Water Quality Assessment
Morong-Teresa River

Laguna Lake Development Authority
Resource Management and Development Department
Environmental Laboratory and Research Division

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WATER QUALITY ASSESSMENT
MORONG/TERESA RIVER
2011

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Water Quality Assessment of Morong/Teresa River

1.0 Introduction

The study of the water quality of Morong/Teresa River was undertaken by the Environmental Laboratory and Research Division of the Laguna Lake Development Authority on April 25, 2011 and October 24, 2011 representing the dry and wet season, respectively. The objective of the study is to assess the present condition of the river in terms of conformity with the 1990 Water Quality Criteria set for Class "C" Waters by DENR. It will also provide baseline data on the river's characteristics based on its biological indicator organisms such as the benthic fauna, the algal populations and the presence of the coliform group of bacteria. These data would then serve as basis for the Rehabilitation Program to be implemented in the river system.

The Laguna Lake Development Authority together with the Local Government Units and communities from Antipolo, Morong and Teresa undertook a clean-up drive in 1994. Truckloads of garbage and water hyacinths were removed from 3 km. portion of the river in Barangay Bagumbayan and San Roque.

The River Rehabilitation Program was revived this year thru the "Adopt a River Program wherein LLDA partnered with different sectors. A Memorandum of Agreement (MOA) on "Adopt a River" has been signed on April 18,2011 by the nine ((9) barangays in the Teresa Morong River System.

2.0 Background Information

2.1 Morong Teresa River System and Sub-Watershed

The Morong River, also referred to as the Morong Teresa River, is a river system in the province of Rizal. It is one of the 21 major tributaries of Laguna de Bay. It covers fourteen (14) barangays and stretches up to 10 km from Antipolo City down to Teresa and Morong, Rizal and finally to Laguna Lake. The Morong River sub-basin has a drainage area of 70.2 sq.km.

According to latest census, Morong is a first class municipality in the province of Rizal. It has a population of 50,538 inhabitants in 8988 households. Morong is politically divided into eight (8) barangays with three (3) barangays situated in the Poblacion (San Pedro, San Jose and San Juan). The other barangays are Bombongan, Caniogan, Lagundi, Maybucal and San Guillermo. Majority of the people depend on farming as a livelihood, many others are engaged in business like garment industry, poultry and piggery. (en.wikipedia.org/wiki/Morong,_Rizal)

In the town of Teresa, the predominant source of livelihood is agriculture but with the opening of the FR Cement, Teresa Marble and ABC Chem,, the members of the community slowly shifted to industry in the mid '90's. (en.wikipedia.org/wiki/Teresa,_Rizal)

The Municipality has undergone a lot of changes specifically in the infrastructure and public facilities as observed by the team during the ocular

inspection. The Material Recovery Facilities (MRF) was completed last December 5, 2010 in Pantay barangays namely: Bagumbayan, Dalig Dulumbayan, May-iba, Poblacion, Prinza, San Gabriel, San Roque, Calumpang and Sto. Cristo.

3.0 Sampling Location

Five (5) river sampling stations were identified for this study. Two (2) stations are in Teresa, Rizal. (Brgy. May-iba and Sitio Sukol) while three (3) stations are in Morong, Rizal namely: Poblacion, Brgy. Bombongan and Mouth of Morong, River. Please refer to Figure 2 on the corresponding location.

Stn I- Mouth of Morong River
Stn II- Poblacion
Stn III- Brgy. Bombongan
Stn IV- Brgy. May-iba
Stn V- Sitio Sukol

Figure 1. Map of Morong-Teresa River System

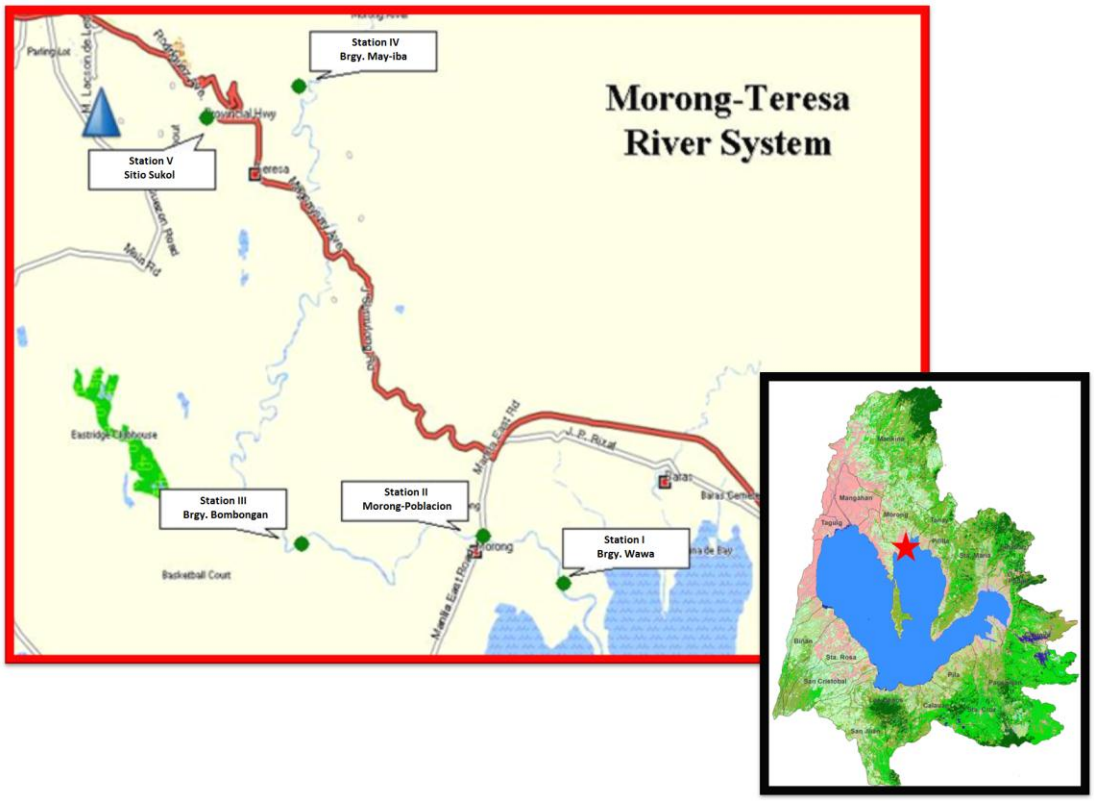
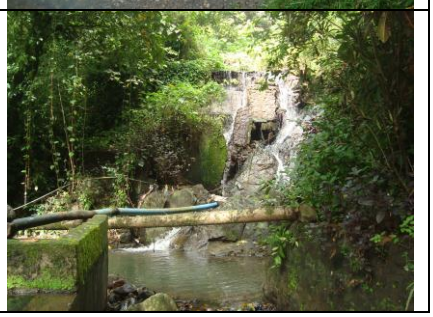


Figure 2. Sampling stations

	DRY	WET
Station I Mouth of Morong River		
Station II Poblacion		
Station III Brgy Bombongan		
Station IV Brgy. May-iba		
Stn V Sitio Sukol		

4.0 Methodology

A reconnaissance survey or "Lakbay-llog" was undertaken by the Environmental Laboratory and Research and Development (ELRD) staff prior to actual sampling activities. The purpose of "Lakbay-llog" is to come up with a map of the river system and to be able to determine the extent of the river from Sitio Sucol to mouth of the river, and lastly, to determine or assess the existing development along the river system,

Collection of samples were conducted in the identified river stations in April and October 2011.

