**STATUS REPORT:**

# THE CLARK FORK RIVER VOLUNTARY NUTRIENT REDUCTION PROGRAM 2002-2005

## The Progress of a Voluntary Program in Reducing Nutrients and Noxious Algae in the Clark Fork River in Montana

November 23, 2005

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## I) Introduction:

### A. Purpose of this Report

The purpose of this report is to review the progress made by the Clark Fork Voluntary Nutrient Reduction Program (VNRP), a voluntary effort to control nutrient pollution and nuisance algae in the Montana portion of the Clark Fork River. A first tri-annual progress report on the VNRP was issued in 2002 by the Tri-State Water Quality Council (Council). This report seeks to update the 2002 report with specific information on nutrient reduction activities and river quality changes since that time, as well as provide a general explanation of nutrient and algae issues, local and state policy regarding nutrients/algae, and specific programs being implemented to resolve nutrient and nuisance algae problems in our surface waters.

The VNRP is a collaborative effort among a group of municipalities, industries, state government and environmental groups in western Montana. The VNRP effort focuses on the Clark Fork River above its confluence with the Flathead River, a watershed of approximately 11,000 square miles. The VNRP agreement was facilitated by the Council, which continues to coordinate the VNRP's implementation. The Council is a non-profit watershed organization working to improve water quality in the Clark Fork-Pend Oreille watershed through mutual respect, collaboration, science and education.

In October, 1998, the VNRP participant organizations signed a formal agreement which committed them to specific measures each would take to reduce discharge of nitrogen and phosphorus to the river, and to monitoring the effects of their work on water quality in the river. Part of the VNRP agreement specified that the group would formally evaluate its efforts every three years during the 10-year duration of the VNRP (from 1998 to 2008). This second tri-annual report will do the following:

1) Review the specific commitments of each signatory in the VNRP agreement.
2) Review the progress each signatory has made in meeting its commitments, noting progress on point-source and non-point reductions since1986, and especially focusing on new progress during 2002-2005.
3) Examine the "results" as measured by the Council's nutrient and algae monitoring in the Clark Fork River during 1998-2005.
4) Identify the issues emerging as the signatories strive to reach the VNRP's ambitious nutrient and algae reduction goals before 2008.

### B. Historical Retrospective on Development of the VNRP Agreement:

<u>The Nutrient Pollution Problem:</u> In 1988, a study commissioned by Governor Ted Schwinden of Montana identified excess nutrient loads and resulting high levels of attached algae growth as one of two major water quality issues in the Clark Fork basin (heavy metals pollution was the other issue). High levels of nitrogen and phosphorus in the Clark Fork result in summer blooms of dense mats of attached filamentous algae (Cladophora sp.) in the upper river, and heavy growths of diatom algae on the river bottom below Missoula. This algae, known locally as "moss" or "slime," is also a nuisance to irrigators, fishermen, and boaters and reduces the aesthetic value of the river.

The Ecological Effects of Excess Algae: The documented negative ecological effects of excessive algae growth in rivers include: 1) degradation of aquatic habitats, 2) depletion of dissolved oxygen supplies, especially at night; 3) loss of diversity in aquatic invertebrate communities; and 4) stress on native fish populations. Low summertime oxygen levels and changes in invertebrate communities have been measured in the Clark Fork where heavy algae growths occur. In lake ecosystems, like Lake Pend Oreille, excess nutrients and algae can lead to classic eutrophication problems: loss of water clarity, proliferation of noxious algae and weeds, and changes in lake ecology. Lake Pend Oreille is experiencing symptoms of eutrophication along shorelines, but not yet in the open waters of the lake.

Identification of the Problem and Sources: Studies funded by the 1987 reauthorization of the Clean Water Act, quantified the nutrient pollution problems in the Clark Fork River. These studies--known as the section 525 studies for the pertinent section of the Clean Water Act--were completed in the Montana, Idaho, and Washington sections of the Clark Fork-Pend Oreille watershed in1992. The Montana study identified the upper Clark Fork from Warm Springs downstream to near Clinton, Montana, as well as the area downstream of Missoula, as sites with high levels of instream nutrients, and correspondingly excessive growths of algae (Ingman, 1992). Key sources of nutrients identified in the Clark Fork included the larger municipal wastewater treatment plants, as well as septic systems, some industries, and agriculture. The 525 study identified wastewater effluent from municipal and industrial plants as the source of 49% of the soluble phosphorus and 28% of the soluble nitrogen in the Clark Fork.

