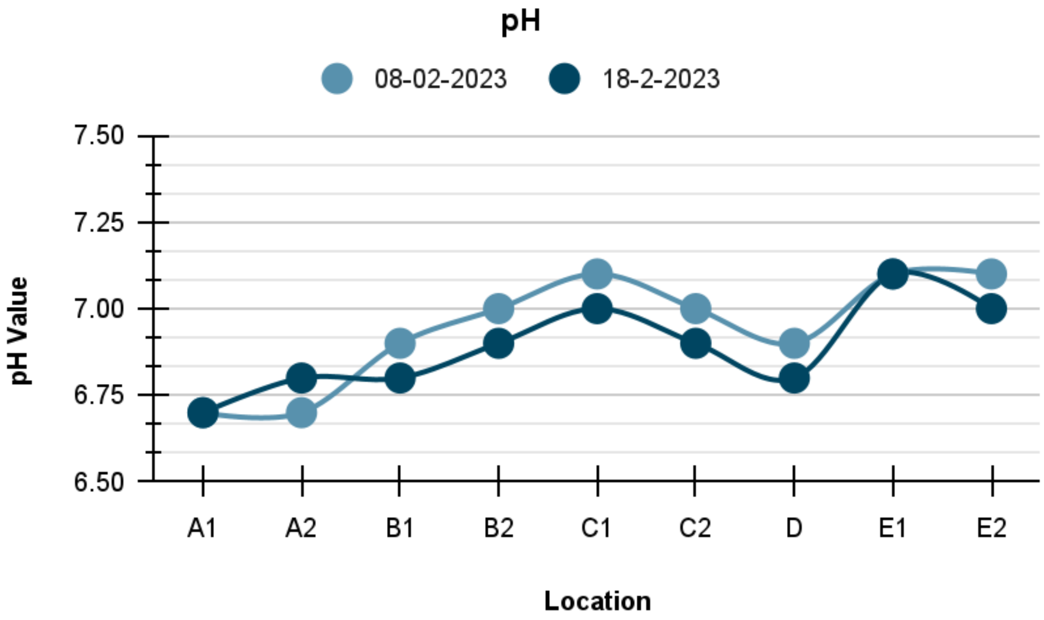

Figure 4-2: Variations of pH Level Along the Canal

From the graph it is shown that the PH of the sample collected on the second day is relatively lower than the samples collected on the first day. Because there was rainfall before the sample collection of the second day.

Excessively high and low pH can be detrimental to the use of water. High pH causes a bitter taste, water pipes and water-using appliances become encrusted with deposits, and it depresses the effectiveness of the disinfection of chlorine, thereby causing the need for additional chlorine when pH is high. Low-pH water will corrode or dissolve metals and other substances.

Although sample wastewater is in the range of standard limit but due to the presence of industrial pollutants, this water is causing deterioration for both terrestrial and aquatic life. Pollution can change a water's pH, which in turn can harm animals and plants living in the water. Many aquatic species like fish, insects, snails, and frogs are facing a great threat. Along with the terrestrial beings like birds, cows, human beings, and other animals cannot use the water.

So, it can be said that the pH level of this canal is not adequate for the survival of living beings and it’s having a negative impact on the environment.

4.3 Conductivity of wastewater

Electrical conductivity has an immense impact for determining the quality of water. It is the ability of water to conduct an electrical current in a solution over a certain distance, which means it conducts electricity through the water molecules and makes significant changes in water quality. It is usually measured in Siemens (S) per distance. The power for water to conduct electricity comes from the ion concentration within the water, which comes from dissolved solids and inorganic materials like carbonate compounds, chlorides, and sulfides. As per EPA, at 25º C temperature fresh water has a conductivity of 500 µS/cm, according to USGS river and Stream water ranging from 0-1000 µS/cm. But polluted water has much higher electro conductivity for the presence of various pollutants.