The water sample for physico-chemical analyses were collected using a plastic pail container or directly into one (1) gallon plastic container and wide mouth glass bottle for oil and grease analysis. The chemical parameters analyzed at the laboratory include pH, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Oil./Grease, Dissolved Oxygen (DO) Ammonia, Nitrate, Inorganic Phosphate, Total Phosphorus, Total Nitrogen, Hardness, Conductivity, Chloride, and Turbidity and including Heavy Metals analysis for Cadmium and Lead. Dissolved Oxygen fixation is done on site by adding one (1) ml each of Manganous sulfate ($MnSO_4$) and Potassium Iodide (KI) and the final reading was completed in the laboratory using the Winkler Azide Modified Method. Water temperature and other observations were also recorded.

Biological samples for benthic analysis were collected using a surber sampler or Ekman Grab depending on the water depth and type of bottom substratum. Phytoplankton sample was collected by taking three (3) pails of surface water passing through a 35 micron meshed-size plankton net. Benthic flora and fauna samples were preserved with Lugol's and 10% formalin solution, respectively. Biological analysis was conducted at the ELRD laboratory using the inverted and stereozoom microscopes for qualitative and quantitative analyses. Identified algal species were presented up to genera level while benthic organisms were identified from family to genera. Estimates were presented as the number of algae or benthos per square meter area.

Microbiological samples were collected using a sterilized borosilicate glass specifically for the purpose. The bottles were filled up with water collected just below the surface water and placed in a cooler containing ice while being brought to the laboratory. Water samples were analyzed for Total and Fecal coliforms using the multiple-tube fermentation procedure as a Most Probable Number (MPN) index and qualitative test was done for the detection of ***Escherichia coli***.

Water temperature and other physical observations during the dry and wet season sampling were noted and recorded. Site description and observations noted during the sampling are presented in Table I-A and Table I-B.

5.0 Water Quality Assessment

The assessment of the water quality of Morong/Teresa River System was based on the physical and chemical analyses of water in the five (5) identified stations and compared with the 1990 Water Quality Criteria for Class “C” Waters as provided in the DENR Administrative Order No. 34, algal populations, benthic and bacteriological characteristics. Only those chemical parameters with Class “C” criterion were evaluated and given emphasis on this report.

Table I-A General Observation and Description of Sampling Stations (Morong/Teresa River) – Dry Season

Stations	Mouth of Morong River	Poblacion	Brgy. Bombongan (Bombongan bridge)	Brgy. May-iba (San Jose bridge)	Sitio Sukol Teresa, Rizal)
Station Number	**I**	**II**	**III**	**IV**	**V**
Date	25 April 2011	25 April 2011	25 April 2011	25 April 2011	25 April 2011
Time	11:45 AM	11:00 AM	10:20 AM	9:35 AM	9:10 AM
GPS Reading	P 0311440 UTM 1604619	P 0310191 UTM 1605262	P 0307327 UTM 1605125	P 0306782 UTM 1611093	P 0305822 UTM 1611302
Water Condition	stagnant	slow flow	very slow flow	slow flow	slow flow
Air Temperature (^{o}C)	30	31	28	29	28
Water Temperature (^{o}C)	28	29	28	27	21
Color	greenish	brownish	greenish brown		
Nature of River Bed	muddy bottom	sandy bottom	sandy bottom	sandy bottom	sandy bottom
Weather Condition	sunny	sunny	sunny	sunny	sunny
Other Observations	thick growth of water hyacinth, residential area	high river banks, presence of water hyacinth & kangkong, approx. 3 feet depth, with few rocks & boulders	presence of fishing activity Cast nets, with few rocks & boulders mostly adobe,	with garbage, approx. 24 inches width & 4 inches depth, with fish fry	resort area owned by the Municipality of Teresa, mini falls, some water diverted to raceway and collecting concrete tanks and slowly flowing downstream, spring water from the side goes directly to a water tank, approx. 18 inches width, presence of fish fry

Table I-B General Observation and Description of Sampling Stations (Morong/Teresa River) – Dry Season

Stations	Mouth of Morong River	Poblacion	Brgy. Bombongan (Bombongan bridge)	Brgy. May-iba (San Jose bridge)	Sitio Sukol Teresa, Rizal)
Station Number	**I**	**II**	**III**	**IV**	**V**
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Weather Condition	sunny	sunny	sunny	sunny	sunny
Other Observations	thick growth of water hyacinth, residential area	high river banks, presence of water hyacinth & kangkong, approx. 3 feet depth, with few rocks & boulders	presence of fishing activity Cast nets, with few rocks & boulders mostly adobe,	with garbage, approx. 24 inches width & 4 inches depth, with fish fry	resort area owned by the Municipality of Teresa, mini falls, some water diverted to raceway and collecting concrete tanks and slowly flowing downstream, spring water from the side goes directly to a water tank, approx. 18 inches width, presence of fish fry

5.1 Evaluation of Physico-Chemical Characteristics

Table II-A and II-B shows the dry and wet seasons result of physici- chemical characteristics including results on heavy metals only during the dry season in the Morong/Teresa River System.

