Appendix E: Monitoring Data Report from Mary Skopec at IOWATER

Four Mile Creek Summarization and Interpretation

Monitoring on Four Mile Creek began in June of 2004 to assess the quality of the creek and to understand the changes created by the cessation of wastewater inputs from the City of Ankeny and have continued to the present time. Monitoring activities have been conducted as part of the regular Polk County Snapshots (one to two times a year) and as part of the IOWATER citizen monitoring program. Initially the IOWATER testing was conducted one to two times a year, but starting in 2010, was increased to approximately monthly testing. Data collected as part of the Polk County Snapshot includes both laboratory testing methods for nitrate, nitrite, orthophosphate as P, total phosphate as P, turbidity, *E. coli* bacteria, total kjeldahl nitrogen, bromide, fluoride, ammonia nitrogen as N, sulfate, total coliform bacteria and IOWATER field kit methods. Data collected as part of the IOWATER program includes field measurements for nitrate, nitrite, phosphorus, chloride, dissolved oxygen and water transparency.

Sites sampled as part of the monitoring were FMC1, FMC2, FMC3, FMC4, FMC5, FMC6, FMC7, FMC8, FMC9, and FMC10. Sites were ordered from the headwaters (FMC1) to the lower stretches of Four Mile Creek near it's confluence with the Des Moines River (FMC10, See Table 1). For purposes of graphing and interpretation, results that fell below the method reporting limit were standardized to ½ of the method reporting limit (for example, if a nitrate result was reported as <0.5 mg/L, the result was standardized to 0.25 mg/L for graphing).

Station Name	Station Type	UTMX	UTMY	Latitude	Longitude
Site FMC1 - Fourmile Creek	River/Stream	445380	4633292	41.84965	-93.658
Site FMC10 - Fourmile Creek	River/Stream	455987	4604378	41.58989	-93.5281
Site FMC2 - Fourmile Creek	River/Stream	448132	4630020	41.82036	-93.6245
Site FMC3 - Fourmile Creek	River/Stream	450708	4625158	41.77674	-93.5931
Site FMC4 - Fourmile Creek	River/Stream	451690	4621989	41.74826	-93.581
Site FMC5 - Fourmile Creek	River/Stream	452617	4618529	41.71715	-93.5696
Site FMC6 - Fourmile Creek	River/Stream	453750	4616908	41.70262	-93.5559
Site FMC7 - Fourmile Creek	River/Stream	454563	4612016	41.6586	-93.5457
Site FMC8 - Fourmile Creek	River/Stream	454347	4608786	41.6295	-93.5481
Site FMC9 - Fourmile Creek	River/Stream	454556	4607047	41.61385	-93.5454

Table1. Four Mile Creek Sites

Figure 1 shows the box plot graphs for phosphorus, transparency and dissolved oxygen using the IOWATER field methods. The data show very high levels of phosphorus throughout the entire Four Mile Creek watershed. Iowa currently lacks a water quality standard for phosphorus, but the scientific literature indicates that at levels above 0.1 mg/L adverse impacts to aquatic life occur including frequent and severe algal blooms. Based on the IOWATER field methods, phosphorus rarely occurs below 0.1 mg/L. Median levels of phosphorus in Four Mile Creek are above 1 mg/L and at times reach nearly 10 mg/L, particularly in the lower stretches. The wastewater discharge for the City of Ankeny enters Four Mile Creek downstream of FMC4 and just upstream of FMC5. The large increase in phosphorus between these two sites is a direct result of municipal wastewater. Municipal wastewater contains large amounts of phosphorus and since these facilities are not currently required to remove phosphorus, streams often experience significant increases in phosphorus, especially if the stream flow is typically low. Phosphorus levels above the City of Ankeny are impacted by wastewater discharges from the town of Slater that occurs above sites FMC1 and FMC2 and Alleman that occurs before site FMC3. Phosphorus levels show some variability suggesting that the amount of water in the stream may provide for some dilution and processing when flows are higher (Figure 2). The increases in phosphorus levels during the latter part of 2011 and 2012 document the impact of the extreme drought conditions on phosphorus in Four Mile Creek.

Dissolved Oxygen levels in Four Mile Creek generally meet Iowa's water quality standard for warm water streams (5 mg/L); however several of the sites recorded dissolved oxygen levels below the standard occasionally (FMC1, FMC2, FMC5) and all of the sites had 10% or greater of dissolved oxygen readings below 6 mg/L. The low oxygen readings suggest that the stream is having difficulty assimilating all the nutrients discharged to it through the wastewater systems. Given that the oxygen readings are taken during the day, it is reasonable to assume that the oxygen levels may be much lower at night when aquatic plants are no longer providing oxygen to the stream through photosynthesis.

Transparency measurements for the ten Four Mile Creek sites indicate that water clarity is typically pretty high with median transparency levels above 40 cm for all of the sites except for FMC3 and FMC4 (Figure 1). It is unknown why the water clarity is lower at these two sites, although it may be related to algae growth in response to the high phosphorus levels coming from further upstream in the creek. As is expected, transparency values show extreme variability throughout the season ranging from 10 cm to 60 cm (Figure 3). These changes in transparency are likely related to rainfall runoff events that cause erosion in the watershed and within the creek banks. Further analysis to correlate transparency values to rainfall needs to be conducted to document the impact of erosion on transparency in the watershed.

Nitrate plus nitrite as N concentrations in Four Mile Creek are typically low with median concentrations between 2 and 5 mg/L (Figure 4). The statewide median concentration for nitrate plus nitrite as N for Iowa's ambient stream network is 5.5 mg/L (DNR Water Fact Sheet 2013-1). Iowa currently does not have an aquatic life standard for nitrate, but the drinking water standard

is 10 mg/L for waters designated as drinking water sources. Four Mile Creek is not a drinking water source, but the 10 mg/L standard is provided as a frame of reference on the graphs below. Four Mile Creek is largely urban stream, particularly in the lower stretches (below FMC3). Data collected from around the State of Iowa demonstrate that urban streams typically have lower nitrate levels than agricultural streams due to lower inputs of nitrogen and because runoff in urban areas is dominated by overland flow that is delivered to the creek through storm sewers. Since nitrate forms in the soil profile, water that doesn't infiltrate the soil before being delivered to the stream does not have the opportunity to leach nitrate from the soil and deliver it to local creeks and streams. The time series data in Figure 5 show that nitrate levels in most of Four Mile Creek were below 10 mg/L from 2004 and into 2011. However, levels jump in late 2012 and 2013. Some of the increase in 2013 can be explained by the hydrologic response to the end of the drought that occurred in late 2011 and 2012. Nitrate is water soluble and the lack of rainfall prevented mobilization of nitrate to streams. Statewide, nitrate levels were much higher in 2013 than in 2011 and 2012. However, nitrate levels in Four Mile Creek did appear to have fairly large spikes during 2012 that are not understood at this time. Further analysis to determine the reasoning for these spikes is needed.