History of the Nutrient Pollution Clean-Up Effort: In 1993, the Environmental Protection Agency published a combined Clark Fork-Pend Oreille Basin Water Quality Study based on the conclusions of the 525 studies in each state. This study included a Management Plan for nutrient pollution and associated problems in the Montana, Idaho, and Washington State portions of the Basin.

The Council was formed in 1993 to implement the Plan’s recommendations. In 1994, the Council began to facilitate discussions among interested stakeholders, and to support scientific studies about possible voluntary nutrient pollution controls in the upper and middle Clark Fork. In 1998, these discussions among the municipalities, State, industry, and environmentalists culminated in the development of the Clark Fork VNRP.

The VNRP is a landmark agreement in Montana—it is one of the first approved Total Maximum Daily Load (TMDLs) in the state, it covers a huge watershed, it includes a detailed water quality restoration plan, and it was developed through a collaborative process led by the stakeholders, not by state or federal government. The State of Montana agreed to let the stakeholders work for 10 years to achieve the VNRP’s in-stream water quality targets without the regulatory pressure of constricting the nutrient limits in the signatories’ Montana Pollution Discharge Elimination System (MPDES) permits.

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### C. Formalization of Nutrient/Algae Targets on the Clark Fork:

The VNRP specifies water quality targets for 200 miles of the Clark Fork river above the Flathead confluence, and allocates the necessary pollution reductions between the important dischargers. Signatories to the VNRP have until 2008 to meet their commitments, which are intended to meet the targets and eliminate the nuisance algae problems in the river.

The water quality targets in the VNRP were developed based on analysis of conditions in the Clark Fork river, and the work of third-party reviewers who looked at large data bases on nutrient-algae problems in a variety of geographic settings (Dodds and Smith, 1995). The targets finally arrived at by the VNRP Committee of the Council are expressed in Table 1:

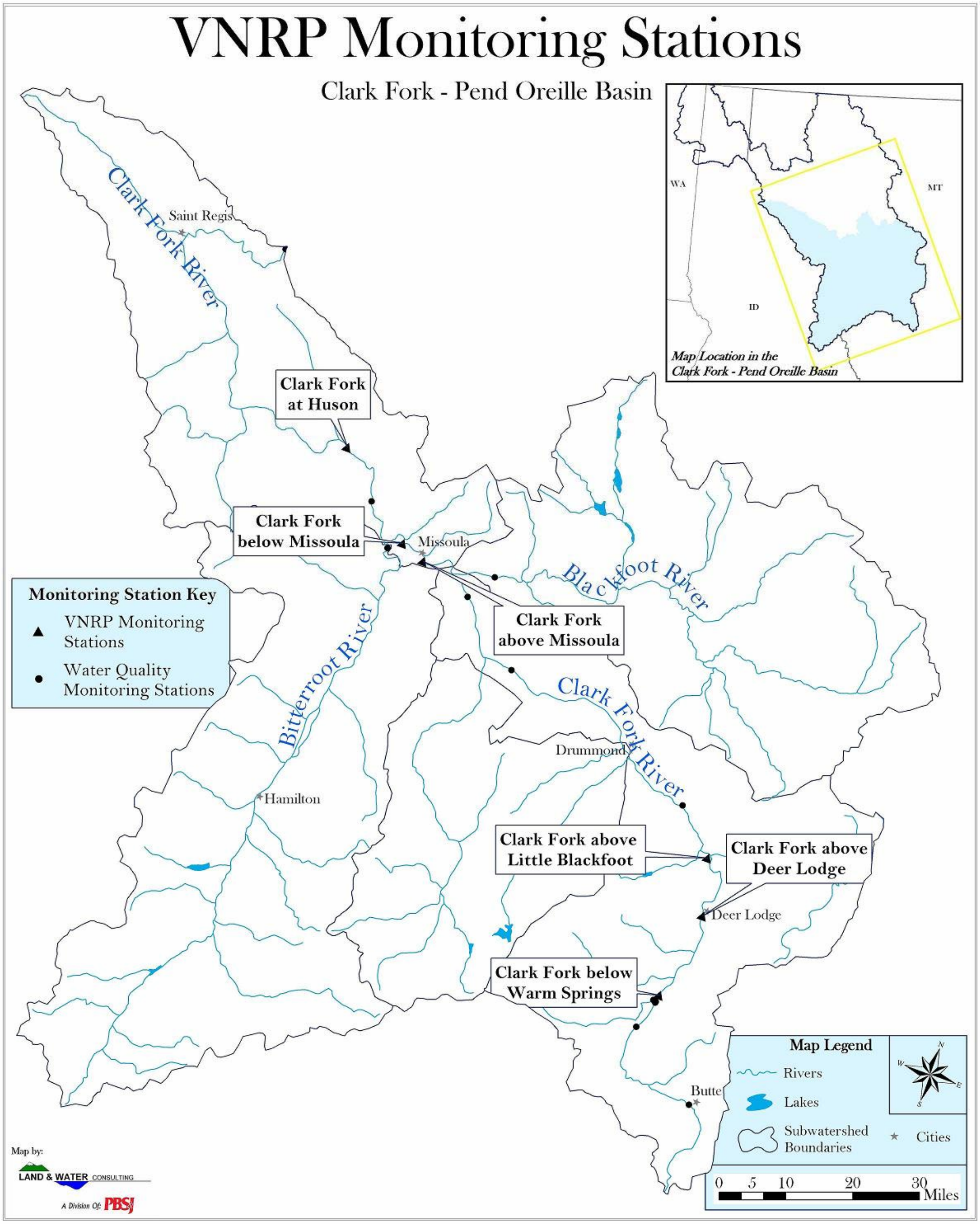
**Table 1: VNRP Targets for Clark Fork River above the Flathead**

