

Water Testing of the Upper Basin in the
Whitewater River

By

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INTRODUCTION

The habitat water plan is attempting to improve water quality through pollution reduction and protection. One of the areas identified as high priority is the Whitewater River Watershed. It is cited as impaired due to levels of fecal coliform bacteria that exceed the Total Maximum Daily Load (TMDL). Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are set up by the Kansas Department of Health and Environment (KDHE) and are approved by the Environmental Protection Agency (EPA). Currently the goal for this watershed is to make it meet Primary Contact Standard TMDL, which is 200 colonies/100mL for fecal coliform bacteria. Kansas hopes to have implemented all pollution reduction plans during the 2003-2007 timeframe and hopes to have two-thirds of landowners responsible for their own individual sites. Since 2007 marks the midpoint of the ten year timeframe they also hope to see that data collection reflects a decrease in the levels of bacteria, indicating that the implementations are effective.

This watershed has several possible sources of pollution. There are three point sources in this area upstream to the monitoring site 038 (Towanda) that may contribute levels of bacteria. All three have National Pollutant Discharge Elimination System (NPDES) permits, so the goal here is to inspect the sites to ensure there is complete compliance. There are 75 livestock waste management systems, but only 10 are NPDES permitted. KDHE must be informed if the farm has 300 or more animals. Our primary focus for pollution in this area is the non point sources; these include livestock waste, runoff, and failing on-site waste water systems. The land use in the upper two-thirds is 65% crop which is likely to contribute nutrients from pesticides used on crops. When it rains the pesticides often create runoff that enters nearby streams. On-site waste systems (septic tanks) may also be contributing to the bacteria levels. There is a higher density of people in the lower one-third of the basin so it is likely that this is where we will see possible effects of this.

As part of the continued effort to monitor this basin we tested for fecal coliform as well as several other possible impairments which include: biochemical oxygen demand (BOD), phosphorus, nitrates, dissolved oxygen, total dissolved solids, conductivity, and turbidity. In addition to this we also wanted to determine if any of the eight streams was contributing more pollutants to site 038 (Towanda) than another. This would possibly give us a better determination of the source of the pollutants so that we could better correct the problem. Our samples were collected in the fall 2005, a low stream flow category. Collecting samples after a major rainfall would have been almost impossible due to the location of several of our testing sites.

The Biochemical Oxygen Demand (BOD) must be below 5mg/L, anything higher indicates an excess of bacteria colonies and large quantities of biodegradable wastes. Nitrates and phosphorus can both lead to aging of the stream due to an exploded growth of algae which will then deprive the lake of oxygen. The TMDL for nitrates is acceptable up to 1.2mg/L and up to 0.1mg/L

for phosphorus. Oxygen levels must be above 5mg/L so that aquatic life is not harmed, anything lower will begin to kill the fish and other aquatic organisms. The total dissolved solids measurement represents a test for anything other than water. A level greater than 500mg/L cause impairment and "harder" water. As stated above the TMDL for fecal coliform bacteria is 200 colonies /100mL anything higher suggests that pathogenic organisms may be present and the water is unsafe for swimming or drinking. Fecal coliform has a secondary contact standard for non contact recreation (fishing and boating) and it is not to exceed 2000 colonies/ 100mL.

METHODS

Procedures

We used a one gallon bucket with a rope tied to the handle in order to retrieve a sample of water from the middle of each stream. Water was immediately drawn, covered, and set aside to be tested later for BOD and nitrate levels. We used protocols described by Hach Water Analysis Handbook (Hach, 1992). At each site we tested dissolved oxygen, phosphates, turbidity, conductivity and temperature. The dissolved oxygen, nitrates, and phosphates were measured using AccuVacs and the DR2000. The total dissolved solids, conductivity and temperature were tested using the Hach conductivity/TDS meter. The turbidity was tested using a 2100P turbidimeter. In the lab we tested nitrates, fecal coliform bacteria and BOD levels. Additional data for nitrate, phosphorus and fecal coliform were used.

The BOD test takes 5 days to complete. The first step in measuring BOD is to obtain equal volumes of water from the area to be tested and dilute each specimen with a known volume of distilled water which has been thoroughly shaken to ensure oxygen saturation. After this, an oxygen meter is used to determine the concentration of oxygen within one of the vials. The remaining vial is then sealed and placed in the dark and tested five days later. BOD is then determined by subtracting the second reading from the first. The range possible readings can vary considerably: water from an exceptionally clear lake might show a BOD of less than 2mg/L. Raw sewage may give readings in the hundreds and food processing water may be in the thousands. For our purposes, we used 5mg/L as the cut point for as per TMDL and numbers were compared.

What to expect:

BOD level (in ppm)	Water quality
1-2	Very good (there will be not much organic waste present in the water supply)
3-5	Fair (Moderately clean)
6-9	Poor: Somewhat Polluted
100 or >	Very poor: Very polluted (contains organic waste).

Stream site Description

Site 1 occurred on Rock Creek: We pulled the sample off of Diamond Road from the west side of the bridge. Rock Creek is south of the town of Potwin. The Public Land Survey (PLS) address is NE corner NE ¼ of section 19 in T25S R4E.

Site 2 occurred on Fourmile Creek: We pulled the sample off of Diamond Road from the west side of the bridge. Fourmile Creek is south of the town of Potwin. The PLS address is SW corner SW ¼ of section 8 in T25S R4E.

Site 3 occurred on Dry Creek: We pulled the sample off of 196 highway on the north side of the bridge. Dry Creek is near to the town of Potwin. The PLS address is SW ¼ SW corner of section 24 in T24S R3E.

Site 4 occurred on Diamond Creek: We pulled the sample off of 80th Road on the north side of the bridge. Diamond Creek is near the town of Potwin. The PLS address is NE ¼ NW corner in section 30 in T24S R3E.

Site 5 occurred on Henry Creek: We pulled the sample off of Santa Fe Lake Road on the west side of the bridge. Henry Creek is north of the town of Potwin. The PLS address is NE ¼ NE corner in section 1 of T24S R3E. There were some farms nearby with chickens and pigs, this may have contributed to the high levels that we received when testing this site.

Site 6 occurred on Upper Whitewater River: We pulled the sample off of 120th Road on the west side of the bridge. Upper Whitewater River is north of the town of Potwin. The PLS address is NW ¼ NW corner in section 5 of T24S R4E.

Site 7 occurred on East Branch of Whitewater River: We pulled the sample off of River Valley Road on the west side of the bridge. The East Branch of Whitewater River is north of the town of Potwin. The PLS address is NE ¼ SE corner in section 8 of T24S R4E.

Site 8 occurred on Wildcat Creek: We pulled the sample off of Butler Road on the east side of the bridge. Wildcat Creek is south of the town of Potwin. The PLS address is SE ¼ SE corner in section 19 of T25S R3E.

Site 9 occurred on Whitewater River: We pulled the sample off of 254 highway on the south side of the bridge. This Whitewater River site is west of the town of Towanda. The PLS address is SW ¼ SE.

Main Stem Segments, WQLS, are 18, 19, 21 and 23 (Whitewater River) starting at confluence with Dry Creek (immediately upstream of Whitewater River confluence with Walnut River) and traveling upstream to headwaters in south Marion County. Tributary segments, WQLS, are W. Br. Whitewater River, Whitewater Creek, Prairie Creek, W. Br. Whitewater River, Wildcat Creek, Sand Creek, W. Wildcat Creek, Gypsum Creek, E. Br. Whitewater Creek, Rock Creek, Fourmile Creek, Dry Creek, E. Br. Whitewater River, Henry Creek. Non-WQLS are Elm Creek, Badger Creek, and Walnut Creek.