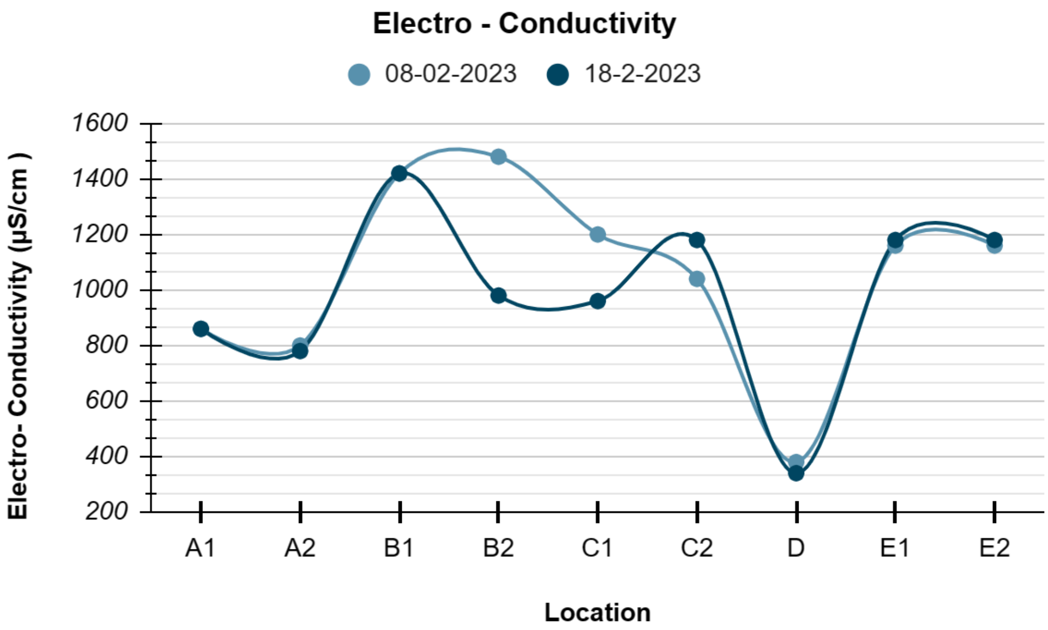

Figure 4-3: Variations of Electro-Conductivity Level Along the Canal

From the graph it is vividly clear that the water of the canal contains different types of pollutants which increases the conductivity of the water. At point A1 the electro conductivity is found 860 µS/cm. Which is in than the standard level. A2 point also remains almost the same, there is no such big difference. But at point B1 it raises to 1420 µS/cm because of high number of dissolved particles containing salts and minerals. Due to the structure of the canal, there was huge sludge and for this particle settled down. In point B2 the velocity of water is higher than B1 so that particles cannot settle there and for this the electro conductivity is less than B1. At point C1 and C2 water velocity is slowed down due to the vegetation and for this particle settle down easily and dissolve with the water molecules. This helps pollutants to bind with water and conduct higher amounts of electricity through the water molecules. A wastewater line containing industrial waste is also discharging effluents which makes the same electro conductivity level according to the upstream. Due to the presence of various substances like human waste, detergents, industrial discharges, and other organic and inorganic materials the electrical conductivity of sewerage water is generally lower compared to other types of water. A sewerage line is discharging effluents into the canal directly, that's why at point D electro conductivity is lower than the other points. As the effluents go downstream from point C2, thus the electro conductivity level of point E1 & E2 remains same as the upstream.

Lower electro conductivity in water is considered better due to association with higher purity and lower environmental impacts. But the water quality of the canal flowing through the Daffodil International University is higher than the standard limit and causing harm to the aquatic organisms.

4.4 Turbidity of wastewater:

Turbidity is the cloudiness or haziness of water which caused because of the large number of particles are suspended on it. Turbidity has a significant impact on surface water. It illustrates the clarity of water and presence of particulate matters. High turbidity level cause negative impact on aquatic flora and fauna. As per WHO standard level of turbidity of drinking water can be maximum 5 nephelometric turbidity unit (NTU). EPA recommends turbidity level should be kept below 50 NTU for surface water.