| |
|---|
| **VNRP Algae Targets:** |
| 100 milligrams/meter2 chlorophyll a (summertime mean), and |
| 150 milligrams/m2 (peak), chlorophyll a |
| |
| **VNRP Nutrient Targets:** |
| 20 micrograms/Liter of Total Phosphorus (upstream of Missoula) |
| 39 micrograms/Liter of Total Phosphorus (downstream of Missoula) |
| 300 micrograms/Liter of Total Nitrogen (anywhere in river) |

The VNRP is designed to achieve these targets before 2008, through the investments of the signatories in significant new nutrient pollution control. Once these targets are achieved it is believed that excess algae will be reduced to a point which no longer harms the aquatic habitat, the aquatic life, or the aesthetic quality of the river.

However, the VNRP signatories realize that nutrient levels are only one of several natural factors affecting algae growth. Sunlight, temperature, drought or flood patterns, browsers (insects or others) and other factors that are not under human control also affect algae growth. Therefore, the algae levels in the Clark Fork are not expected to respond in a simple linear fashion to nutrient reductions.

**FIGURE 1: Clark Fork VNRP Project Area and Selected Monitoring Stations**



**II) Point Source Nutrient Reduction Measures and Their Effectiveness**

The VNRP was signed by eight distinct entities—and each has specific commitments detailed within the document. The major signatories and their specific commitments are summarized in Table 2:

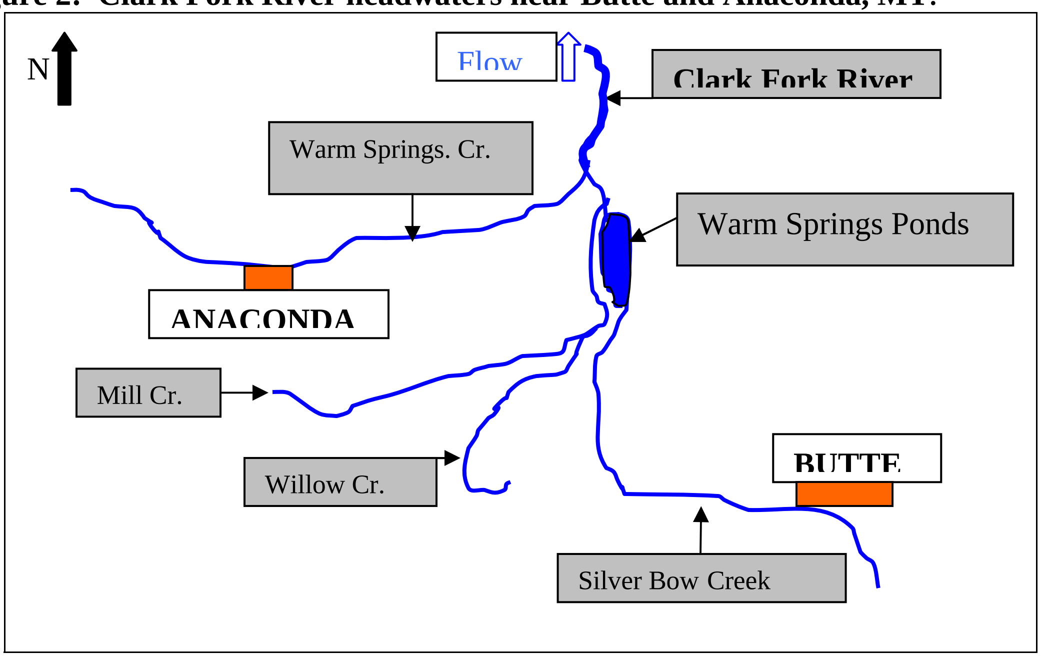
**TABLE 2: VNRP Signatory Commitments:**