Monitoring Sites are station 038 at Towanda. The designated uses are expected aquatic life support, primary contact recreation, domestic water supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segments (18,19,21 and

23). The impaired use is contact recreation. The TMDL for Fecal Coliform Bacteria is 200 colonies per 100 ml.

RESULTS

Overall Data Comparisons

Figure 2 show us that the streams in the upper Whitewater River Basin exceeds the TMDL frequently with 77 out of 168 samples tested over the TMDL (200 colonies/ 100 ml) for fecal coliform bacteria. Telling us that 46% of the water tested is over the KDHE regulations. This stream would be considered impaired with bacteria and is not in TMDL regulation. There is no pattern in the data we collected to determine where the fecal coliform may be coming from.

Figure 3 show us that the streams in the upper Whitewater River Basin exceeds the TMDL a little more than half of the times tested with 87 out of 171 samples tested over the TMDL (1.2 mg/L) for Nitrate. This tells us that 51% of the water tested does not meet TMDL regulations. This stream is impaired with a high amount of Nitrate. According to our data we found no pattern of where the excess is coming from.

Figure 4 shows us that the streams in the upper Whitewater River Basin exceed the TMDL frequently with 154 out of 168 samples taken tested over TMDL (0.1 mg/L) for phosphorus. This tells us that 92% of the water tested is over KDHE regulations. This stream is highly impaired with phosphorus. There seems to be a pattern of all the phosphorus samples taken after 12/16/04 tested drastically lower than previous then all of the previous dates that tested way over.

Figure 5 shows us that the streams in the upper Whitewater River Basin do not exceed TMDL 16 out of 63 samples taken tested over the TMDL (5 mg/L) for BOD. This tells us that only 25 % of the samples taken are over KDHE regulations. This stream would not be considered impaired. There is no seen pattern for BOD over the data taken.

Other data was also collected to look for ephemeral events on conductivity and turbidity (Fig. 6 and 7). A high level of conductivity represents a surge of salt release, most likely from oil well operations. There are a number of oil well production sites in the drainage basin. A high conductivity level is likely to be an ephemeral event, short-lived spike. Fig. 6 shows no such events occurred during our sampling period during the past year.

A high level of turbidity occurs usually during a high runoff event, triggered by large amount of rainfall. The turbidity levels for our samples show that we sampled during low runoff times which typically occur during fall and early spring (Fig. 7).

Individual Stream Comparisons

Fecal Coliform Bacteria High colony counts are infrequent unless there was a recent fecal pollution. This kind of bacteria cannot multiply outside the intestine of a warm-blooded animal. They are directly associated with other pathogens, such

as protozoa and viruses, which can cause sickness in people and animals. The higher the level the higher is the likelihood disease causing pathogens are present in the water. The source of these bacteria includes failing or improperly constructed septic systems, runoff from livestock confinement areas or livestock wintered adjacent to streams or ponds.

TMDL (KDHE) criterion shows that the level exceeds 2000 colonies per 100ml the water is not safe for non-contact recreational use, such as boating and fishing. Also, if the level exceeds 200 colonies per 100ml the water is not safe for human contact, such as swimming and drinking. On the collecting dates 9-4-04, 10-29-02, 4-23-03, 6-30-03, 7-22-03, and 8-13-02, all of the rivers reached the level of 2000 but never exceeded TMDL criterion for non-contact recreational use. This might have been due to the weather and also some farmers might have let the cattle get into the rivers. All of the rivers on most of the days exceed the criterion for human contact, since there are livestock close to the rivers and many streams and ponds run into these rivers.

Fig.8 shows that Rock Creek and Four Mile exceeded the criterion for human contact very often, 58% and 47% of the time. Rock Creek exceeded the criterion the most compared to all other rivers. Dry and Diamond Creek exceeded the criterion 37% and 43% of the time, there are no farms close by. Henry, Upper Whitewater River, East Branch of Whitewater River exceeded the criterion 52%, 52%, and 43% of the time because there are plains by the rivers where farmers let their cattle grass. West Branch of Whitewater River exceeded the criterion a fair amount compared to the other rivers, 40% of the time. But mainstream site at Towanda (038) had the best reading of all rivers on 29% of the time. After analyzing the data, Rock Creek, Upper White Water River, and Henry add the most pollution to the White Water River.

Fig. 9 shows the mean numbers of colonies per 100ml for various streams. Diamond Creek and Upper White Water River have the highest mean number of colonies about 730 and 700. Next highest numbers were, Four Mile, Dry Creek, E.B. White Water River, and Four Mile ranging from 590 to 665. Rock Creek and Towanda have the lowest mean number of bacteria colonies, ranging from 145 to 190. In between the rivers with the lowest mean number of bacteria colonies and the once with the high number lies W.B. White Water River with 490 mean numbers of bacteria colonies.

Nitrate The main reasons for checking the levels of nitrates when monitoring surface water is that it tells us how recently a stream has been polluted and the amount of nitrates can be related to a possible health hazard. Also the concentration of nitrates may indicate the possibilities of nuisance alga blooms. Nitrates are the final products of the biochemical oxidation of ammonia. Sources of nitrates include nitrogen fertilizers runoff, wastewater treatment plant effluent, leaking septic systems, lagoons and livestock. Nitrates can also be from organic material in eroded soil, decomposing plant material and wildlife. Drinking water with high nitrate content causes methemoglobinemia in infants, which is due to lack of oxygen in the blood. Since this raised level of nitrates leads to an

explosive growth of algae and a sudden death and decomposition event. As a result the level of oxygen will reduce leading to a threat to aquatic life. Nitrate levels greater than 1.2mg/L of water for TMDL can lead to eutrophication.

Figure 10 shows the percentages above the standard TMDL for the different streams. We see that, the Dry creek exceeded the standard TMDL two times while the E.B. WW River and the Henry exceeded once. The west stream was also least polluted as it exceeded only by 29%. Based on the results, the streams were all impaired.

These streams of the White Water Basin were tested three different times (9/23/05, 10/07/05, and 10/28/05) although the data was added to the previous results from other testers (Fig 11). The two east streams Rock and Four mile were the least polluted and the Dry Creek and the E.B.WW River were the most polluted with 1.4 mg/L exceeding the TMDL standard value of 1.2mg/L and having percentages of 86 and 76% respectively. This is possibly because they were close to a farmland. For the three upper streams, we saw that the Henry was highly polluted on the last check day as it was 1.3mg/L exceeding the TMDL value. For the mid-streams, the Dry creek was also highly polluted on the first and third check as compared to the Diamond. The mean values also show that the 3, 4, 7, 6, 5, all exceed the standard value and the standard deviation also shows that the Dry creek deviated the most from the standard Towanda stream and the Rock was the closest. The west stream had the same as Towanda and all the other streams were more polluted as compared to that on Towanda.

Phosphorus Phosphorus is a nutrient that at increased levels can cause an overgrowth of algae, oxygen depletion, odor and a decrease in water transparency. Phosphorus is found in fertilizer, detergents, and human sewage. Point sources of phosphorus pollution include municipal and industrial wastewater discharge. Non point sources of phosphorus pollution include runoff from agricultural fields, feedlots, and urban areas. The TMDL for phosphorus is 0.1 mg/L. Levels of phosphorus that exceed this level cause a stream to be classified as impaired.

Figure 12 shows the percent of times each river exceeded the TMDL standard. Site 038, Towanda tested above the TMDL standard 100% of the time but also had the lowest mean and standard deviation. Next, the upper streams with 95-100% above TMDL and a higher mean that ranged from 3.2 to 5.4 mg/L. The west stream was above standard 90% of the time and had a mean of 4.4 mg/L. The midstream and east streams had the lowest percentage of times over TMDL standard with 84-89%. The mean for the mid and east streams was similar to that of the upper and west, ranging from 3.0 to 5.5 mg/L (Fig 13). From our data all of the streams would be classified as impaired.