In this study it has been found that the turbidity level of the canal is much higher than the standard limit. From the first point of upstream turbidity level is close to 100 as untreated industrial wastewater is directly discharged into the canal. At the second point it remains almost the same. From the graph it can be shown that turbidity level at point B1 and B2 of the samples collected first is higher than the second day. On the first day the level of turbidity is averaging more than 60 NTU as there was rainfall before the sample collection of second day. Rainfall water lowers the density of suspended particles and contributes to decrease the cloudiness of water. But on the

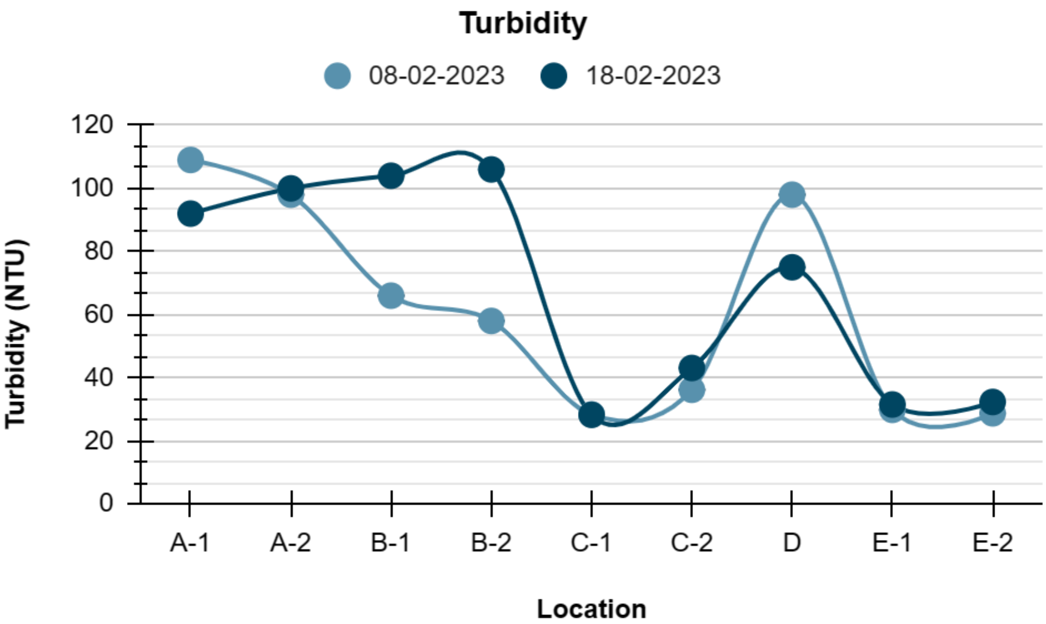

Figure 4-4: Variations Turbidity Level Along the Canal

second day sample the turbidity level is more than 100 NTU. The reason for the high level of turbidity is the grow of algae. Wastewater has passed through a long trail and there was no direct discharge of wastewater into the canal, for this the turbidity level at point C1 and C2 is ranging 25 NTU to 45 NTU. The household and municipal wastewater is directly discharged into the canal at point D, various types of suspended particles are present there which increases the haziness of water. The turbidity level of the first and second day was found to be 98 NTU and 75 NTU accordingly.

Suspended particles are less at point E1 and E2 and for this the turbidity level is ranging from 25 NTU to 35 NTU. Since those two points are downstream, the velocity of water is higher than the other points. High velocity prevents the settling of suspended solid thus the turbidity is lower in E1 and E2 point.

As the turbidity level of the canal is higher than the standard limit it prevents sunlight from passing the water and causing detrimental effects on the photosynthesis process of both aquatic and photosynthetic organisms. Turbid water absorbs and retains more solar radiation and increases the water temperature. High water temperatures cause negative impact on aquatic life. It inhibits the natural exchange of oxygen between the water and atmosphere so there are less fish and aquatic faunas on the canal. Turbid water also causes sedimentation which altered the health of benthic habitats, including aquatic insects and bottom-feeding animals, and streambed habitats.

Due to the high turbidity level water of the canal, it makes the water toxic in an adverse manner and causing great threat to the environment.

Chapter 5: Conclusion and Recommendation

5.1 Conclusion

Water samples were collected from different parts of a canal and water quality parameters were measured for those samples. The variation of different water quality parameters was plotted in a graph to observe the variation of those values along the water path. The graph shows that the values of the parameters vary from place to place and over time. These changes happen due to some factors like rainfall, physical obstacles, structure of the canal, presence of vegetations and the most important the place and density of the untreated discharge.