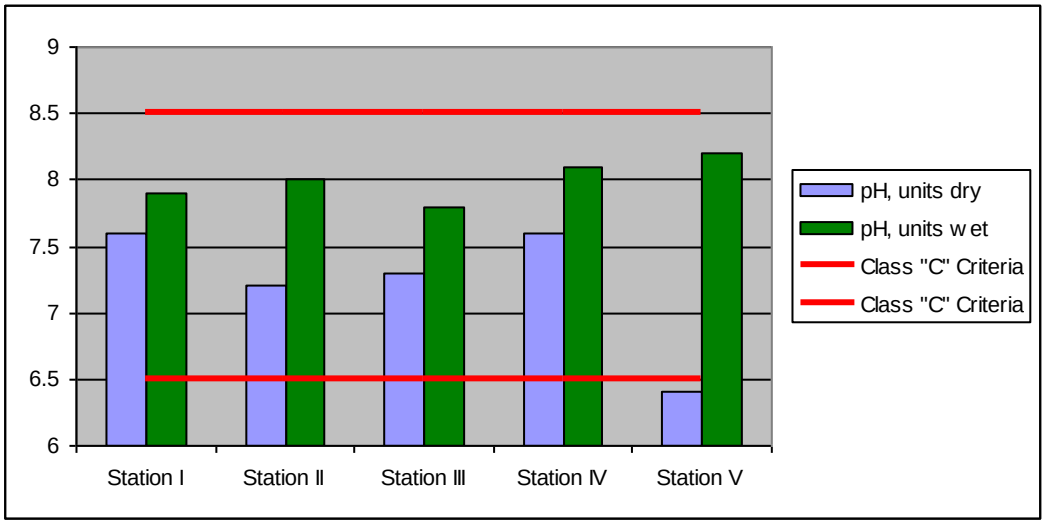
Table II-A. Physico-Chemical /Heavy Metal Results Morong/Teresa(April 25, 2011)

PARAMETERS	STATIONS					DENR Class C Water Quality Criteria
	I	II	III	IV	V	
pH, Units	7.6	7.2	7.3	7.6	6.4	6.5-8.5
Total Suspended Solids, mg/L	<1	7	3	138	8	<30 (increase)
Total Dissolved Solids, mg/L	266	328	691	394	447	1000
Total Solids, mg/L	266	335	694	532	455	*
Chemical Oxygen Demand, mg/L	6	12	52	44	32	*
Biochemical Oxygen Demand, mg/L	<2	4	8	8	4	10
Dissolved Oxygen, mg/L	7.8	4	3.9	16.7	1.6	5 (minimum)
Oil/Grease, mg/L	1	2	8	<2	1	2
Ammonia, mg/L NH_3-N	0.0033	0.4688	0.3505	<0.002	<0.002	*
Nitrate, mg/L-NO_3-N	2.141	0.3693	0.3731	0.0308	0.0994	10
In. Phosphate, mg/L PO_4	0.7473	0.5781	1.1108	0.0043	0.1109	0.4
Total Phosphorus, mg/L	0.8568	0.7902	1.5434	1.0102	0.5098	*
Total Nitrogen, mg/L	5.2	5.9	7.8	6.7	3	*
Chloride, mg/L	22	45	63	48	197	350
Alkalinity, mg $CaCO_3$/L	136	240	456	284	168	*
Calcium Hardness, mg $CaCO_3$/L	80	156	228	88	96	*
Total Hardness, mg $CaCO_3$/L	132	236	336	208	176	*
Turbidity, NTU	2	1	8	58	5	*
Conductivity, µS/cm	396	685	1145	779	1084	*

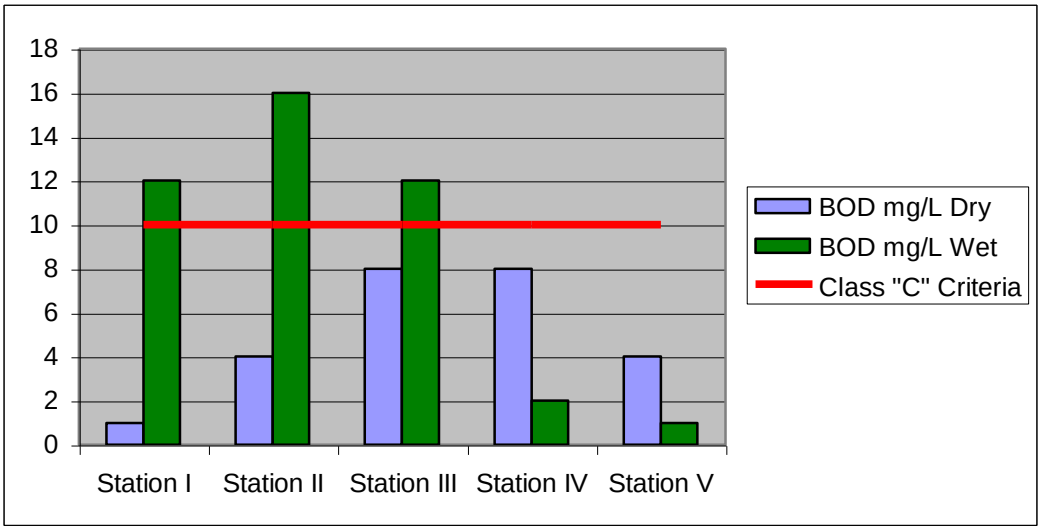
Table II-B. Physico-Chemical /Heavy Metal Results Morong/Teresa (24 Oct. 2011)

PARAMETERS	STATIONS					DENR Class C Water Quality Criteria
	I	II	III	IV	V	
pH, Units	7.9	8.0	7.8	8.1	8.2	6.5-8.5
Total Suspended Solids, mg/L	15	21	16	16	3	<30 (increase)
Total Dissolved Solids, mg/L	290	316	302	308	213	1000
Total Solids, mg/L	305	337	318	324	216	*
Chemical Oxygen Demand, mg/L	23	19	19	16	8	*
Biochemical Oxygen Demand, mg/L	12	16	12	2	<2	10
Dissolved Oxygen, mg/L	4.7	5.4	4.4	7.5	8	5 (minimum)
Oil/Grease, mg/L	<1	<1	<1	<1	2	2
Ammonia, mg/L NH_3-N	1.4080	1.5420	1.8752	0.2103	0.1177	*
Nitrate, mg/L-NO_3-N	1.7379	1.7279	0.9000	0.5696	2.4105	10
Inorg. Phosphate mg/L PO_4	1.0438	1.0958	1.2812	0.0586	0.0057	0.4
Total Phosphorus, mg/L	2.7680	2.692	1.7688	1.972	1.2012	*
Total Nitrogen, mg/L	4.1	4.7	4	4.2	4.4	*
Chloride, mg/L	22	22	19	22	26	350
Alkalinity, mg $CaCO_3$/L	180	196	204	196	104	*
Calcium Hardness, mg $CaCO_3$/L	116	92	112	112	28	*
Total Hardness, mg $CaCO_3$/L	180	200	196	184	104	*
Turbidity, NTU	14	23	14	19	8	*
Conductivity, µS/cm	463	485	509	451	303	*
Cadmium (Cd mg/l)						0.01
Lead (Pb mg/l)						0.05