Chloride levels in Four Mile Creek also depict an urban stream. Chloride levels steadily increase from the upstream sites to the downstream sites (Figure 4). This increase is expected as the heavily urbanized segments of Four Mile Creek undoubtedly receive higher road salt applications than the more rural segments of the watershed. The sudden increase in chloride above FMC5 and the very large spike in chloride at Site FMC6 may be also be related to the wastewater discharges above FMC5.

E. coli bacteria levels in Four Mile Creek show very high levels at the majority of the sites (Figure 6). The one-time sample maximum standard for *E. coli* is 235 CFU/100ml (show with a blue line on Figure 6). All of the Four Mile Creek sites exceed this standard more than 50% of the time as indicated by the median line in the box plots. Several of the sites exceed this standard more than 75% of the time (FMC3, FMC4, FMC6, FMC7, FMC8 and FMC9). Additionally, the State of Iowa uses a geomean standard of 126 CFU/100ml to determine bacteria based impairments. The majority of the Four Mile Creek sites also exceed this standard the majority of the time. Unlike other parameters, the *E. coli* values do not have a strong upstream to downstream component, which suggests that wastewater discharges may not be the biggest contributor to *E. coli* levels in Four Mile Creek. Figure 7 shows the temporal variability in *E. coli* levels throughout the watershed. Based on the time series graphs, there does not seem to be an overall increase or decrease in *E. coli* during the period of record and the values show extreme variability likely based on rainfall events that flush bacteria into the system.

The laboratory total phosphorus and orthophosphorus data (analyzed by Des Moines Water Works) correlate well with the IOWATER field kit data (Figure 6 and 8). The laboratory data also reflect the significant impact wastewater discharges are having on Four Mile Creek and show highly elevated levels throughout the watershed. The laboratory data also show that the

fraction of total phosphorus comprised by orthophosphorus (largely dissolved form) is very high, which also is an indication that the phosphorus in Four Mile Creek is coming from wastewater. If the total phosphorus were coming from sediment sources, we would expect the fraction of total P comprised by ortho P to be much lower. Laboratory nitrate plus nitrite as N values are also similar to the IOWATER field kit values and also show an increase in nitrate levels during the drought of 2012 that are currently unexplained (Figure 9 and 10).

Turbidity values in Four Mile Creek are similar to transparency values discussed earlier. While transparency records the clarity of water, turbidity readings record the lack of water clarity. Figure 10 shows that turbidity levels are fairly low throughout the watershed (medians below 10 NTU) with period increases to 100 NTU. Figure 10 also shows that Four Mile Creek has turbidity levels that are generally below the statewide median for all streams of 16 NTU. The time series plots for Four Mile Creek also demonstrate a significant temporal variability in turbidity readings, which is to be expected based on rainfall runoff events.

In summary, Four Mile Creek is a highly urbanized stream with significant wastewater inputs and impacts from the City of Ankeny, Slater and Alleman. Documenting changes in water quality as the Ankeny discharge goes off-line will show the improvements that can be made by altering the amount of phosphorus discharged to a small stream. Chloride values are likely to continue to be elevated in the near term, unless changes are made to road salt applications in the urban environment.

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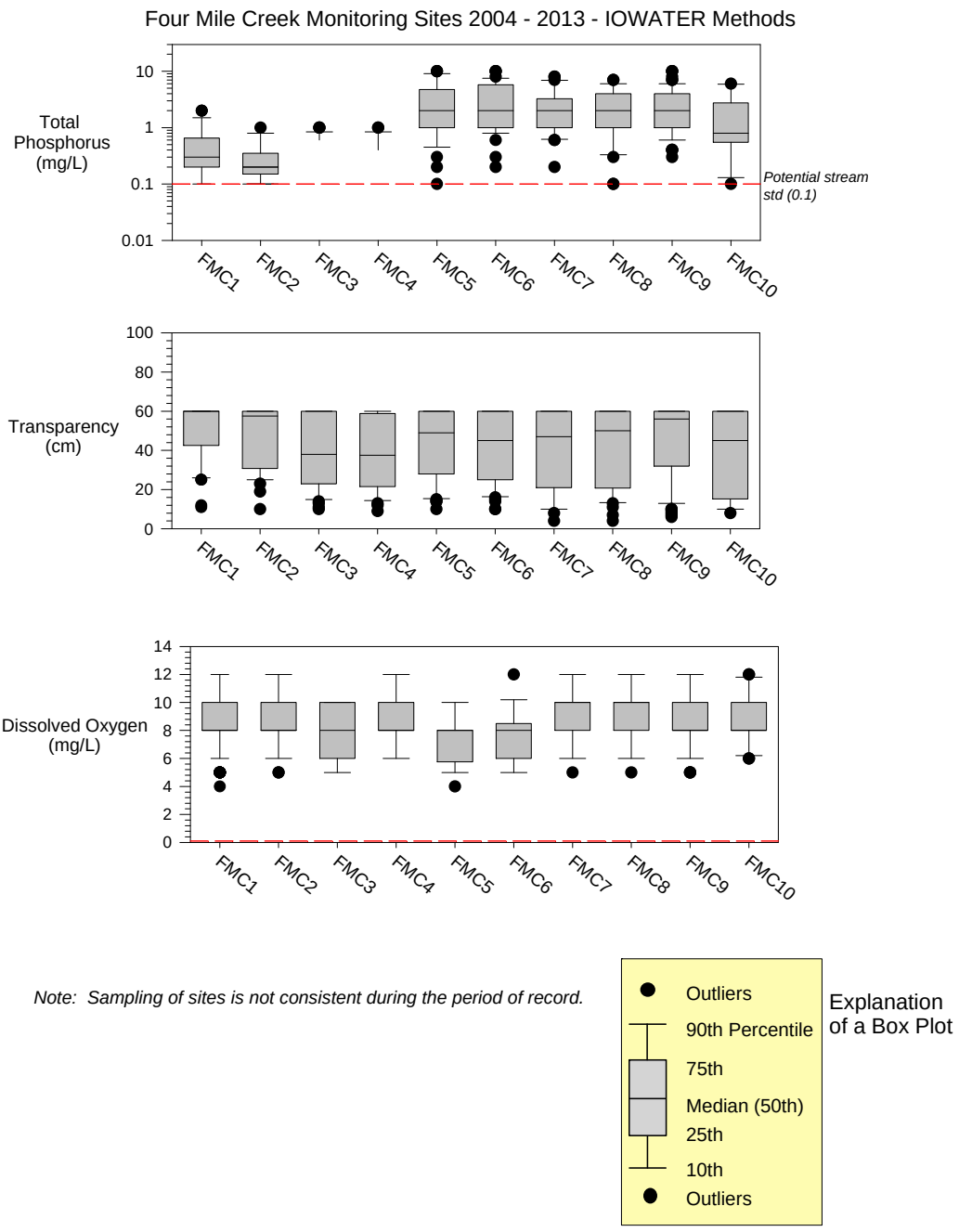