Biochemical Oxygen Demand Biochemical Oxygen demand is defined as: the amount of oxygen used by microorganism in the process of breaking

down organic matter in water (Encyclopedia Britannica, 2005). The more organic matter there is (e.g., in sewage), the greater the number of microbes. The more microbes there are, the greater the need for oxygen to support them; consequently, less oxygen is available for higher animals such as fishes. The BOD is therefore a reliable gauge of the organic pollution of a body of water. One of the main reasons for treating sewage or waste water prior to its return to a water resource is to lower its BOD, i.e. reduce its need of oxygen and thereby lessen its demand from the stream or rivers into which it is released.

The presence of a sufficient concentration of dissolved oxygen is critical to maintaining the aquatic life and aesthetic quality of streams and lakes. Determining how organic matter affects the concentration of dissolved oxygen (DO) in a stream or lake is integral to water quality management. The decay of organic matter in water is measured as biochemical or chemical oxygen demand. Oxygen demand is a measure of the amount of oxidizable substances in a water sample that can lower DO concentrations (Nemerow, 1974; Tchobanoglous and Schroeder 1985)

High biochemical oxygen demand can be caused by high levels of organic pollution, caused usually by poorly treated wastewater and high nitrate levels, which trigger high plant growth

A comparison of mean levels of BOD shows that Henry, an upper stream, was consistently above the 5mg/L of the recommended TMDL (Fig.14). The rest of the streams had a mean below the 5 mg/L TMDL. The site 9 at Towanda seems to be in agreement with the other mid and upper stream levels which are close to each other.

A comparison of percent of times the BOD was above the TMDL of 5 mg/L presents a different picture (Fig. 16). Wildcat, Henry and Rock streams were more often above the TMDL level than the other streams. Overall, all the streams show essentially a similar pattern in exceeding the TMDL for BOD levels.

DISCUSSION

Our goal for this project was to continue monitoring for the impairment of fecal coliform and to also test for other possible impairments (BOD, phosphorus, and nitrates). Our data showed that fecal coliform exceeded TMDL level more than 50% of the time. The northern streams and Rock Creek added most of the pollution to the Whitewater River. For BOD we determined that all streams exceeded TMDL at least once. Henry had the highest mean BOD level, but overall all the streams seemed very similar. Mean TMDLs and percentage of times exceeded TMDL for phosphorus were highest for the West streams. The west streams were the most impaired but the others were very close in mean and all streams exceeded the TMDL at least 80% of the time. For nitrates, Dry Creek and E.B. Whitewater exceeded the TMDL the most often. However, differences overlapped such that no one group of streams contributed more than any other. Overall we concluded that all streams in the whitewater river basin are impaired

for all factors tested. Efforts to reduce pollution in this area must continue to lower their TMDLs.

The year 2007 marks the midpoint of Whitewater River Watershed TMDL ten year plan. The first five years were dedicated to implementing the plans or programs that would reduce pollution and also protect the streams from further pollution. At this time we should see a reflection in the data of reduced pollution, but our data does not show that. It is apparent from this data that the current efforts to reduce pollution in the Whitewater River Basin have been ineffective. Fecal coliform levels are not at zero during low stream flow as projected. The streams are testing as impaired for several other factors as well. We recommend further and more frequent monitoring.

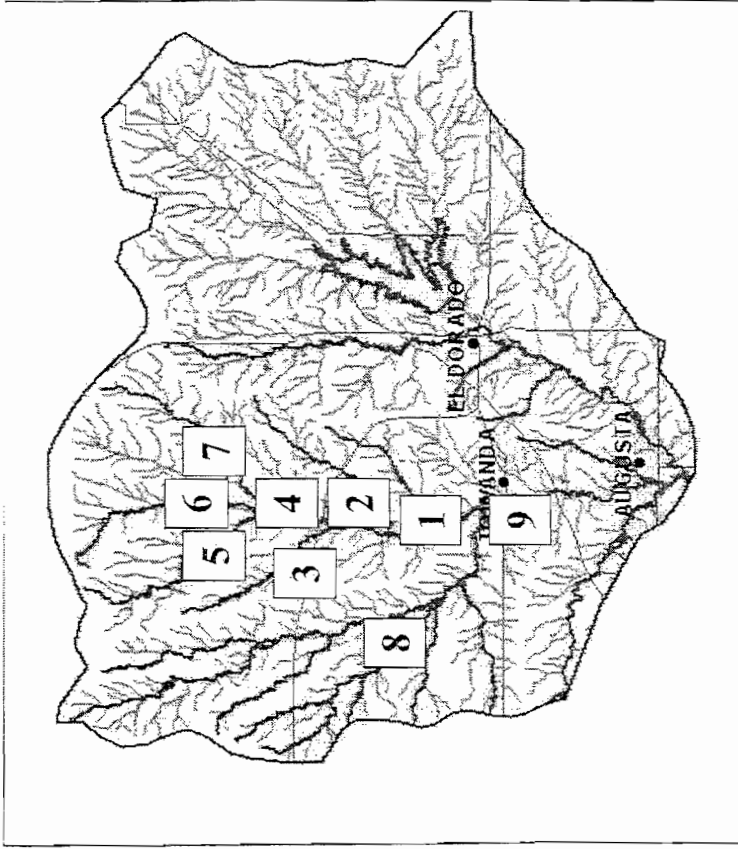
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Hach Water Analysis Handbook. 2nd ed. Loveland

Streams, Stream Gages, TMDL sites, STPs. Kansas Department of Health and Environment, 2002.

Figure 1. Map of collection sites in Upper Whitewater River Basin.



1. Rock Creek
2. Fourmile Creek
3. Dry Creek
4. Diamond Creek
5. Henry Creek
6. Upper Whitewater River
7. East Branch of Whitewater River
8. Wildcat Creek
9. Whitewater River

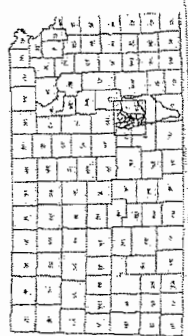


Figure 2. Fecal coliform levels of samples taken from the Upper Whitewater River Basin. TMDL level is 200 colonies of fecal coliform/ 100 ml.

Figure 3. Nitrate levels of samples taken from the Upper Whitewater River Basin. TMDL Level for Nitrate is 1.2 mg/L.