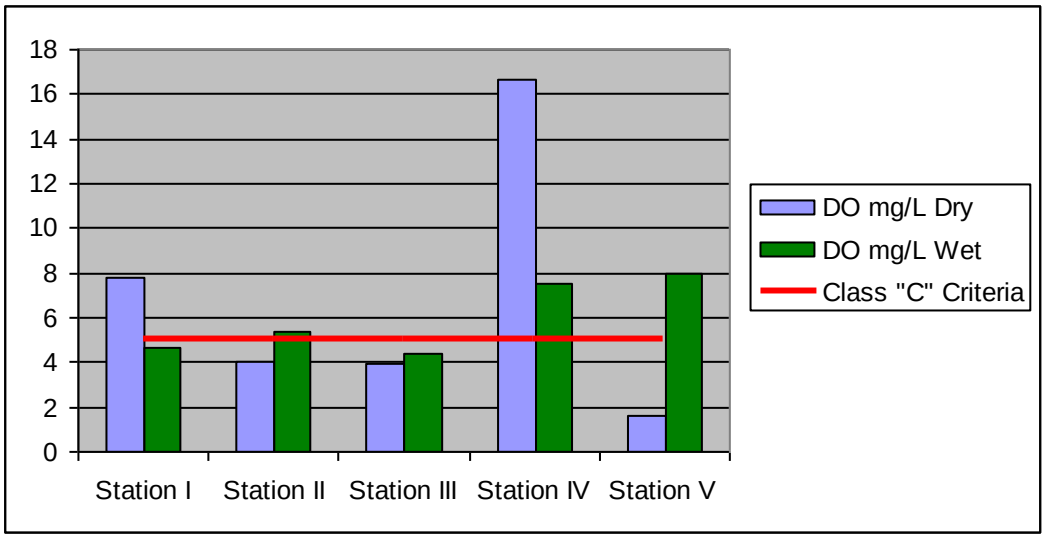
pH is a measure of the basicity and acidity in water. It is measured on a scale of 0 to 14. A value of 7 indicates a neutral condition; values less than 7 indicate acidic condition and values more than 7 indicate basic condition. The pH values in the dry season ranged from 6.4 to 7.6 units. Stn V- Sitio Sukol failed the Class C criteria during the dry season recorded at 6.4 units. However, pH values measured during the wet season were all within the set criteria for Class C waters.



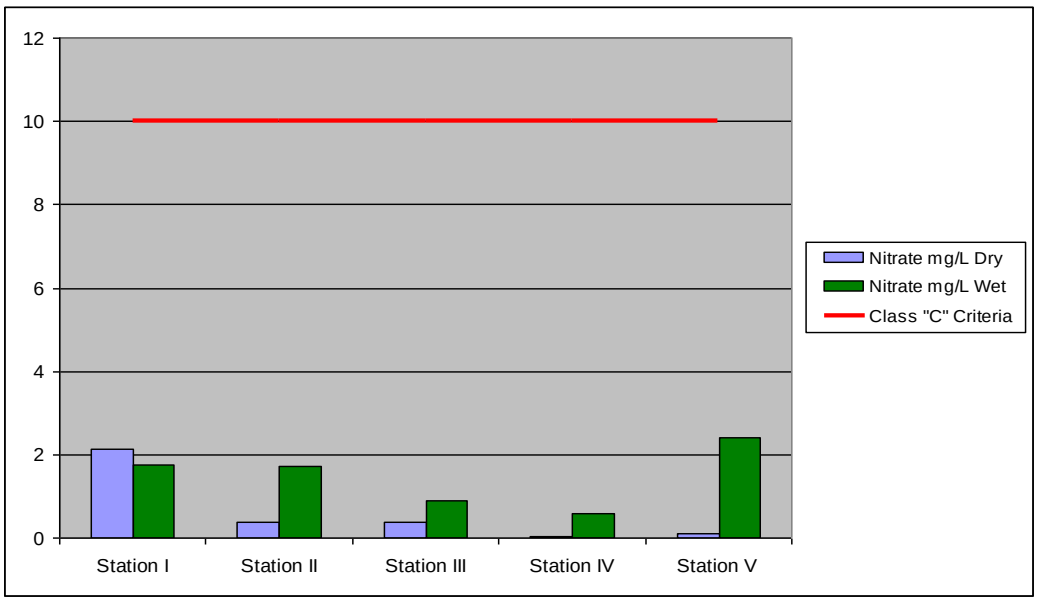
The **Biological Oxygen Demand (BOD)**, is the amount of oxygen required to oxidize the organic matter by aerobic microbial decomposition to a stable inorganic form. The Biochemical Oxygen Demand (BOD_5) in all stations during the dry season were within the threshold level set for Class "C" waters at 10 mg/L ranging from <2 mg/L to 8 mg/l. However, during the wet season only Station IV and V met the criteria for BOD. The BOD in Stations I, II and III were recorded at 12, 16 and 12 mg/L, respectively. The collection of samples was done after the heavy downpour of rain. The sudden flushing of wastes coming from the livestock/pig, urban run-off and domestic wastes coming from the households consequently contributed to the high BOD concentration in the said stations during the wet season.



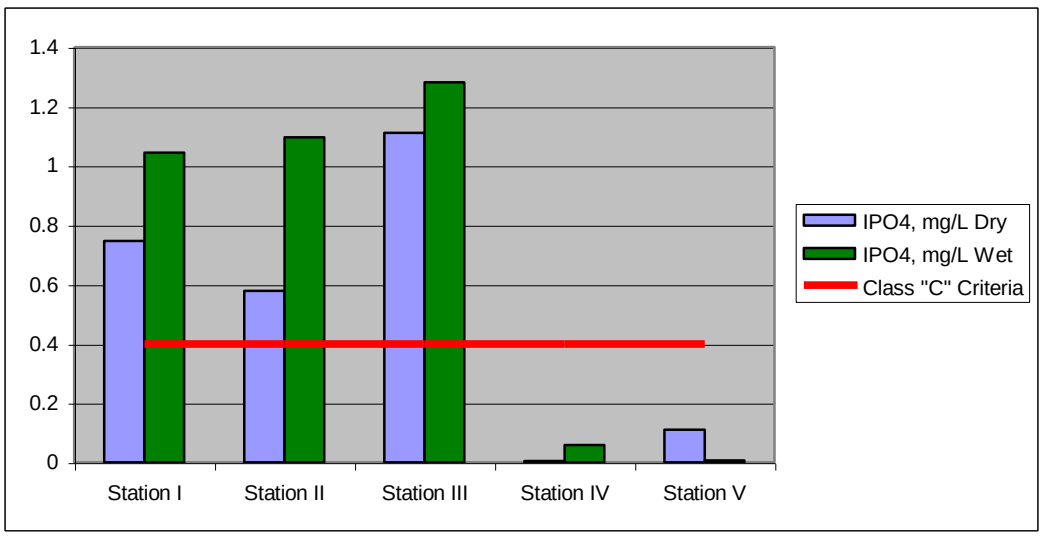
Dissolved Oxygen is naturally occurring gas in surface water. The amount of oxygen depends upon temperature, salinity, turbulence of the water and atmospheric pressure. The decomposition of organic wastes and oxidation of inorganic wastes can deplete the dissolved oxygen level to concentration nearing to zero. The Dissolved Oxygen (DO) ranged from 1.6 to 16.7 mg/L during the dry season and only Stations I and IV passed the 5mg/L criterion for Class “C” water. The DO levels in stations II, III, and V deviated from the criterion for Class “C” waters because of the slow flow of water at the time of collection. On the other hand, the DO levels during the wet season ranged from 4.4 to 8.0mg/L. It is worth mentioning that DO improved in stations II and V during the wet season as compared during the dry season. However, Stations I and III were slightly below the set criteria for DO measured during the wet season at 4.4 and 4.7mg/L.respectively. This could be due to some decaying leaves and algal bloom as evidenced at the time of sampling thus, causing the D.O. to slightly fall.