Figure 1. Four Mile Creek Box Plots of Total Phosphorus, Transparency and Dissolved Oxygen.

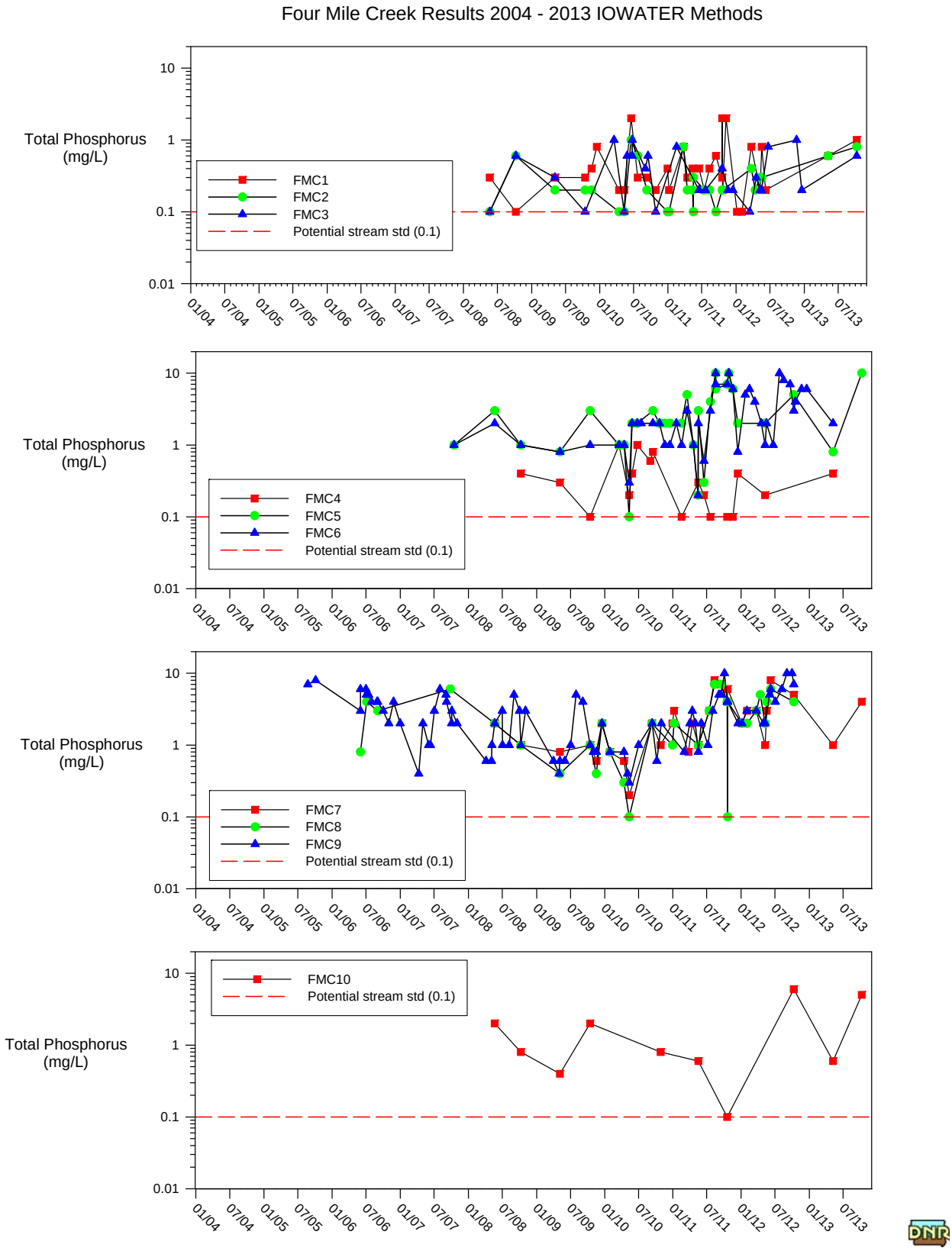


Figure 2. Four Mile Creek Phosphorus Time Series Graphs

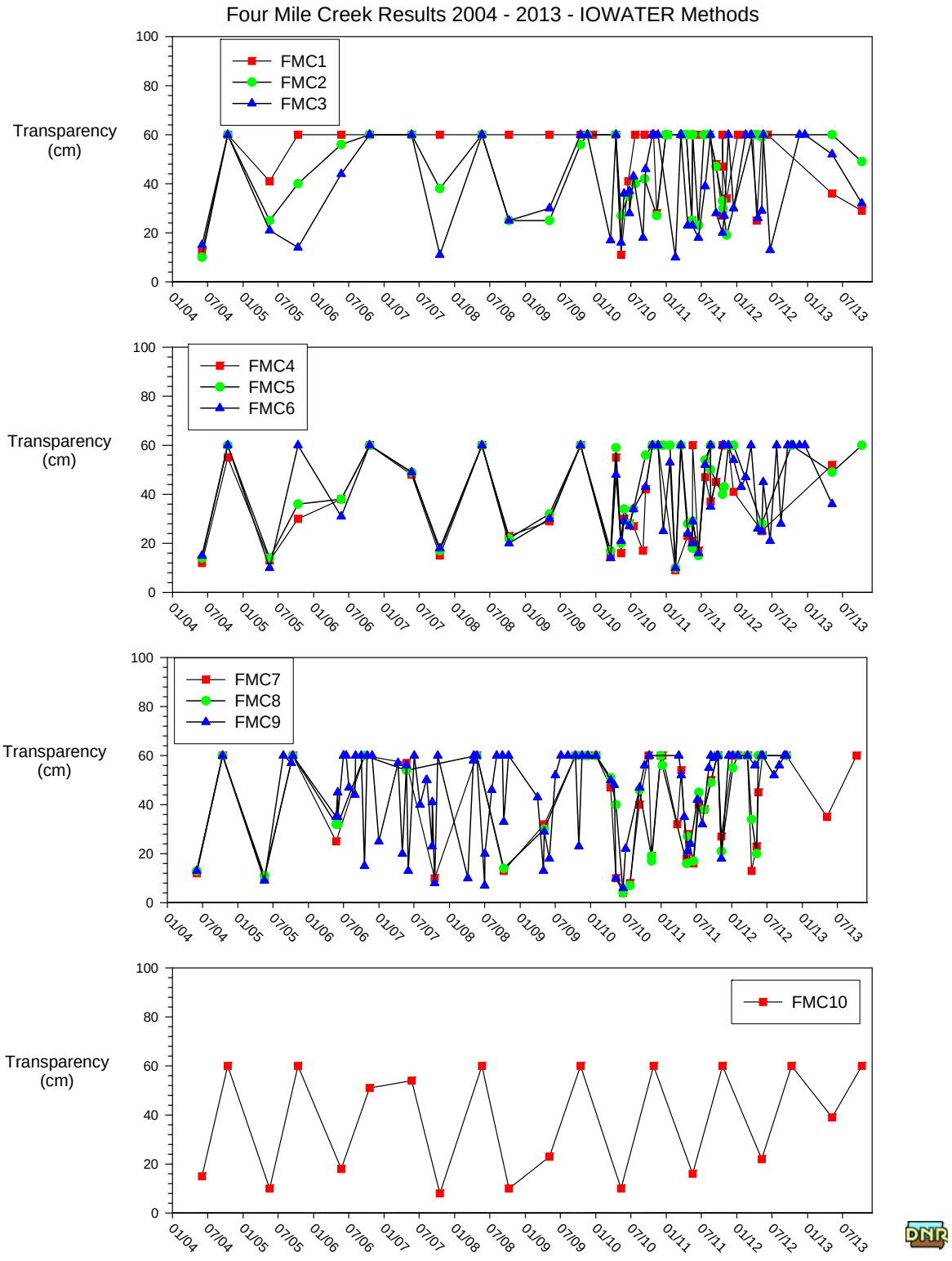