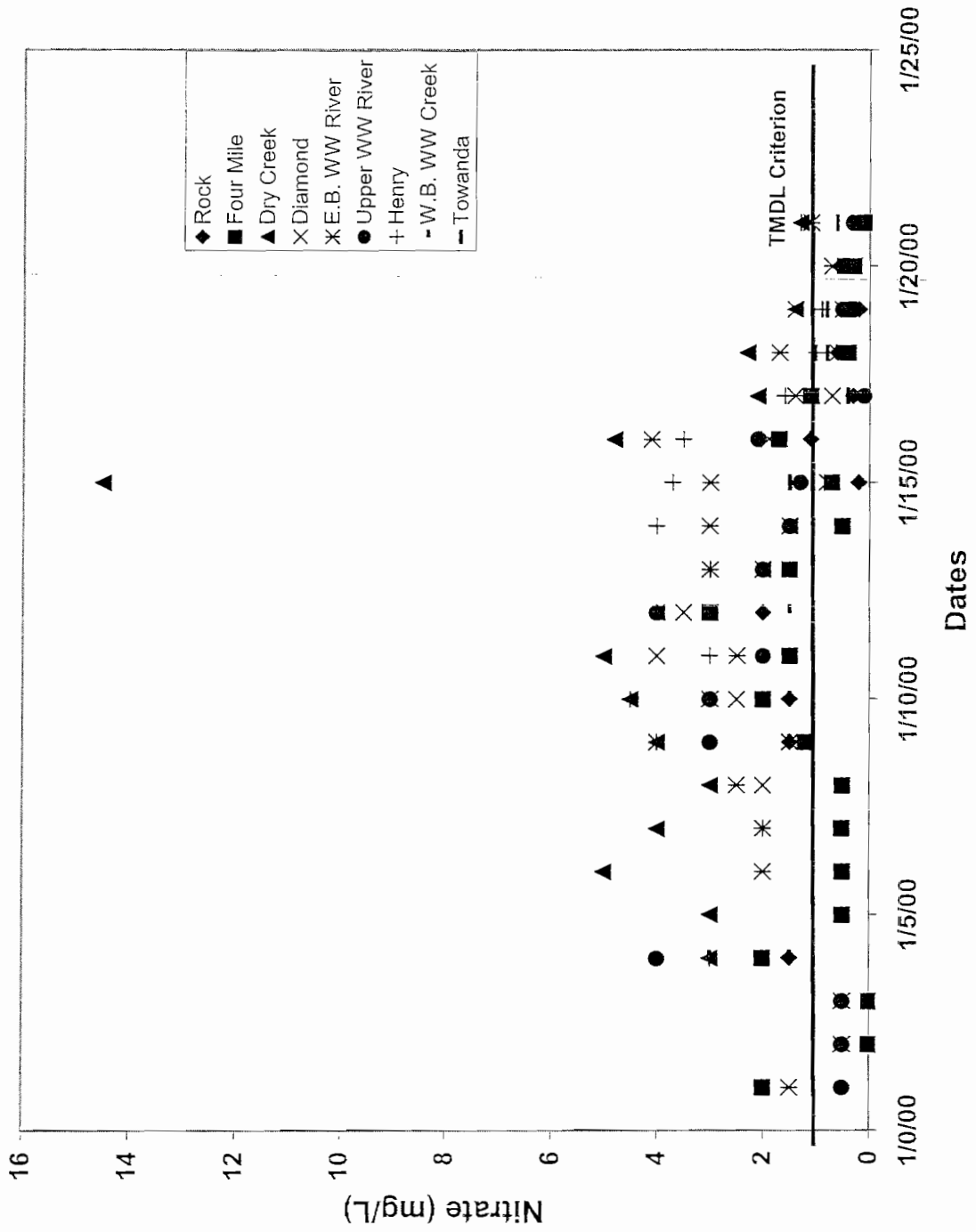


Figure 4. Phosphorus levels of samples taken from the Upper Whitewater River Basin. TMDL is 0.1 mg/L for impairment.

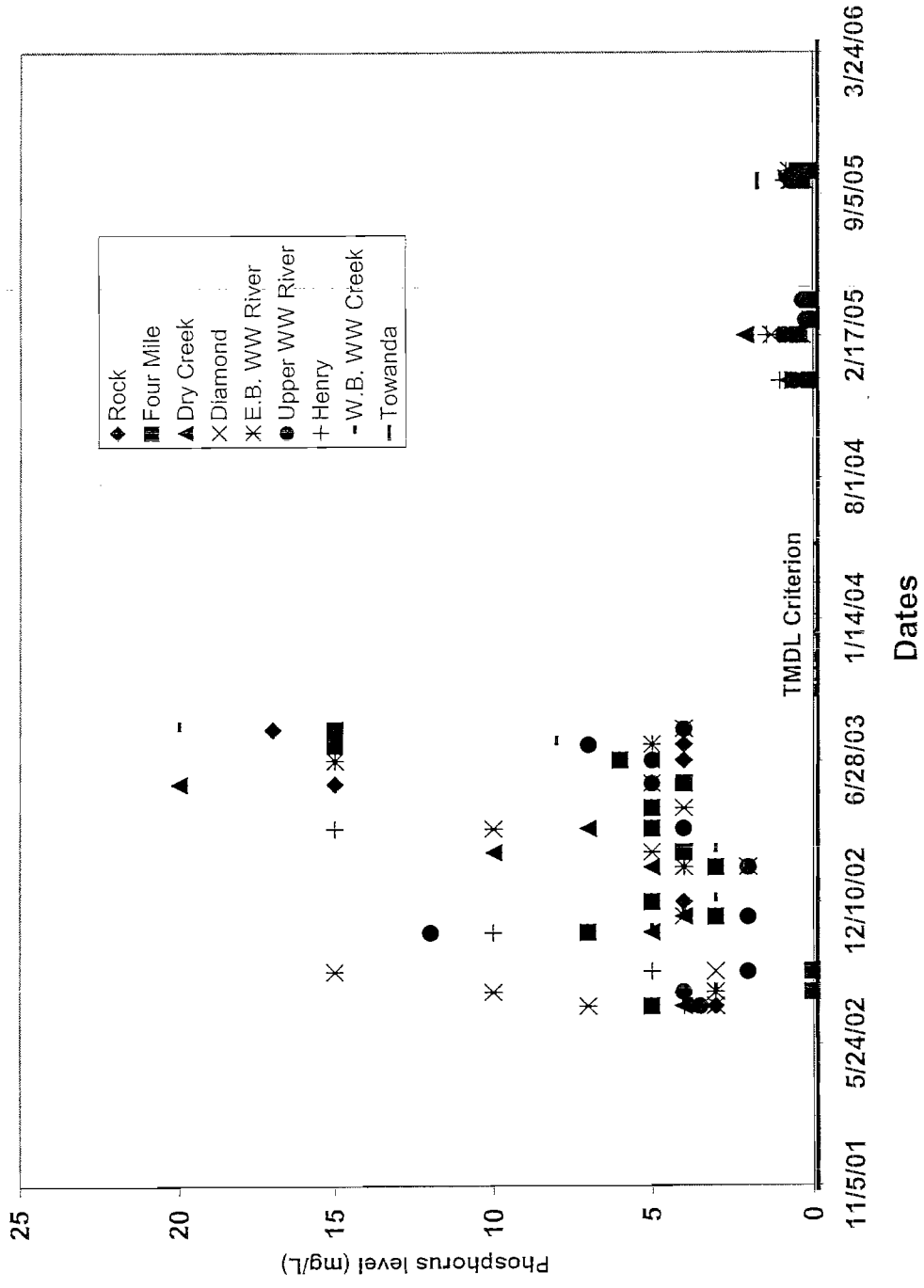


Figure 5. BOD levels of samples taken from the Upper Whitewater River Basin.