The water quality parameters also provide a measure of the health of the water body by comparing it to national standards. The study shows that parameters like electro-conductivity and turbidity are higher than the standard limit. Which is having a negative impact on the inhabitants of the canal and causing environmental degradation.

5.2 Recommendations

By monitoring the water quality parameters of the selected places, it was found that the level of water pollution is very high. During the sample collection time a lot of pollutants like suspended particles are seen in bare eyes. To prevent these measures some steps can be taken.

1. First identify the specific sources of industrial pollutants that are directly contributing to wastewater in the canal. Understand the responsible authorities about how the untreated wastewater is having negative impact on the water quality of the canal. Also know about the Standards for Waste from Industrial Units and make sure the water was treated properly before discharging into the canal.

2. The restoration of the wetlands and repairing zones can be considered, such ecological systems can act as a buffer by filtering pollutants and minimize turbidity by reducing the pollution of water of the canal in the long term.

3. Results can be compared with a constructed wetland.

4. A model of the vegetated canal can be prepared as a constructed wetland.

5. According to the research findings an environmental policy can be introduced for the comprehensive development of water quality management plan.

Need to emphasize the importance of surface water as a vital source of water. And by using the vegetation of the canal, constructed wetland process can be introduced which will reduce the pollution of water of the canal in the long term.

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Appendix

Table-1: Standards for Sewage Discharge

Parameter	Unit	Standard Limit
BOD	Milligram/l	40
Nitrate	”	250
Phosphate	”	35
Suspended Solids	”	100
Temperature	Centigrade	30
Coliform	Number per 100 ml	1000

Table-2: Standards for Waste from Industrial Units or Project Wastes

Serial No.	Parameter	Unit	Places for determination of standards		
			Inland Surface Water	Public sewerage system connected to treatment at second stage	Irrigated Land
1	Ammoniacal Nitrogen (N)	mg/l	50	75	75
2	Ammonia	”	5	5	15
3	Arsenic (As)	”	0.2	0.05	0.2
4	BOD_5 at 20°C	”	50	250	100
5	Boron	”	2	2	2
6	Cadmium (CD)	”	0.50	0.05	0.05
7	Chloride	”	600	600	600
8	Chromium (as total Cr)	”	0.5	1	
9	COD	”	200	400	400
10	Dissolved Phosphorus (as P)	”	8	8	15
11	Chromium (as hexavalent Cr)	”	0.1	1	1
12	Copper (as Cu)	”	0.5	3	3
13	Dissolved Oxygen (DO)	”	4.5-8	4.5-8	4.5-8
14	Electro Conductivity (EC)	µS/cm	1200	1200	1200

Serial No.	Parameter	Unit	Places for determination of standards		
			Inland Surface Water	Public sewerage system connected to treatment at second stage	Irrigated Land
15	Total Dissolved Solids	”	2100	2100	2100
16	Fluoride (as F)	”	2	15	10
17	Sulfide (as S)	”	1	2	2
18	Iron (as Fe)	”	2	2	2
19	Total Kjeldahl Nitrogen (as N)	”	100	100	100
20	Lead (as Pb)	”	0.1	1	0.1
21	Manganese (as Mn)	”	5	5	5
22	Mercury (as Hg)	”	0.01	0.01	0.01
23	Nickel (as Ni)	”	1	2	1
24	Nitrate (as elementary N)	mg/l	10	Not Yet Fixed	10
25	Oil and Grease	”	10	20	10
26	Phenolic Compounds (as C_6H_5OH)	”	1	5	1
27	Radioactive Substance	”	To be specified by Bangladesh Atomic Energy Commission		
28	Radioactive Substance	”	To be specified by Bangladesh Atomic Energy Commission		
29	pH	”	6-9	6-9	6-9
30	Selenium (as Se)	”	0.05	0.05	0.05
31	Zinc (as Zn)	”	5	10	10
32	Total Dissolved Solids	”	2100	2100	2100
33	Temperature	Centigrade			
34	Suspended Solids (SS)	mg/l	150	500	200
35	Cyanide (as Cn)	”	0.1	2	2