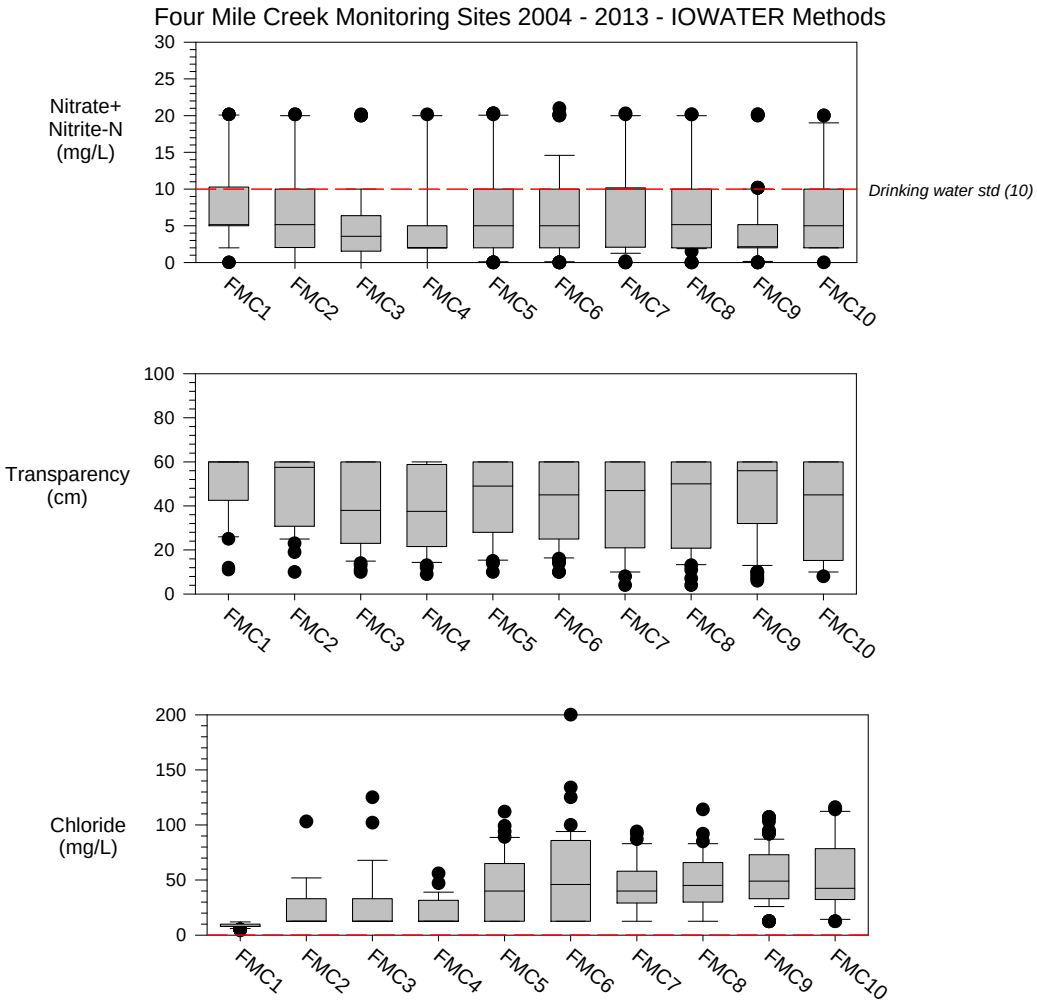


Figure 3. Four Mile Creek Transparency Time Series.



Note: Sampling of sites is not the same during the period of record.

Figure 4. Box plot graphs of Nitrate, Transparency and Chloride for Four Mile Creek.