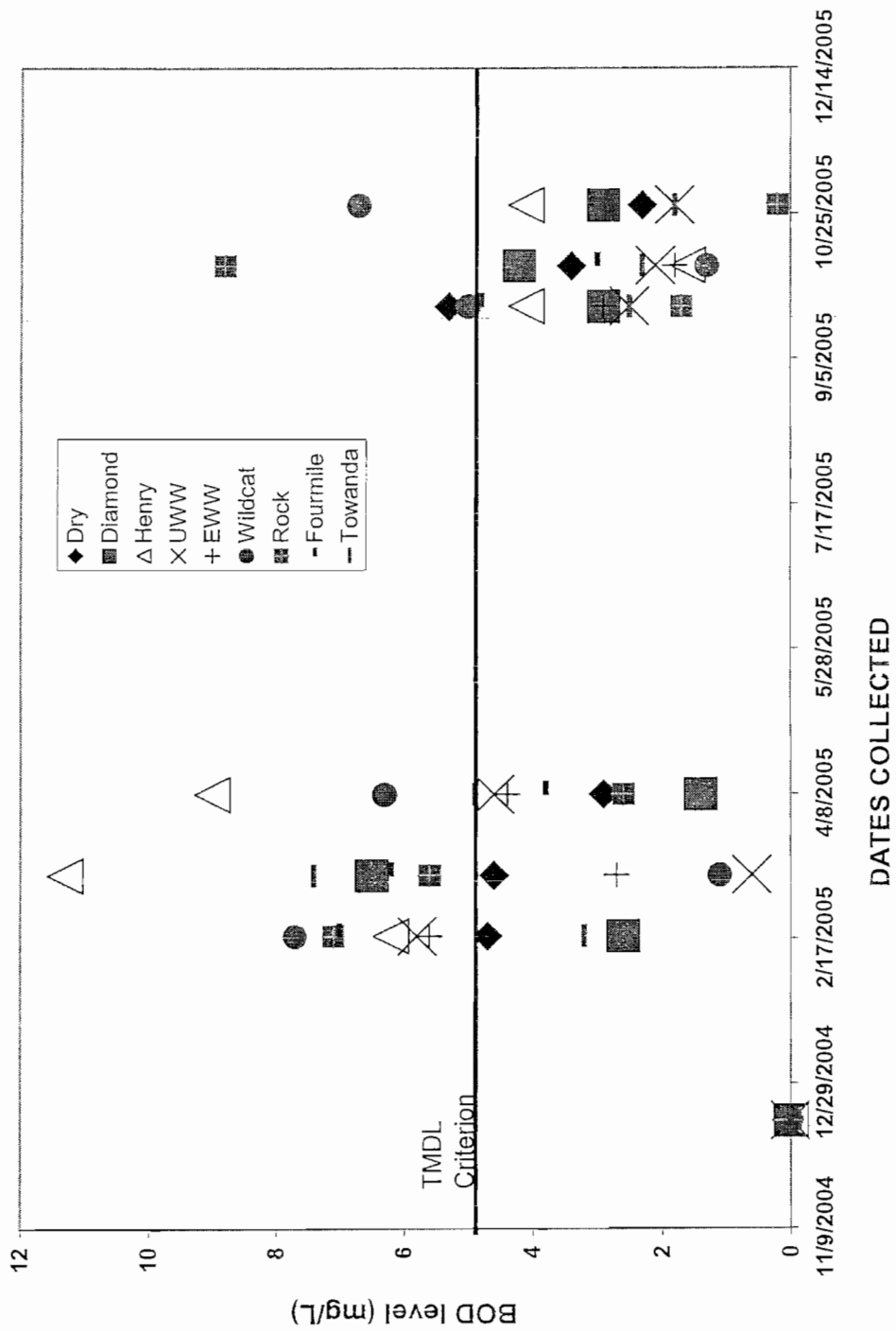


Figure 6. Conductivity levels for all streams.

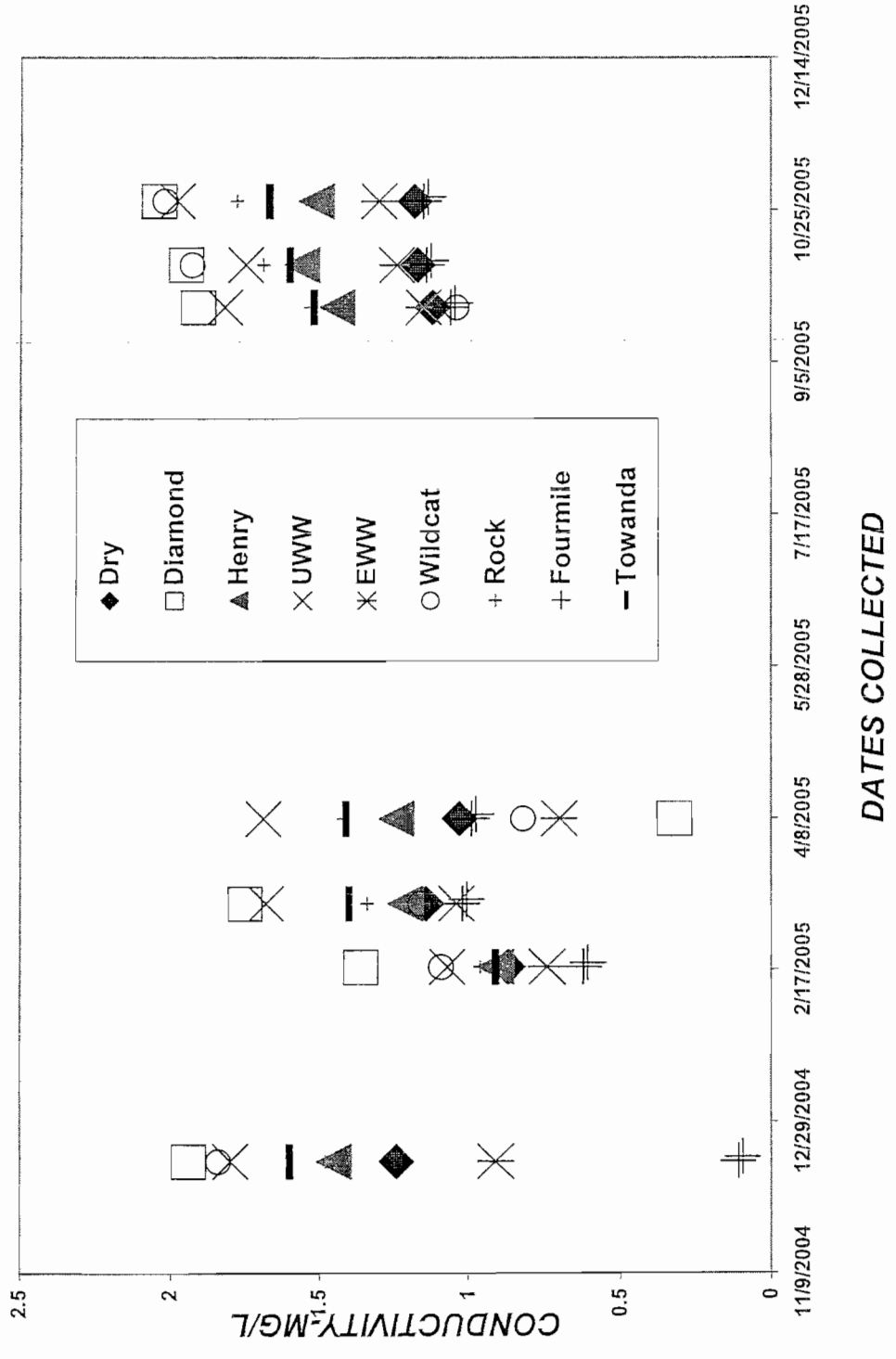


Figure 7. Turbidity levels (NU units) for all streams.

Figure 8. Percent of times samples exceeded the TMDL of 200 colonies of fecal coliform bacteria in each stream.