| Signatory to VNRP and Role: | Specific Commitments in VNRP |
|---|---|
| **Butte-Silver Bow government/ (Butte Metro Sewer wastewater treatment plant)** | *Reduce summer phosphorus and nitrogen discharge loads to 9% and 22% of 1991 levels.<br>*To accomplish this, Butte will:<br>--pump effluent to land application sites;<br>--take other measures as necessary to meet target levels of nutrients in Clark Fork, such as flow augmentation below Warm Springs Creek. |
| **City of Deer Lodge (wastewater treatment plant)** | *Meet in-stream nutrient and algae targets by constructing a land application system for wastewater effluent.<br>*Implementation of a phosphate laundry detergent ban. |
| **Missoula County/ City-County Health Department (septic and subdivision policies).** | *Address septic effluent impact on surface water pollution by:<br>--offering incentives to connect to public sewer for existing facilities and new subdivisions.<br>--Connecting 50% of the 6,780 existing septic systems in the Missoula urban area to sewer.<br>--Continue to connect existing septic systems to sewers in the Missoula area to achieve no net growth of septic systems. |
| **City of Missoula (Missoula wastewater treatment plant)** | *Continue experimentation with biological nutrient removal using existing facility;<br>*Reduce nutrient loading to the river through an upgrade and expansion of the existing wastewater treatment plant.<br>*Collaborate with Missoula County on hooking up septic systems to sewer. |
| **Smurfit-Stone Container Corporation** | *Reduce nutrient loading to meet in-stream nutrient loading and algae targets by:<br>--Use of color removal plant<br>--No direct discharge to river during July-August;<br>--Summer use of storage ponds remote from river;<br>--Research on additional techniques.<br>*Participate on VNRP committee to evaluate progress |
| **Montana Department of Environmental Quality** | *Address new and existing discharge permits.<br>*Implement subdivision review procedures to reduce water quality impacts.<br>*Work with Missoula agencies of septic issues.<br>*Work with Council on a nonpoint prioritization and strategy.<br>*Repository of the Clark Fork model.<br>*Coordinate with VNRP committee. |
| **Tri-State Water Quality Council** | *Provide coordination/administration of VNRP<br>*Oversee implementation/evaluation of VNRP.<br>*Coordinate in-stream data with monitoring subcommittee.<br>*Hire a VNRP Coordinator to work with other parties in watershed.<br>*Report to EPA and the public. |
| **Clark Fork Coalition** | *Continue participation on VNRP committee to monitor and evaluate program. |

**A. Activities and Impact in Butte-Silver Bow County:** The Butte-Silver Bow County government (Butte) has applied diverse strategies for reducing the impact of its municipal wastewater treatment system on nutrient concentration in the Clark Fork. Butte has an MPDES permit to discharge treated wastewater from its wastewater treatment plant into Silver Bow Creek, a small tributary to the Clark Fork, which flows through Butte.

From the beginning of the VNRP process, Butte has focused on meeting nutrient concentration targets (20 micrograms/L total phosphorus, 300 microgram/L total nitrogen) in the Clark Fork river where it begins, at the confluence of Silver Bow Creek, Mill-Willow Creek and Warm Springs Creek, about 20 miles downstream of Butte. This location is the most upstream monitoring point on the Clark Fork itself, and is referred to as "Butte's point of compliance" with VNRP. This allows Butte to take advantage of the Warm Springs Ponds as a nutrient sink for Silver Bow Creek water and of Warm Springs Creek as a conduit for clean dilution water for the Clark Fork.

**Figure 2: Clark Fork River headwaters near Butte and Anaconda, MT:**




Butte-Silver Bow has been using the following strategies for nutrient concentration reduction in the Clark Fork at its "compliance point."