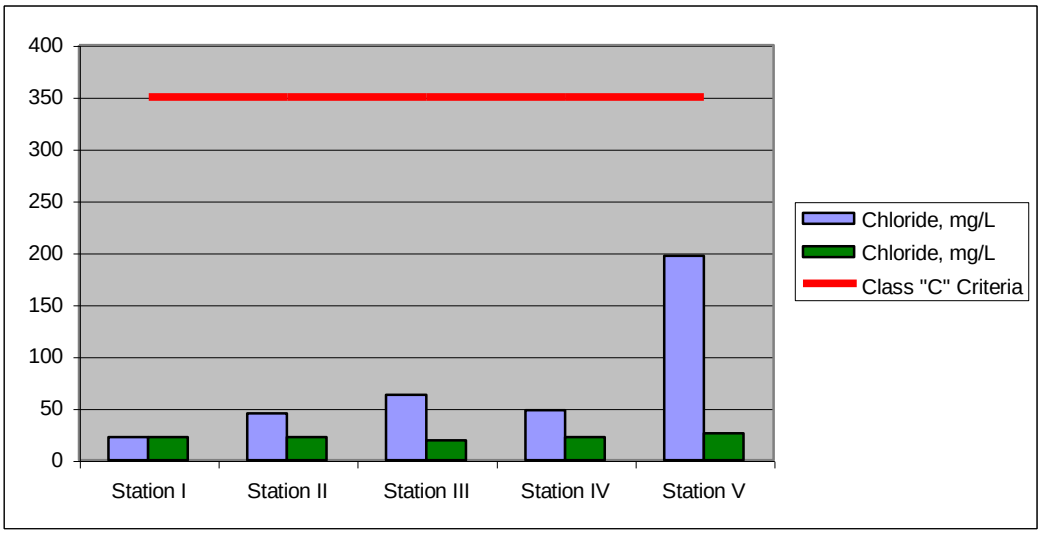
Nitrate the most stable form of combined nitrogen in waters, arises from complete oxidation of nitrogen compound. Human and animal wastes are major sources of nitrate. Nitrate stimulates plant growth. Excessive amount of nitrate can result in algal bloom. Based on laboratory result, nitrate concentrations during the two seasons conformed with the Class "C" criteria of 10 mg/L. Nitrate concentrations in the identified stations ranged from 0.0308 to 2.141 mg/L and 0.5696 to2.4105mg/L for dry and wet seasons, respectively.



Phosphorus is an essential plant nutrient and it may be a limiting factor for plant growth. Phosphorus comes from domestic sewage, detergents/surfactants, industrial effluents, and agricultural run-offs. The Phosphate concentration for Stations IV and V for dry and wet seasons respectively, conformed to the Class "C" Criteria of 0.4 mg/L, while, Stations I, II, and III for both seasons exceeded the set criteria with values at 0.5781,0.7473 and 1.1108 mg/L for dry season and 1.0438, 1.0958 and 1.2812 for the wet season. The high phosphate concentrations in the three aforementioned stations possibly came from the agricultural run-offs coming from nearby rice fields located in Station III and from the domestic wastes coming from the households.

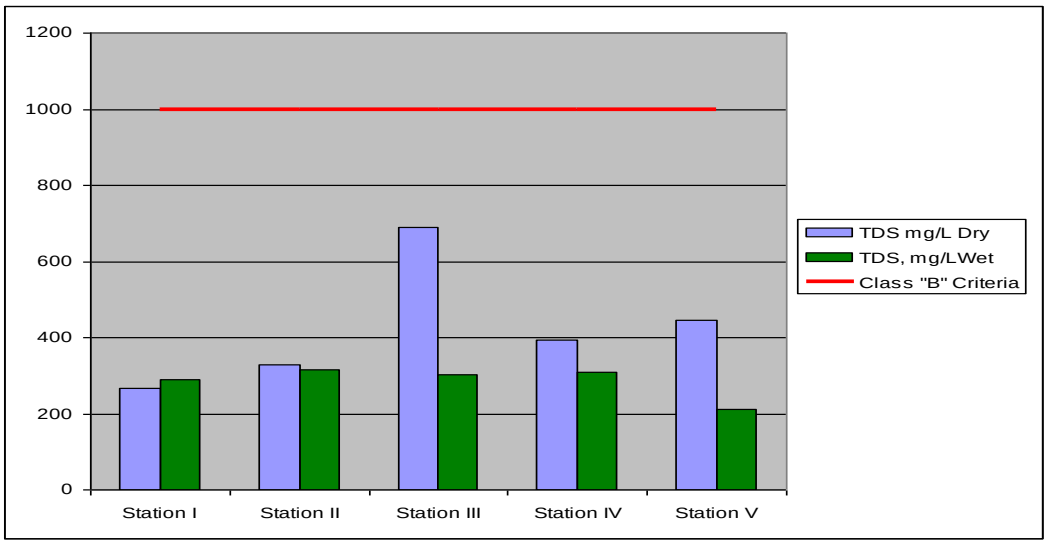


Chloride is a major inorganic anion that occurs in variable concentrations in natural waters. Most chlorides are very soluble and may impart a distinctive salty taste to the water, increase corrosiveness and can adversely affect metallic equipment. The chloride concentrations in all stations for both dry and wet seasons were way below the Class “C” criteria of 350 mg/L.