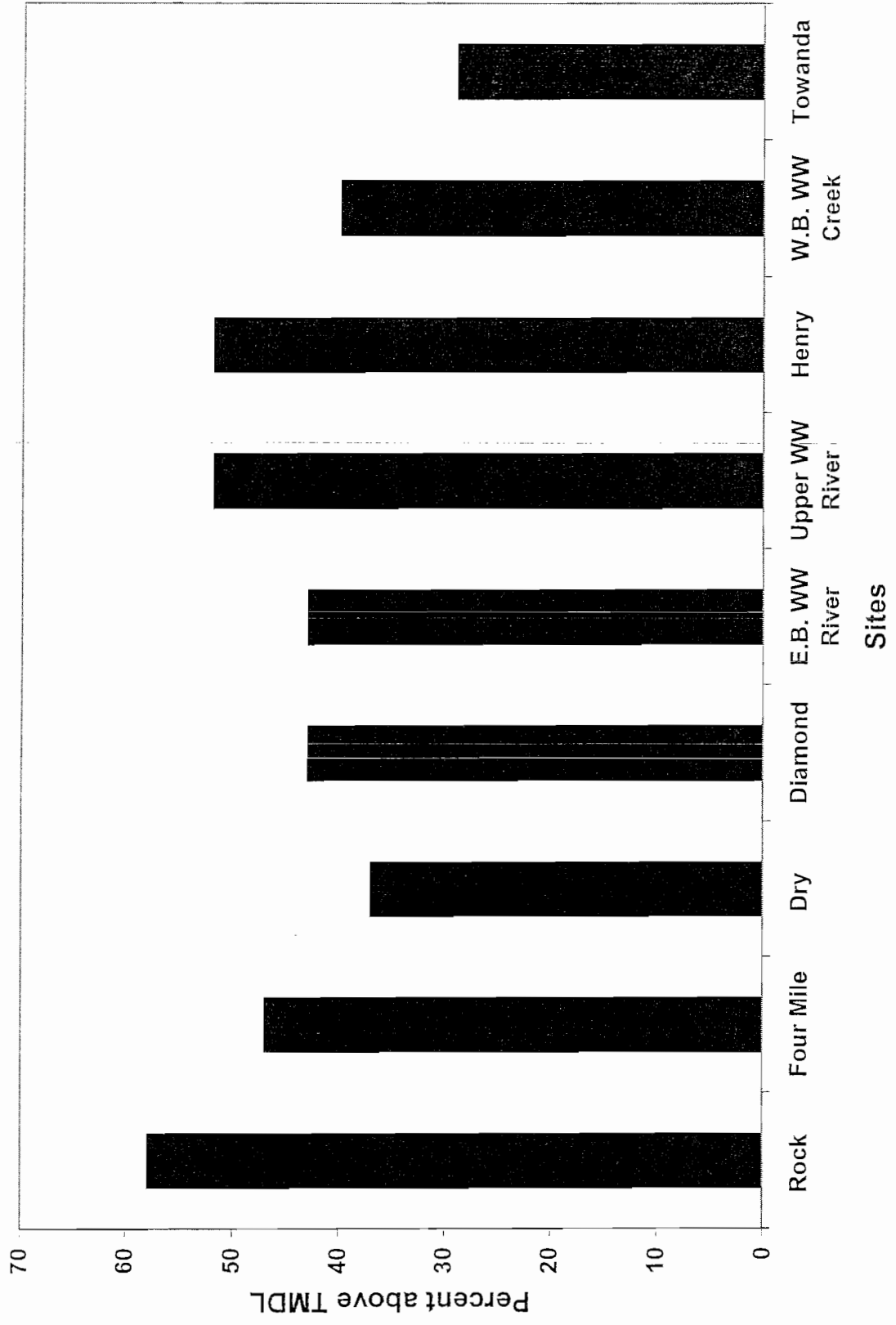


Figure 10. Percent of times Nitrate levels exceeded TMDL levels (1.2 mg/ L).

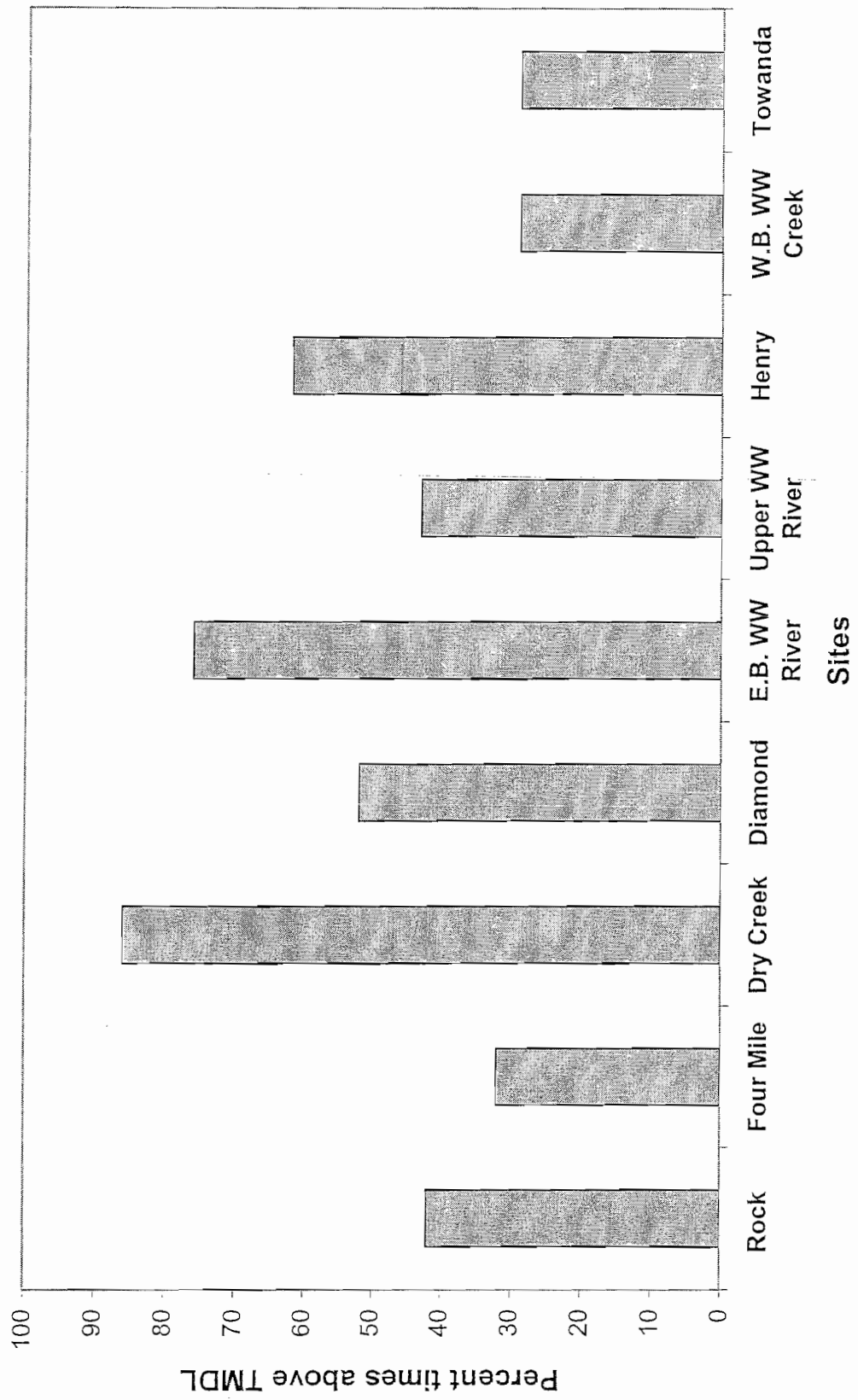


Figure 11. Mean with Standard Deviation for nitrate levels for each stream.