- Starting in 1999, Butte-Silver Bow has allowed ARCO to divert up to 24 million gallons/day (37 cfs) of clean water from Silver Lake into the Warm Springs Creek drainage. The purpose is to alleviate de-watering in lower Warm Springs Creek, and to improve water quality (for metals and nutrients) in the creek and Clark Fork river by dilution. The Silver Lake water significantly dilutes the nutrient content of the Clark Fork river below Warm Springs Creek. Silver Lake water has a phosphorus content below detection and less than 0.1 mg/L total nitrogen, so it serves very well for dilution of nutrients.

- In 2000-2001 Butte-Silver Bow installed a center pivot irrigation system on city-county land west of Butte for the purpose of wastewater effluent irrigation. A pipeline carries treated effluent west from Butte WWTP to the site, where the center pivot irrigates approximately 100 acres. The wastewater treatment plant staff installed the system, and have been operating it each year from late April to early September. This system pumps approximately 0.4-0.6 cfs (0.25 to 0.4 mgd) of treated effluent during peak irrigation season, effectively removing this effluent from Silver Bow Creek.
- Storm water from urban Butte contains nutrients and metals, but much of this water is captured in the Butte hill stormwater retention basins, constructed over the last eight years. These basins result in approximately 60% of the stormwater and sediment from the urban area of Butte being captured. The basins were built primarily to capture metals and sediment. The amount of nutrients retained has not been calculated, but urban stormwater sediments generally include significant attached phosphorus.
- Butte maintains a voluntary laundry detergent phosphorus ban.

From **2002 to 2005,** Butte-Silver Bow took the following additional steps to reduce nutrient impacts on the Clark Fork:

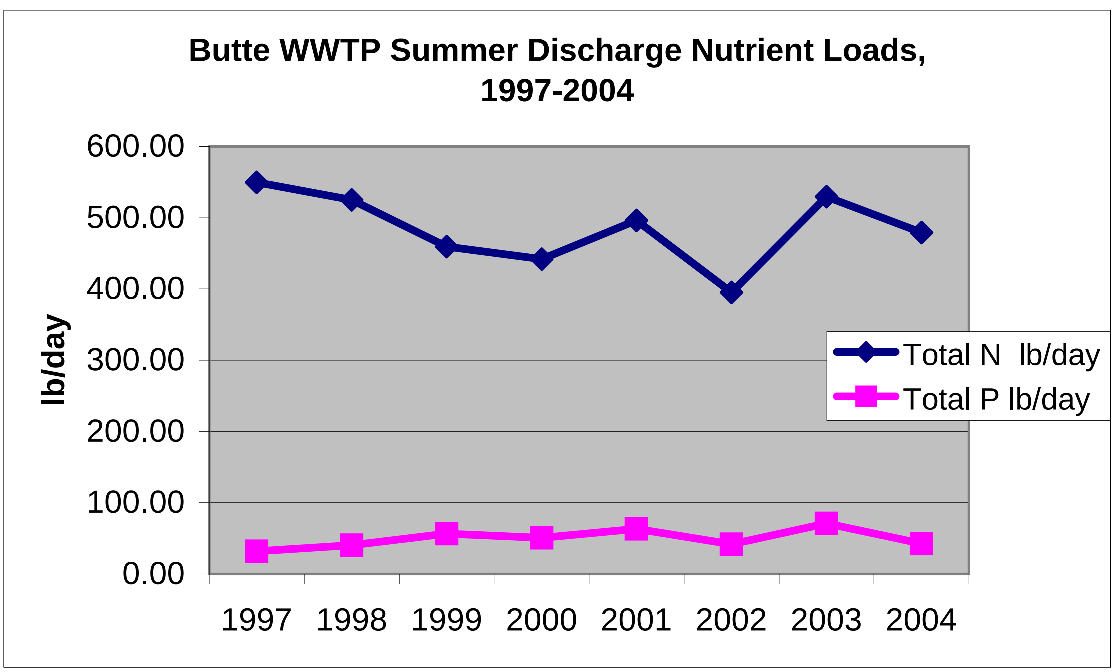
- Beginning in 2004 up to 3 mg/d (4.6 cfs) of Silver Lake water has been discharged into the Metro storm drain, a tributary of Silver Bow Creek in downtown Butte. This provides dilution for nutrients in Silver Bow Creek.
- Plans call for treated water from the Berkeley Pit (treatment of Pit effluent will begin in about 2017) to be discharged into the re-naturalized stream channel of Metro storm drain. This water will come from the Horseshoe Bend Treatment facility and will be very low in nutrients. Approximately 7 mg/d (10.8 cfs) of this treated water will be discharged continuously into the Metro Storm drain; at that time, the importation of Silver Lake flow will be discontinued.
- Butte continues discussion with Montana Resources, Inc. (MRI), a mining company, about the possibility that MRI will take up to 1.5 mg/d (2.3 cfs) of treated wastewater effluent for use in mining operations. A pipeline exists which could be used to pump this effluent from the Butte WWTP to MRI. This effluent would be effectively removed from Silver Bow Creek and the Clark Fork river.
- Butte also has 10” pipelines running from the municipal wastewater plant to the municipal golf course and Copper Mountain recreational park. These two facilities have a capacity to use 1.5 mg/d (2.3 cfs) of treated effluent in summer months. Use of these sites for wastewater effluent irrigation is being considered.
- Two additional projects are being studied: first, Butte is considering the possibility of delivering up to 3 mg/d of treated effluent to a private ranch in the Browns Gulch drainage for use in irrigation. Second, Butte is studying the feasibility of upgrading its WWTP to include biological nutrient removal.