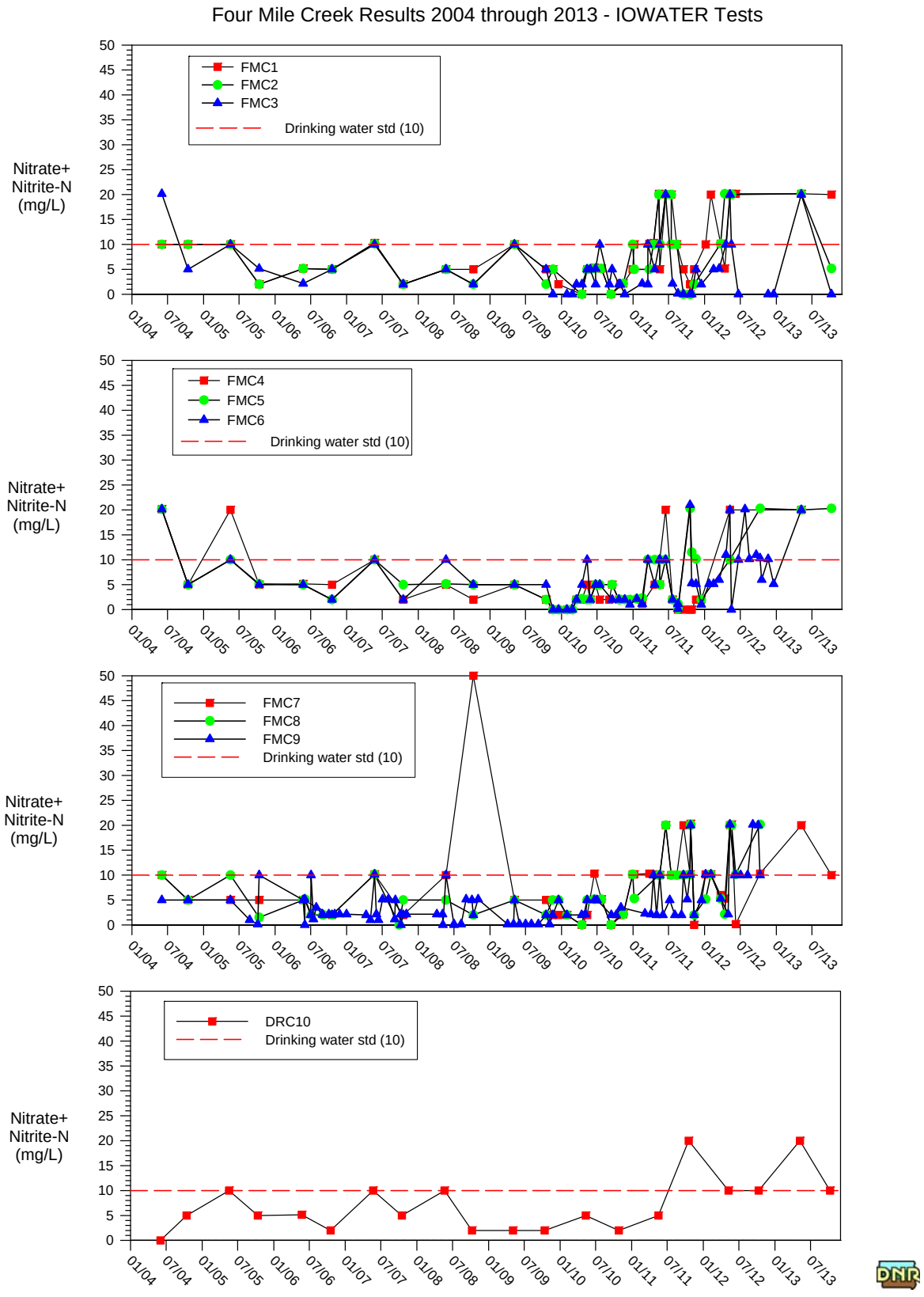


Figure 5. Four Mile Creek Nitrate plus Nitrite as N Time Series.