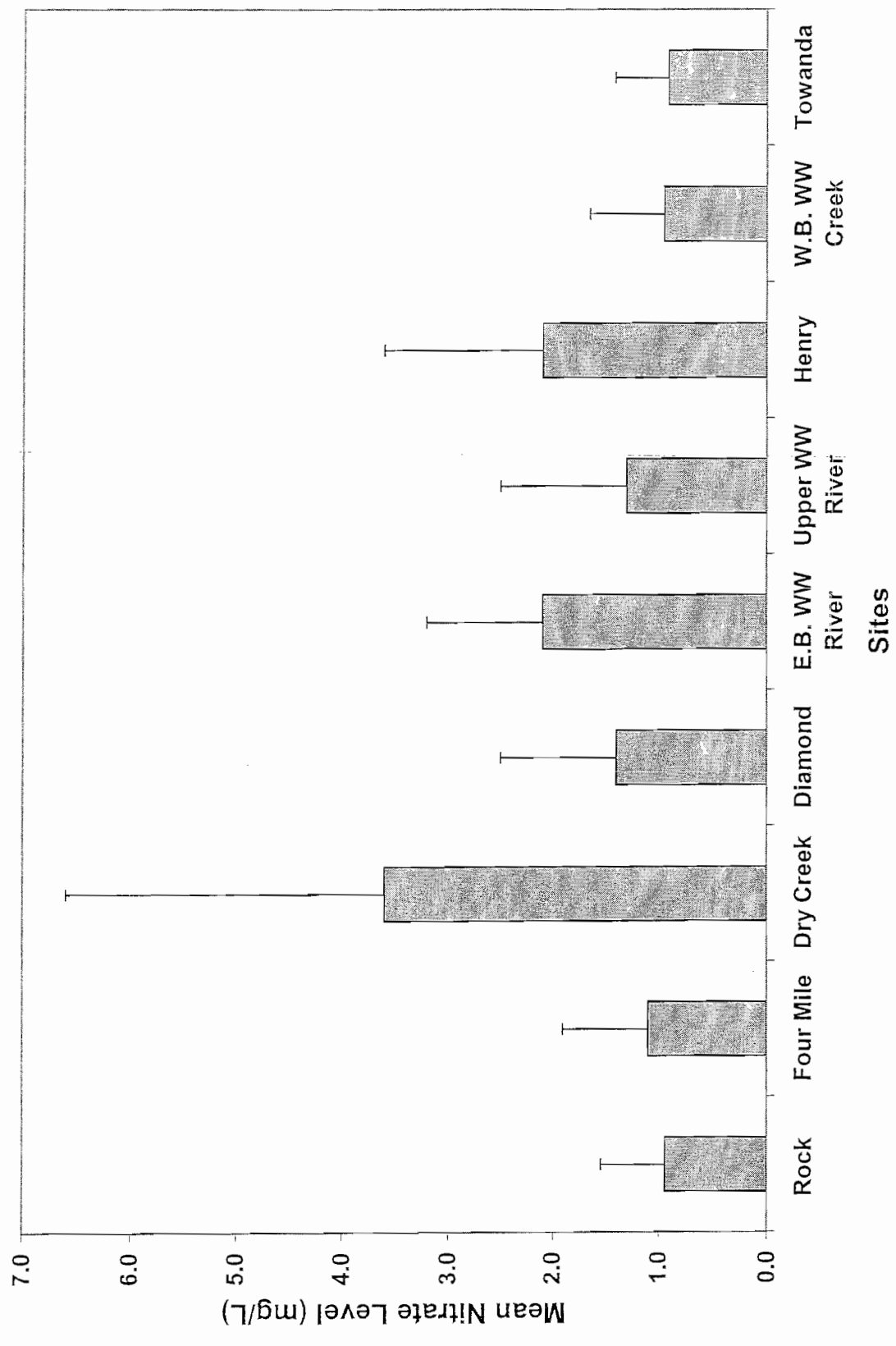


Figure 12. Percent of samples that exceeded the TMDL level (0.1 mg/L) for phosphorus for each stream.

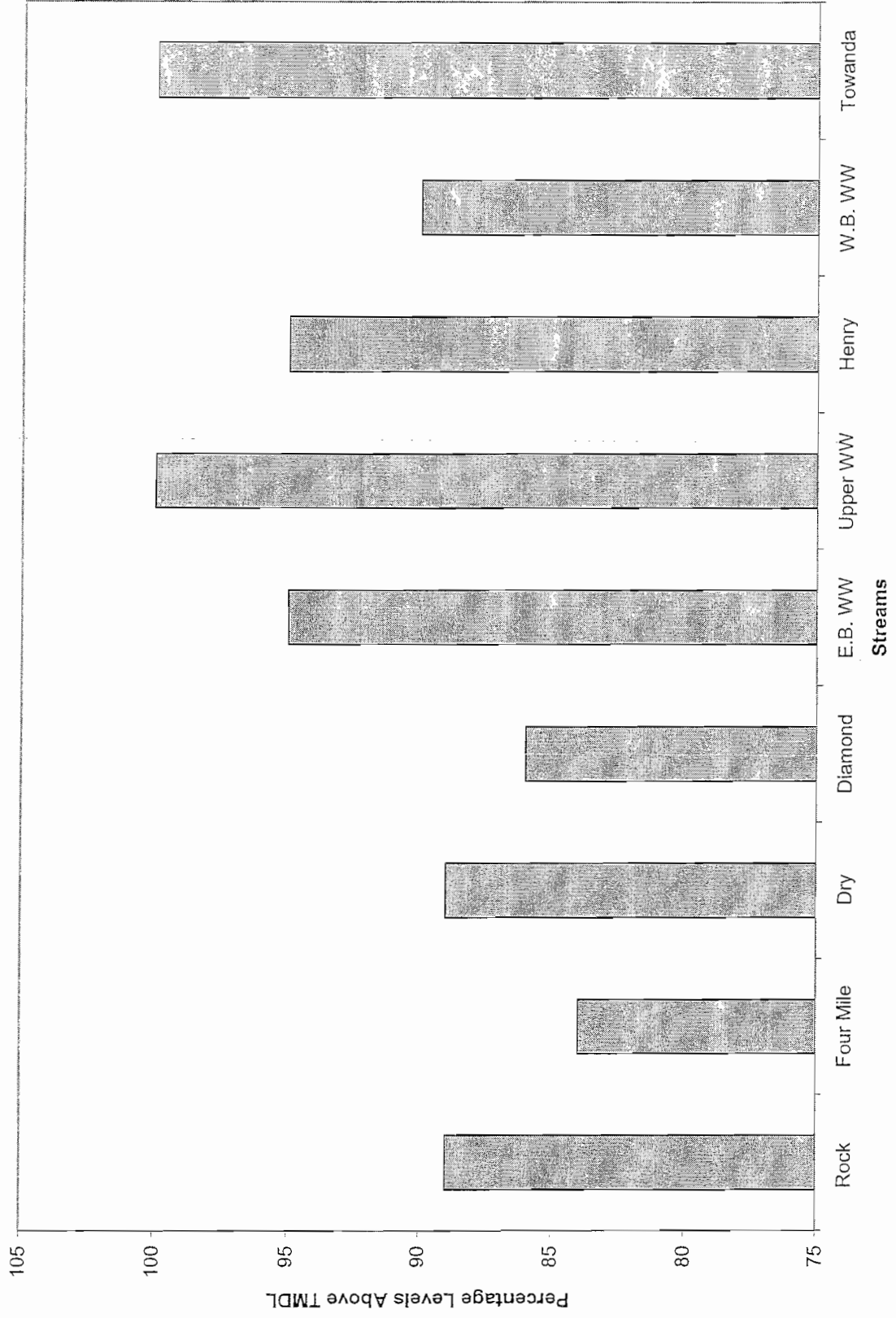


Figure 13. Mean level and standard deviation of phosphorus for each stream.