The land application work done so far directly removes approximately 10% of the summer nutrients in municipal wastewater effluent from Silver Bow Creek (an additional amount is removed by the Warm Springs Ponds before they discharge to the Clark Fork river). The Butte nutrient load is also reduced by the reduction in flow, and especially the retention of stormwater that formerly infiltrated into the sanitary sewer (see comparison data 1989-91 data versus 2004/05 data in Figure in Table 5 ). Future projects now being studied by Butte-Silver Bow may remove a large proportion of the remaining treated effluent from Silver Bow Creek, as estimated below:

**Table 3: Butte-Silver Bow Nutrient Reduction:**
**Summer Nutrient Discharge Estimates for WWTP**

| Site: | Daily Flow (cfs): | Total N Conc. (mg/L) | Total P Conc. (mg/L) | Total N Load (lb/day): | Total P Load: (lb/day): |
|---|---|---|---|---|---|
| WWTP effluent discharge: | 4.9 | 21.20 | 1.74 | 559 | 41.7 |
| Sod Farm use: | -0.5 | 21.20 | 1.74 | -57 | -4.7 |
| Actual discharge to SB Creek: | 4.4 | 21.20 | 1.74 | 502 | 37 |
| Potential MRI reduction | -2.3 | 21.20 | 1.74 | -262.4 | -21.5 |
| Potential golf course and Copper Mtn. reduction | -2.3 | 21.20 | 1.74 | -262.4 | -21.5 |
| Effluent Nutrient Load Needed to meet VNRP*: | (0.84) | 21.20 | 1.74 | ( 95.9) | ( 7.9) |

* VNRP specified that Butte WWTP would reduce its daily summer nutrient load discharge to approximately 96.8 lb/day total N and 9.7 lb/day total P, but meeting the nitrogen load goal would be a stricter contraint at these effluent concentration levels.



**B. Activities and Impact in the City of Deer Lodge:** Deer Lodge has focused its nutrient reduction strategy on a summer-season effluent irrigation project with Grant Kohrs Ranch, a National Park Service facility. This system was designed to pump 1.1 million gallons/day of Deer Lodge wastewater effluent to pastures on the north end of the Grant Kohrs Ranch. This project was inaugurated in summer 2000, and has now functioned for six summers. Initially the Park Service operated the irrigation system and paid the pumping bills. After several years the City of Deer Lodge and the Park Service renegotiated their agreement, and the City assumed a greater portion of the operating costs. Accomplishments and observations for the period 1998 to 2002 included the following.