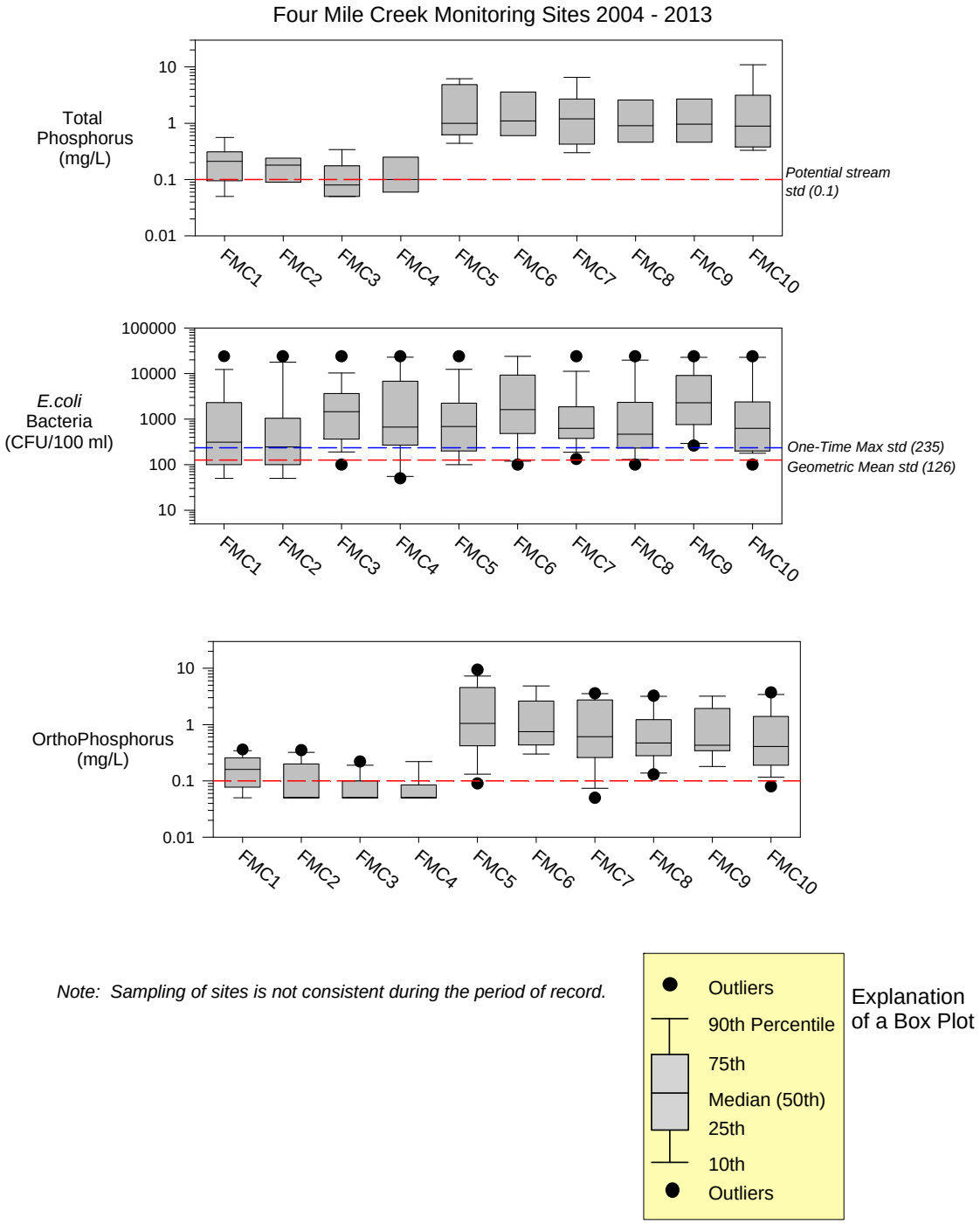


Figure 6. Four Mile Creek Box Plots of E. coli, Total phosphorus and Orthphosphorus.

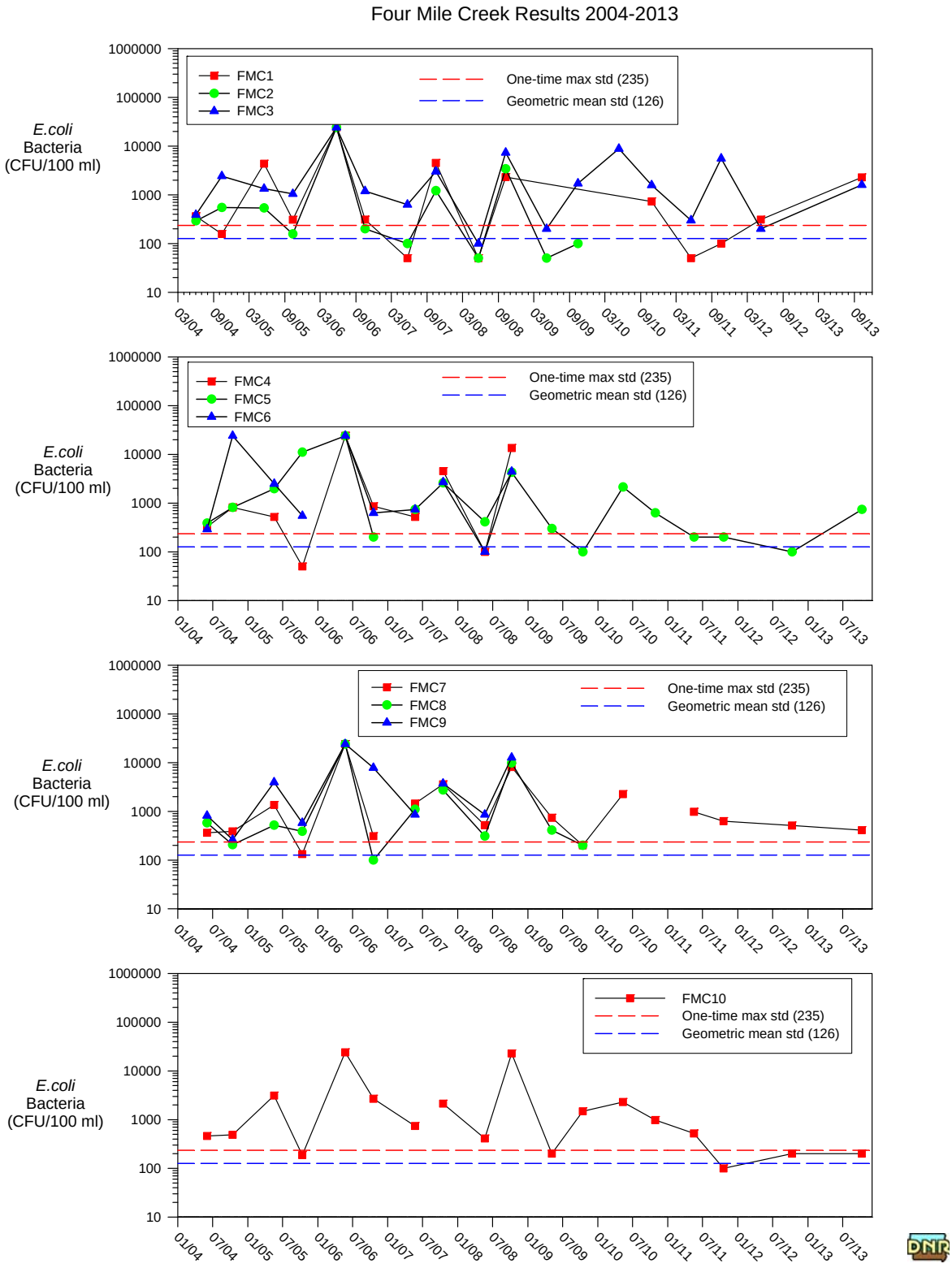


Figure 7. Four Mile Creek *E. coli* Time Series.