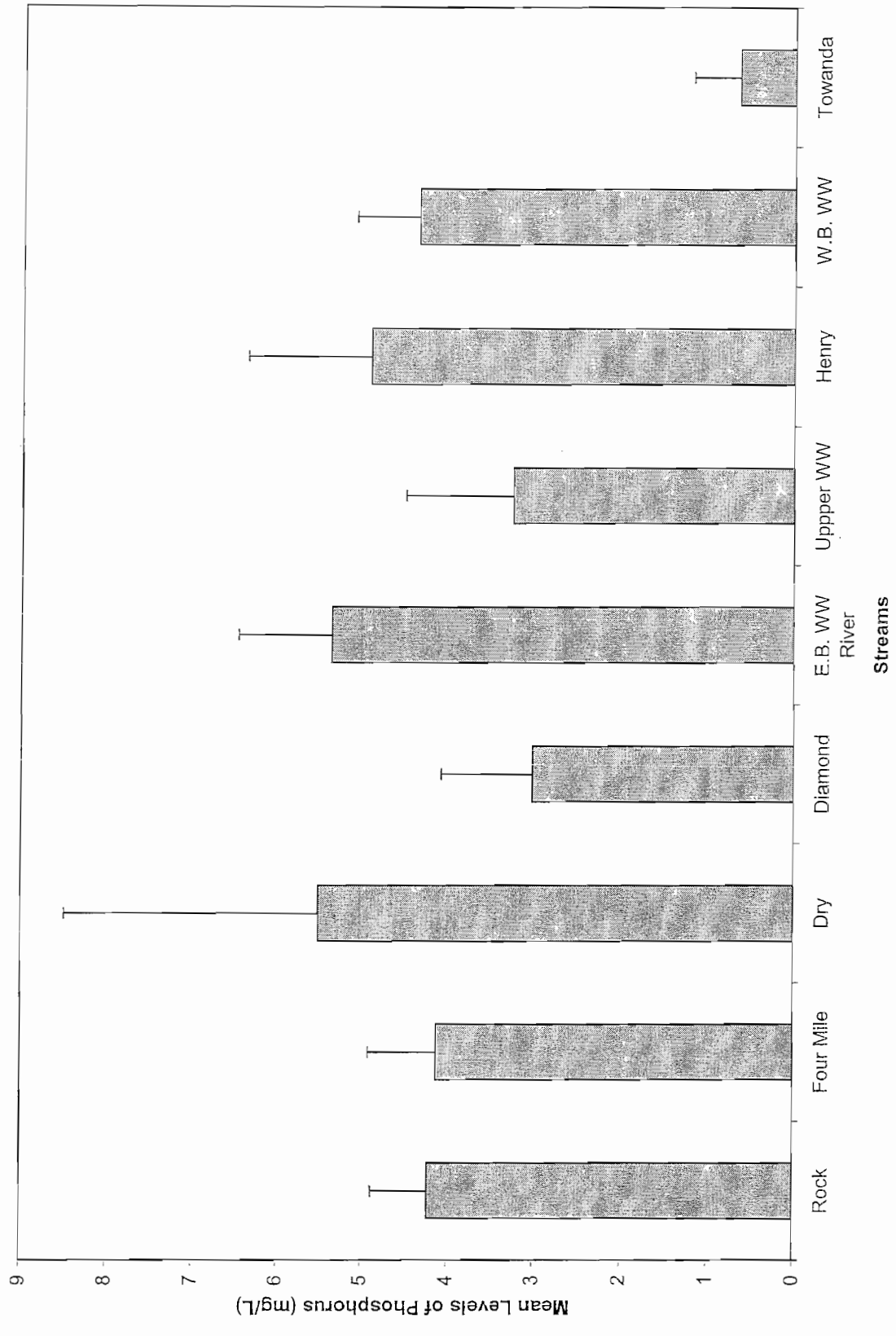


Figure 14. Mean and Standard Deviation for BOD level (mg/L) for each stream.

Figure 15. Percent of times BOD exceeds TMDL (5mg/L) for each stream.

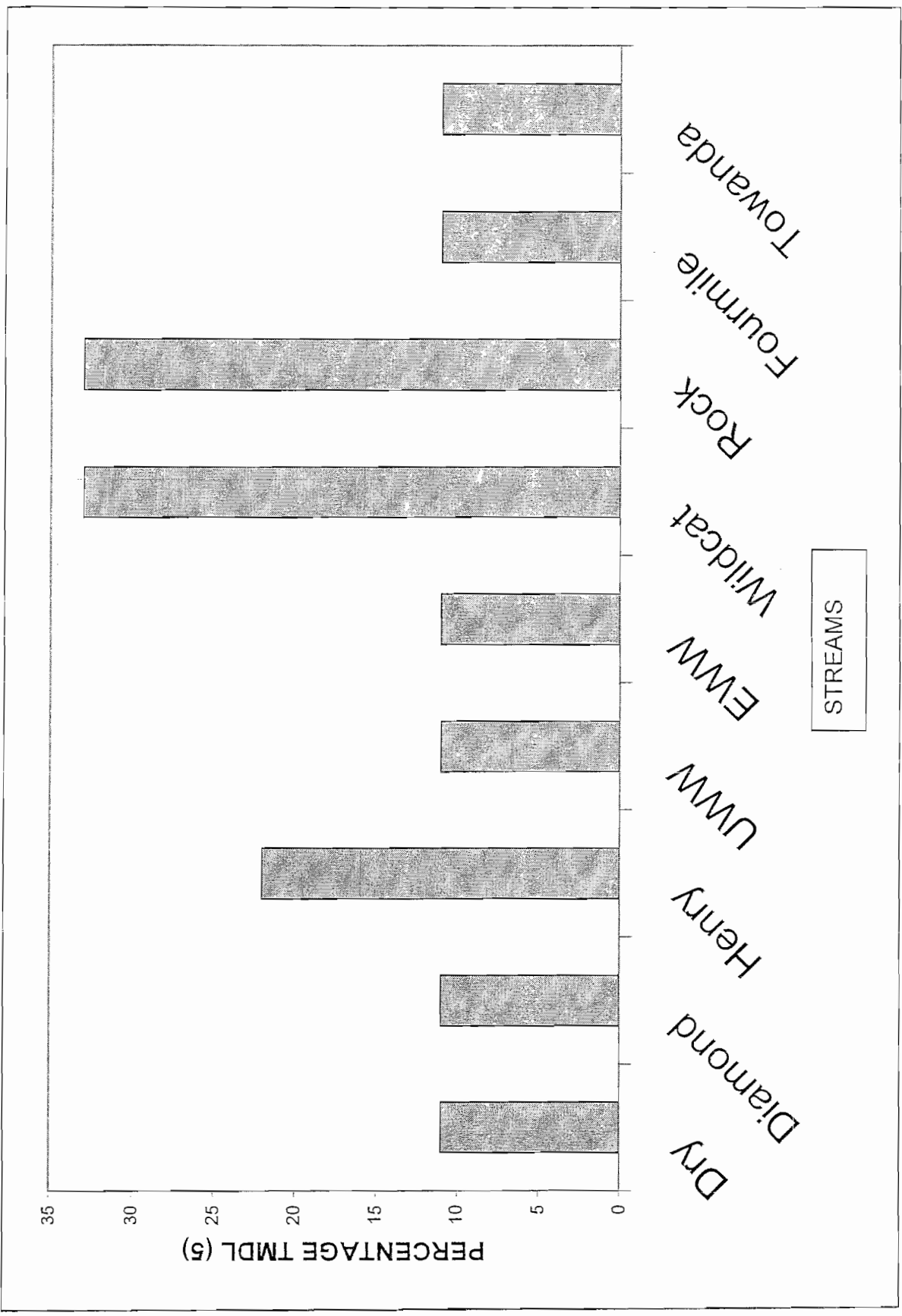


Figure. 9 Mean Number of colonies and Standard Deviation of Fecal Bacteria for each stream in 100ml.

Mean Number of Fecal Coliform Bacteria Colonies / 100 ml