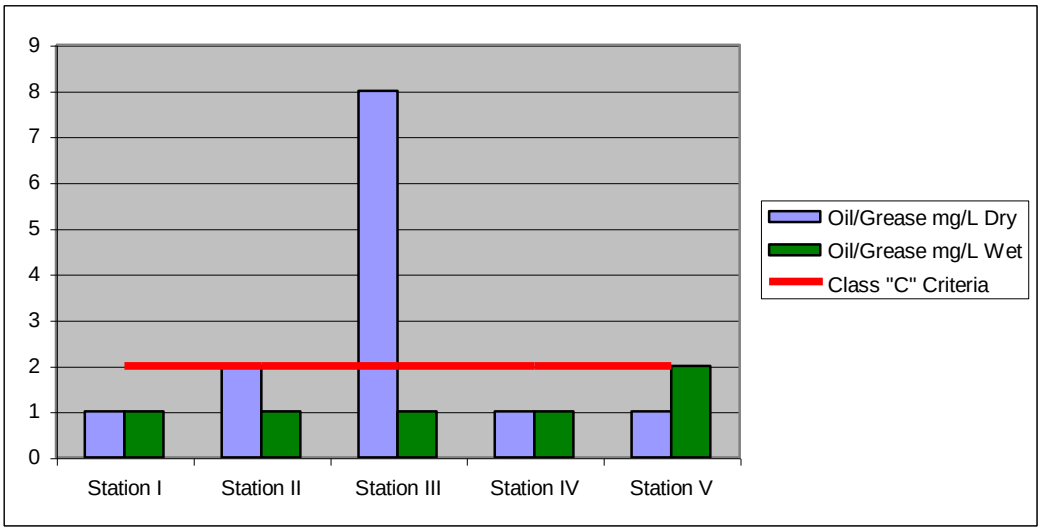


Total Dissolved Solids is the amount of dissolved substances in water. It can be in the form of salt of sodium, chloride, magnesium, silica, sulfate in solution. TDS are due to surface/agricultural run-offs, decaying plant material, soil particles, industrial and municipal discharges.

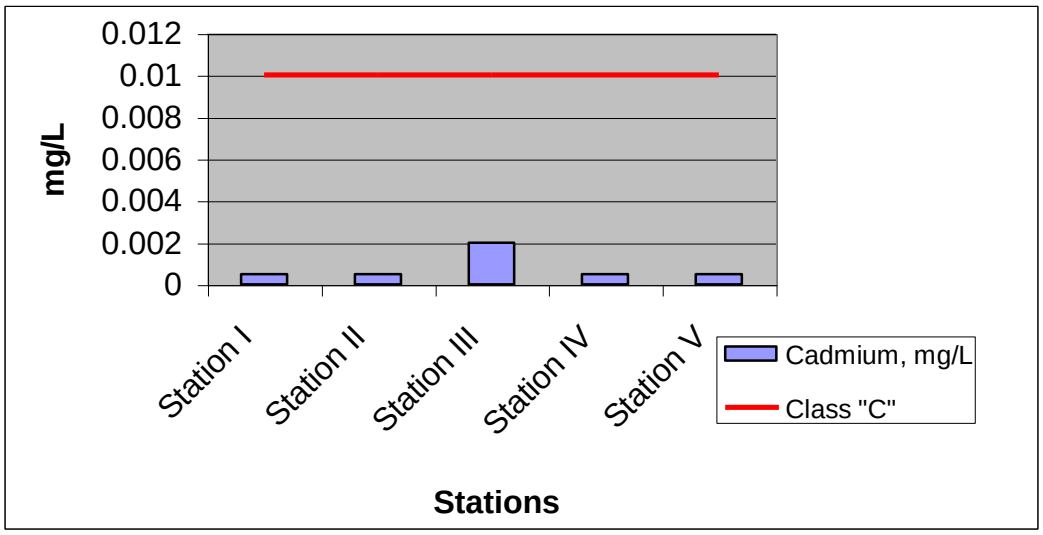
The TDS concentrations during the dry and wet seasons were all within the 1000mg/L criteria for Class “B” (There is no set criterion for Class C waters for TDS).



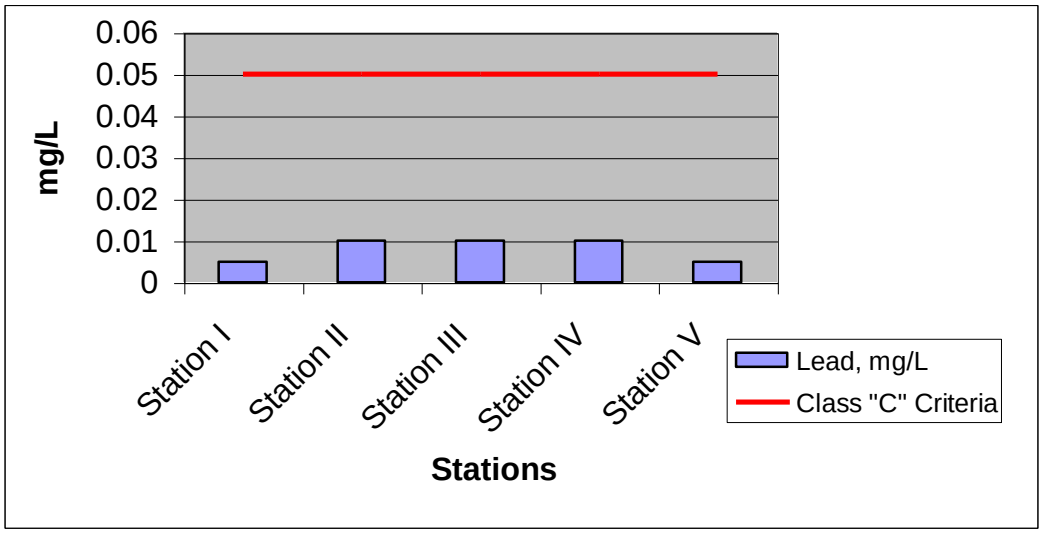
Oil/Grease in water comes from domestic households, manufacturing industries and pump boats navigating the water bodies. The oil/grease in all stations during the dry season except Station III were all within the threshold level of 2 mg/L. The oil/grease value recorded in Station III was 8 mg/L. The high concentration of oil and grease in Station III could possibly come from the domestic households and livestock industries located upstream. It was also observed that water in the aforesaid station has a very minimal flow of water during the time of sampling. Nevertheless, it is worth mentioning that the Oil/Grease concentration has tremendously improved and were all within the standard for Class C waters during the wet season.



Cadmium has a cumulative and highly toxic effect on man in all its form. The presence of cadmium may restrict the use of water as a source of drinking and may have harmful effects on the aquatic environment. The levels of Cadmium in all stations were below the Class C criterion.