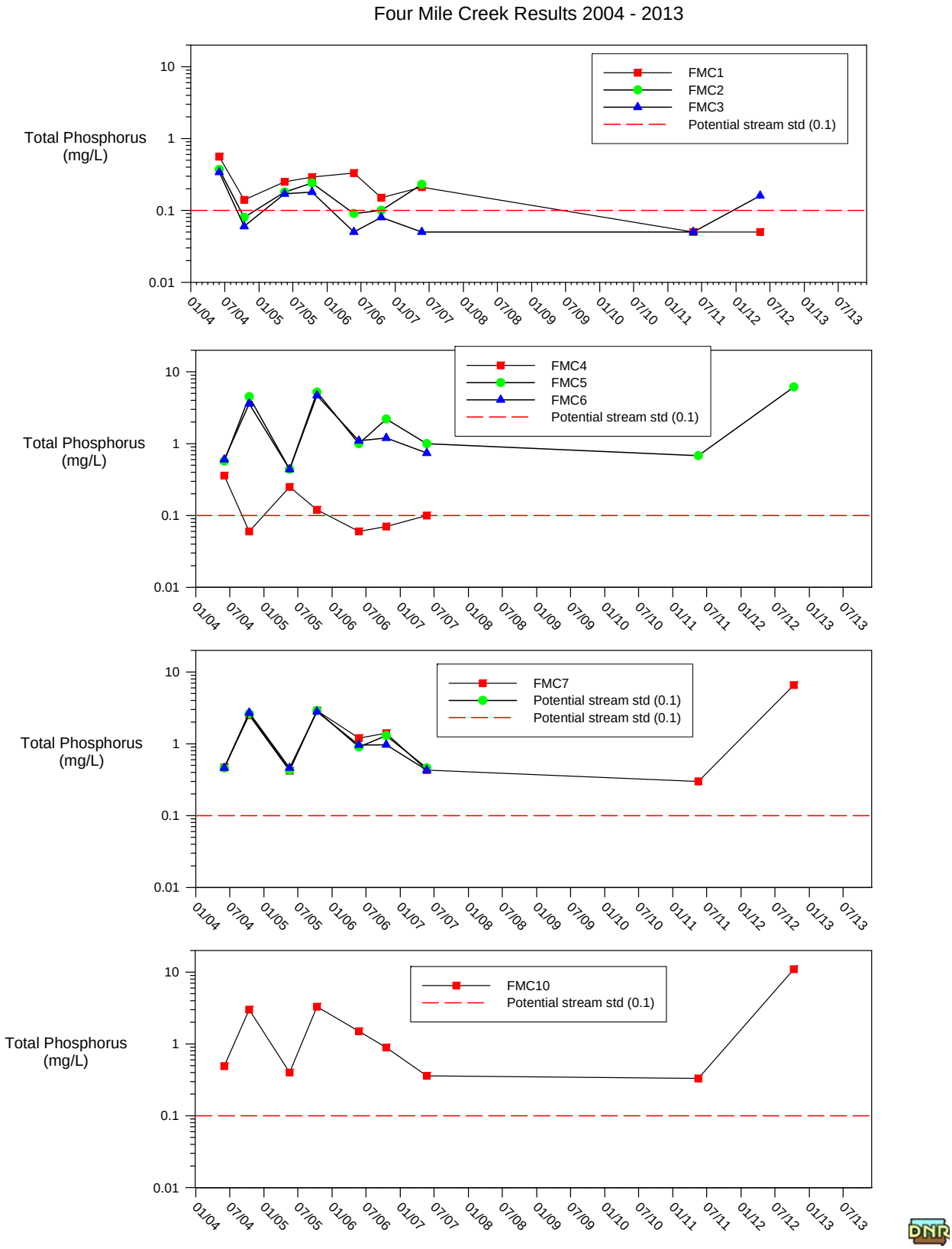


Figure 8. Four Mile Creek Total Phosphorus (Laboratory Methods) Time Series.

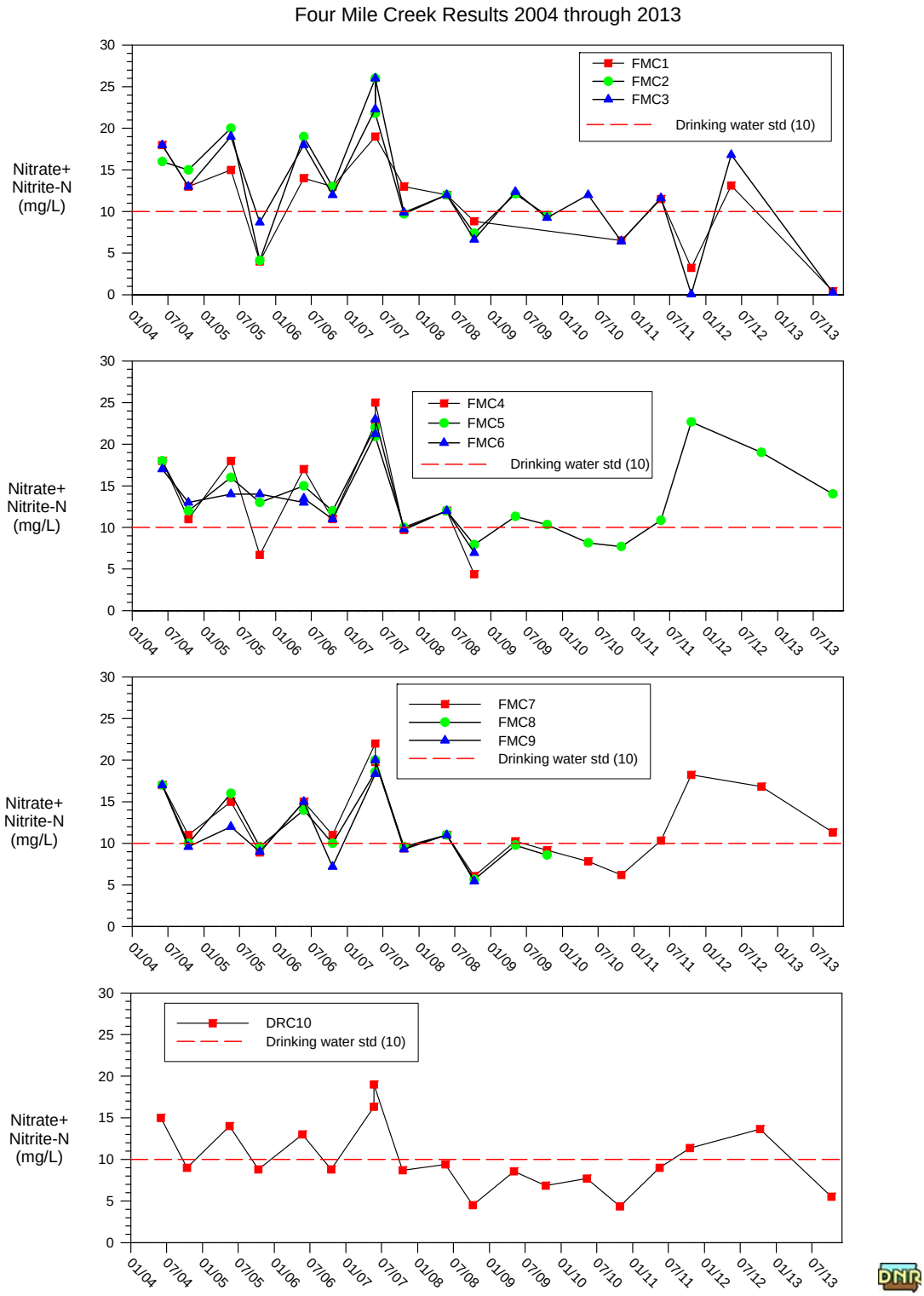
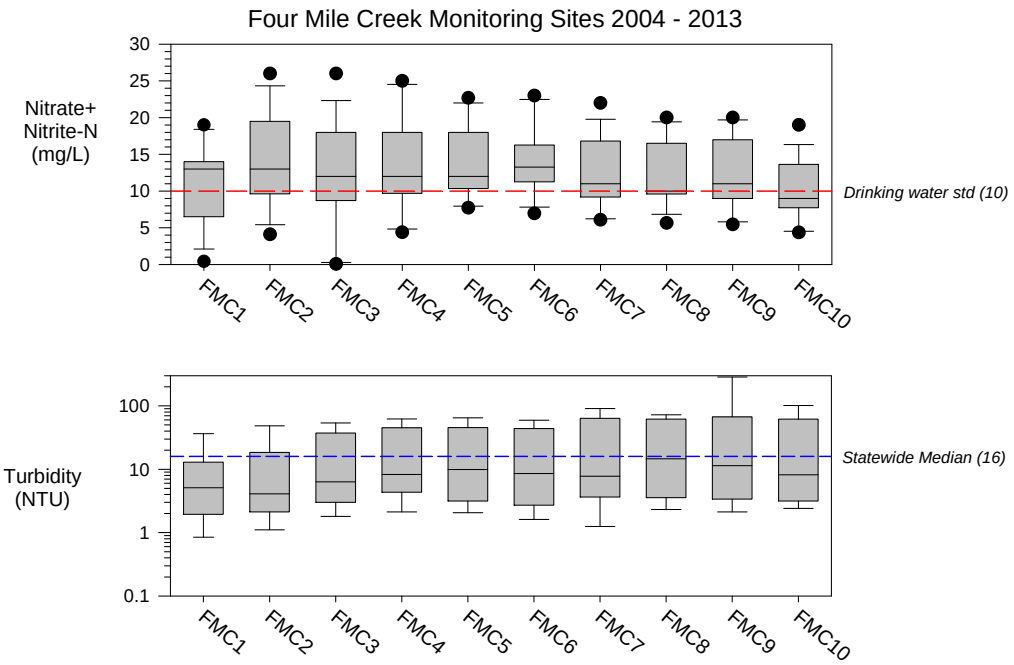