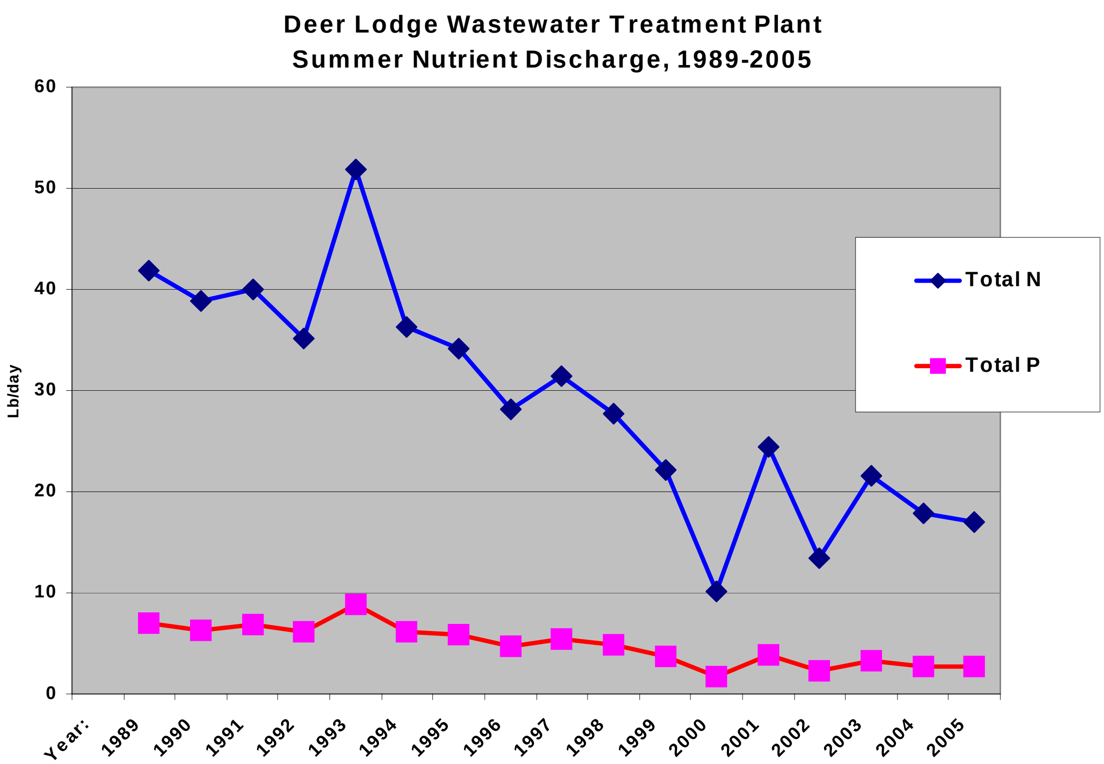
- Constructed the stilling well, pump, and effluent pipeline to Grant-Kohrs ranch. The land application of irrigation effluent project began functioning in 2000 and has been running up to five months per year (May-September).
- The irrigation system was designed to use all the City's effluent in summer, but this has not occurred. In early summer--June and early July-- the high quantity of groundwater inflow into the City's wastewater collection system overwhelms the pumping capacity for the irrigation effluent project, and some dilute effluent continues to be discharged to the river.
- A phosphate laundry detergent ban continues to function in Deer Lodge.

Recent accomplishments in Deer Lodge (2002-2005) include the following:

- In 2003, Deer Lodge replaced several sections of 40-year old sewer line, including one under the Clark Fork river, reducing groundwater infiltration into the system.
- In 2004, the City of Deer Lodge began to prepare a new facility plan for its wastewater, using City funds and grant funding from the Council and the State of Montana. The new facility plan intends to: 1) identify the source of excess seepage inflow during high water in spring; 2) find options to the land application system at Grant-Kohrs Ranch; 3) develop new approaches to meeting the VNRP targets of zero nutrient discharge during summer.
- The Facility Plan process has reached several preliminary conclusions: 1) much of the groundwater infiltration problem is within the sewer collection system in Deer Lodge. A video inspection next spring will identify specific locations; 2) the new MPDES permit for Deer Lodge will incorporate tighter limits for organics, solids, and nutrients, including ammonia. It will also incorporate existing TMDLs for the Clark Fork effective in 2008 (after VNRP), which require zero nutrient discharge from 21 June to 21 September; 3) based on population, the City's wastewater flow should be 0.35 to 0.5 million gallons/day. But due to groundwater infiltration, the early summer flows go as high as 3 million gallons/day, causing significant effluent to be spilled into the river, because the effluent irrigation system only has actual capacity for 0.9 million gallons/day.
- If infiltration can be reduced, the city's current aerated lagoon system can probably meet the future discharge limits for all constituents. Therefore, the key problem is how to reduce or manage the groundwater infiltration.