Lead is a toxic material that accumulates in the skeletal structure of man and animal. The principal natural source of lead is the weathering of the sulfide ores, like galena (PbS). Lead was found to be within the criterion set at 0.05 mg/L. Although concentration of lead is still way below the set standard, it is proper that we take extra precautionary measures because lead usually begins in the nervous system of both adult and children and can re-enter the blood streams and organs.



5.2 Algal Population

Table IIIA-IIIB shows the algal population and the relative % contribution in the five (5) sampling stations during the dry and wet seasons. All five identified stations were classified as moderately polluted to polluted based on algal composition.

Table III-A. Water Quality Assessment in Morong/Teresa River based on Algal Population (April 25, 2011)

Stations	Counts (organism/sq.m)				% Contribution				Water Quality
	CWA	PWA	OTHERS	TOTAL	% CWA	% PWA	% OTHERS	TOTAL	Assessment
I	15221	77369	8878	101468	15	76.2	8.7	100	Polluted
II	10464	105808	3131230	3247502	0.3	3.3	96.4	100	Moderately Polluted
III	38053	80069	6343	124465	30.6	64.3	5.1	100	Polluted
IV	72946	481987	10908	565841	12.9	85.2	1.9	100	Polluted
V	2440	8540	610	11590	21.1	73.7	5.3	100	Polluted

Table III-B. Water Quality Assessment in Morong/Teresa River based on Algal Population (October 24, 2011)

Stations	Counts (organism/sq.m)				% Contribution				Water Quality
	CWA	PWA	OTHERS	TOTAL	% CWA	% PWA	% OTHERS	TOTAL	Assessment
I	4862	46193	4863	55918	8.7	82.6	8.7	100	Polluted
II	6659	134295	1110	142064	4.7	94.5	0.3	100	Polluted
III	6342	108874	5285	120501	5.3	90.4	4.4	100	Polluted
IV	6889	17223	19806	43918	15.7	39.2	45.1	100	Moderately Polluted
V	1579	789	0	2368	66.7	33.3	0	100	Moderately Polluted

Notes:
CWA- Clean Water Algae
PWA-Polluted Water Algae
Others- Algae not classified as CWA or PWA

Station I was classified as polluted during the dry and wet period. There were eight (8) and seven (7) species of algae identified during the dry and wet sampling. Two species identified as clean water algae (CWA) namely: ***Navicula sp.; Pinularia sp***. with percentage contribution of 15.0% and 8.7% were identified during the dry and wet sampling. However, ***Oscillatoria sp. Gomphonema sp***. and ***Nitzchia sp.*** identified as polluted algae (PWA) has a total percentage contribution of 76.2% and 82.6% each for dry and wet collection. Other surface algae identified with 8.7% contribution were ***Epithemia sp., Cymbella sp***. and ***Stephanodiscus s***p. for the dry season and ***Cymbella sp.*** and ***Synedra sp***. with a percent contribution of 8.7 during the wet season.

Station II, a thickly populated area situated within the heart of the Municipality of Morong, was classified as moderately polluted during the dry season to polluted during the wet season In terms of algal composition. Stn. II was the most diversified with nine (9) species of algae identified during the summer season while only six (6) species of algae were identified during the

rainy period. There were two (2) species of algae***, Navicula sp***. and ***Pinnularia sp***. classified as clean water algae with contribution of 0.3% and 4.7% for dry and wet season correspondingly. The identified polluted algae during the dry season were ***Oscillatoria sp***. and ***Nitzchia sp***. with a 3.3 % contribution. The polluted water algae during the wet season were identified as ***Nitzschia sp***., ***Gomphonema sp***, and ***Oscillatoria sp***. with contribution of 94.5%. A relatively high contribution came from other algae during dry season at 96.4% and a very minimal contribution of 0.3% from other species of algae during the wet season.

Station III was identified as polluted based on the algal composition for dry and wet seasons. Six (6) species of algae were identified during the first sampling. The algal concentration was characterized by both clean and polluted water algae ranging from 30.6%-64.3% respectively. Clean water algae consisted of ***Navicula sp***. and ***Pinularia sp***. while ***Gomphonema sp***. and ***Nitzchia sp***. comprised the polluted water algae. Other organisms included were ***Rhopalodia sp***. and ***Stauroneis sp.*** During the wet season Station III was the most diversified in terms of algal composition. A 90.4% contribution of polluted algae was recorded during the wet period. Other species of algae comprised 4.4% of the total algal population.

Station IV Brgy May-iba (San Jose Bridge). Station IV has the highest total number of algal species recorded at 565841 counts/ml. Two (2) clean water algae ***Navicula sp***. and ***Pinularia sp***. were recorded with a relative percent contribution of 12.9%. Two species of polluted algae were identified ***Nitzchia sp***. and ***Gomphonema sp***. with 53.73% and 31.44% abundance respectively. Other organisms included ***Cosmarium sp***., ***Scenedesmus sp***.; ***Zygnema sp***.; ***Stauroneis sp***., and ***Synedra sp.*** comprising 1.9% algal contribution. Station IV was classified as polluted water. On the other hand, during the wet sampling Station IV improved from polluted to moderately polluted The algal distribution during the wet season in said station were 15.7% for clean water algae; 39.2% for polluted algae and 45.1% for other organisms like ***Cymbella sp***. and ***Synedra sp.***

Station V is situated at Sitio Sucol, Teresa, Rizal. The water in said station was classified as polluted during the dry season. The least diversified algal population was recorded in Station V. Only five (5) species were identified. ***Navicula sp.*** and ***Pinularia sp.*** belonging to clean water algae with percent contribution of 21.1 while ***Nitzchia sp***. and ***Gomphonema sp***. dominated the polluted algae with 73.7% contribution. Other organism identified was ***Diploneis sp***. with 5.3% algae population contribution. During the wet season Station V has improved its classification as moderately polluted in terms of its algal population with 66.7% clean water algae indicator composed of ***Navicula sp***, and 33.3% composed of ***Oscillatoria sp.*** an indicator of polluted water algae. The increase in number of clean water algae indicator in Station V has improved its classification from polluted to moderately polluted during the wet season.

5.3 Benthos

Table IIIC-IIID presents the benthos population from the five (5) sampling stations along the Morong/Teresa River System and were classified as having moderately polluted to polluted depending on the number and type of organisms present during the dry and wet season samplings.