Figure 9. Four Mile Creek Nitrate plus Nitrite as N (Laboratory Methods) Time Series.



Note: Sampling of sites is not the same during the period of record.

Figure 10. Four Mile Creek Box Plots of Nitrate and Turbidity (Laboratory Methods).

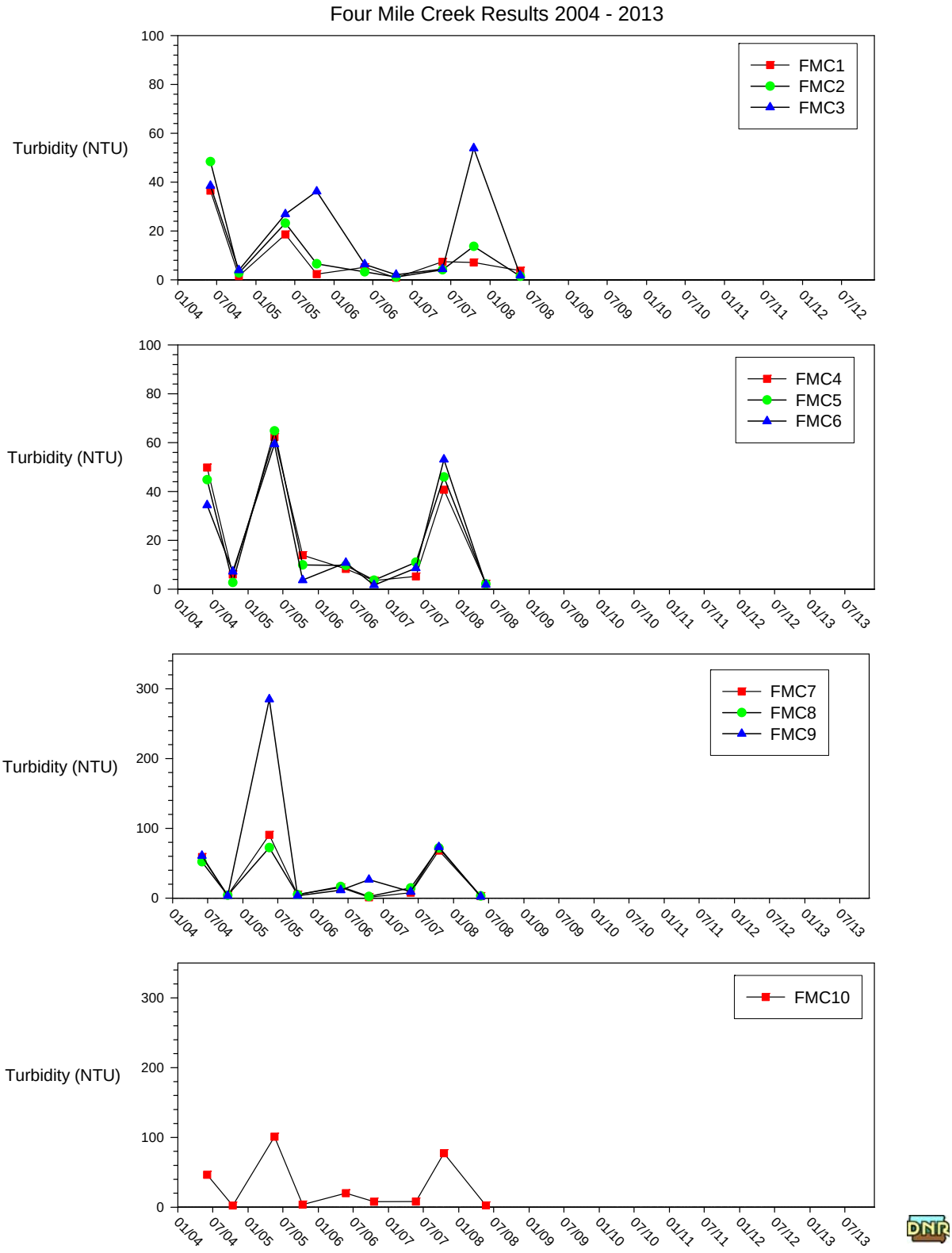


Figure 11. Four Mile Creek Turbidity Time Series.