Table III-C. Water Quality Assessment in Morong/Teresa River Based on Benthic Population (April 25, 2011)

Stations	Individual / square meter					Percentage Contribution					
	CWI	MPWI	PWI	OTHERS	TOTAL	%CWI	%MPWI	%PWI	%OTHERS	TOTAL	WQ Assesment
I	0	5612	143	0	5755	97.5	2.5	2.5	0	100	Moderately Polluted
II	0	0	1237	0	1237	0	0	100	0	100	Polluted
III	0	144	7943	98	8182	1.8	97.1	97.1	1.2	100	Polluted
IV	0	2133	755	89	2977	71.6	25.4	25.4	3	100	Moderately Polluted
V	44	2400	22	89	2555	93.9	0.9	0.9	3.5	100	Moderately Polluted

Table III-D. Water Quality Assessment in Morong/Teresa River Based on Benthic Population (October 24, 2011)

Stations	Individual / square meter					Percentage Contribution					
	CWI	MPWI	PWI	OTHERS	TOTAL	%CWI	%MPWI	%PWI	%OTHERS	TOTAL	WQ Assesment
I	0	143	48	0	191	0	74.87	25.13	0	100	Moderately Polluted
II	48	0	95	0	143	33.57	0	66.43	0	100	Moderately Polluted
III	0	96	48	0	144	0	66.67	33.33	0	100	Moderately Polluted
IV	77	0	33	0	110	70	0	30	0	100	Moderately Polluted
V	33	66	0	0	99	33.33	66.67	0	0	100	Moderately Polluted

5.3.1 **Moderately Polluted**

The organisms found in Station I indicate moderate pollution. During the dry season, Station I ranks second in terms of population density with 5612 organism/m^2 area or relative percent contribution of 97.5 moderately polluted water. During the wet season, Station 1 has the most number of benthic organisms recorded at 191 per square meter.

Station IV is the most diversified in terms of organisms present. Fort eight percent (48%) or 1422 organism/m^2 was dominated by ***Thiara scabra*** species. ***Thiara*** (Gastropods) was able to survive in this station including some ***Opheciphalus striatus*** (dalag) with 3% contribution. The presence of dalag was possible due to the favorable levels of BOD and D.O. Besides, dalag use their gills for breathing and are capable to carry gas exchange. During the wet season, Station IV was classified as moderately polluted water with 70% organism identified as clean water indicator and 30% were identified as polluted water indicator.

Station V Results of analysis for the dry season revealed that only Station V recorded a clean water indicator with 44 org./m^2 identified as ***Baetis*** *sp*. with 1.7% contribution. The diverted mini falls to raceways and collecting tanks could have favored to the aforementioned species. Station V was dominated by organisms that can survive in moderately polluted water with relative % contribution of 93.9% dominated by ***Thiara scabra*** in the dry season. Fish fry were also observed present in the water tank.

During the wet season sampling conducted in October,2011 it is worth mentioning that Stations II and III has improved from polluted to moderately polluted in terms of water quality assessment. All stations during the wet season were all classified as moderately polluted based on benthic organism identified,

5.3.2 **Polluted Stations**

Two (2) sampling stations (**Stations II and III**) located in the Poblacion and Brgy. Bombongan respectively were classified as polluted in terms of benthic population during the dry season. Station II has the least number of organisms recorded. Analysis of samples yielded 100% of polluted water indicator belonging to Class Oligochaeta and Chironomid larvae.These organisms are known as pollution tolerant form. Accumulation of organic wastes and undetected toxic wastes coming from the households can be considered as stressors to the benthic organisms.

Station III was classified as polluted during the dry season and has only six (6) species present. The quality of the water favored the proliferation of bio-indicators tolerant to pollution. The combined pollution of moderately and polluted indicators yielded 1.8% and 97% composition respectively. Other species present was ***Cypricercus cypricercus*** with 95organism/m^2 area comprising 1.2%. However, during the wet season, Station III was classified as having moderately polluted water.

5.4 **Microbiological Characteristics**

Microbiological examination of water is used to monitor and control the quality and safety of various types of water. The method is intended to determine the degree of contamination with wastes. The Coliform group of bacteria is the main indicator on the suitability of water for domestic/ industrial and other beneficial uses including fishery and recreation. The presence of coliform group expressed in Most Probable Number (MPN) serves as index of the degree of pollution.

Table IV. Results of Microbiological Analysis of Water (Dry and Wet Season)

Sampling Station	Location	Total Coliform (MPN/100mL)		Fecal Coliform (MPN/100mL)		Detection of Escherchia
		Dry	Wet	Dry	Wet	
I	Mouth of Morong River	220,000	70,000	220,000	13,000	+
II	Poblacion	30,000	54,000	300,000	24,000	+
III	Bgy. Bombongan	40,000	35,000	40,000	13,000	+
IV	Bgy. May-iba	2,200,000	35,000	1,400,000	35,000	+
V	Sitio Sukol	20,000	170,000	20,000	130,000	+

Table IV shows the results of microbiological analysis based on the Total and Fecal Coliform concentrations. All five (5) stations monitored during the dry and wet seasons significantly exceeded the DENR criteria for Class C Waters of 5000 MPN/100 ml for Total Coliforms. Station IV gave the highest total and fecal coliform in the dry season wherein piggery/hog farms are located measured at 2,200,000 and 1,400,000 MPN/100ml, respectively. Recorded values for Fecal Coliforms were extremely high during the dry season ranging from 20,000-1,400,000 MPN/100ml and 13,000-130,000 MPN/100ml during the wet season. Station V gave the highest total and fecal coliform during the wet season and this could possibly be due to surface run-off measured at 170.000 and 130,000 MPN/100ml,respectively. The presence of ***Escherichia coli*** (E.coli) in all stations could be alarming because it can pose health hazards such as diarrhea and urinary tract infection and other diseases.

Conclusion

Based on the results of analyses and observations made during the survey and sampling activities, it is categorically revealed that pollution is evident in the Morong/Teresa river system. The pollution in the river appeared to be attributable to domestic wastes and from the wastes coming from piggery and hog farms. The color of the water from greenish to turbid brown and the presence of garbage in some sections of the river strongly support the polluted water quality assessment based on phytoplankton and from moderately polluted to polluted assessment of the river based on the benthic fauna results of analysis.

Recommendation

Based on the results of the water quality assessment, it is strongly recommended that river clean-up be done in order to improve/rehabilitate the deteriorating water quality of the Morong/Teresa River. The identified sources of pollution from the households and specifically those coming from piggery/hogs must have a proper waste treatment plant to ensure that wastes coming from their farm will not be harmful to aquatic organisms.

Local government of Morong and Teresa in collaboration with LLDA should initiate the activity and with full support from the two involved towns. Regular monitoring of the river system is also recommended to assess improvement of its water quality after the initial study. All efforts to rehabilitate the Morong/Teresa River System will not be realized unless illegal settlers continue to dwell in the areas along the river system.