- Preliminary estimates indicate that the City of Deer Lodge may need to replace (or slipline) 15,000 feet of 8-inch sewer main to reduce infiltration. However, certain residential parts of Deer Lodge experience high groundwater which is partly alleviated by the sewer system. If the sewer no longer accepts groundwater inflow, then a supplementary drainage system will need to be constructed.
- Another part of the solution to excess flow caused by groundwater infiltration, is to store excess effluent at the wastewater treatment plant during summer. The old facultative lagoon, if lined, would have ample storage to complement the effluent irrigation system and allow for zero discharge to the river during the early summer.
- Over $200,000 of City of Deer Lodge funds and $300,000 of grant funds have been invested in the sewer main replacements/river crossing, preliminary wastewater engineering report and other work since 2003, as well as the $500,000 invested in the late 1990s to install the wastewater effluent irrigation project.
- Although Deer Lodge's effluent irrigation system has not met its goal of removing all summer effluent discharge to the river, it has succeeded in dramatically reducing the average summer nutrient discharge. The summer average discharge in 1989 was 41.8 lbs/day of total nitrogen and 7.0 lbs/day of total phosphorus. By 2005, the summer average discharge had declined to 17.0 lbs/day of total nitrogen and 2.7 lbs/day of total phosphorus (see Figure 4 below).

**FIGURE 3:**



## C. Activities and Impact at Missoula City-County Health Dept.:

The Environmental Health Division enforces the City-County Health code, which regulates septic systems and subdivisions. The Missoula Valley Water Quality District, housed within the does monitoring and research on surface and groundwater quality. Together with the City of Missoula's Public Works Division these agencies are implementing a program to transfer existing septic systems to sewer, and to sewer new subdivisions and growth areas. Cumulative progress since 1997 includes:

- Newly sewered areas in the Missoula valley include East Reserve I and II, East Missoula, and Mullan Road areas. The East Reserve and East Missoula locations were neighborhoods with dense existing development on septic systems, while Mullan Road has several dense existing developments, and rapid subdivision and construction of residential housing. East Reserve I and II were connected to city sewer at the time of the last report (2002), while East Missoula and Mullan Road areas are more recent connections to the wastewater treatment plant.

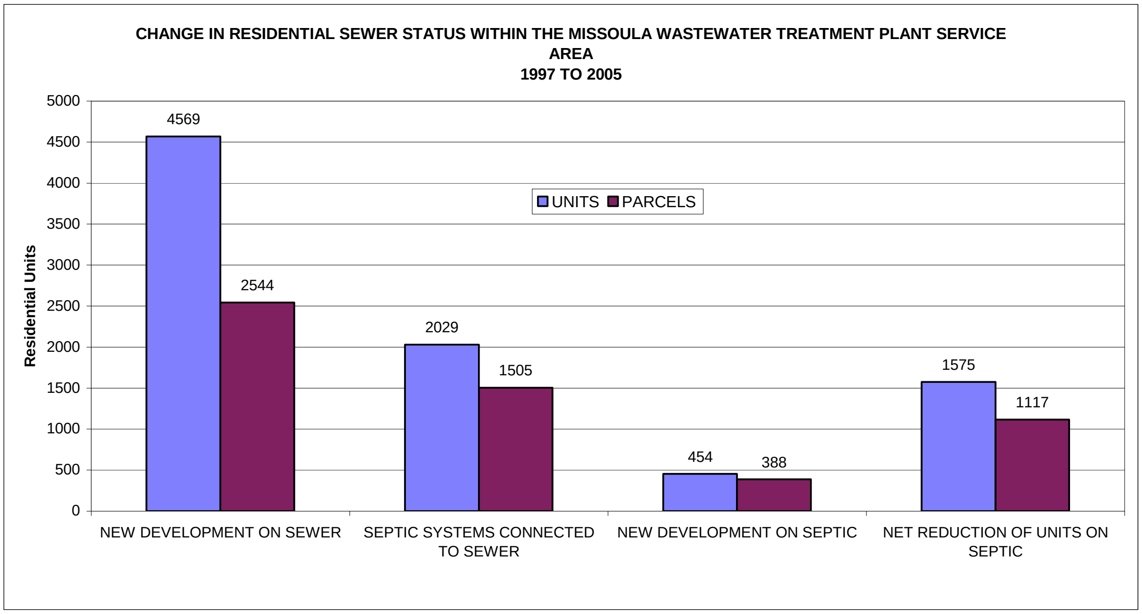
- A total of 2,209 existing residential units had their septic systems connected to the City of Missoula sewer system, connected to the Missoula wastewater treatment plant. The goal is to connect approximately 3,390 existing septic systems to sewer by 2008, so the Missoula City-County governments have accomplished 65% of their VNRP-related goal.

- Meanwhile, a total of 4,590 new residential units were built in Missoula's projected sewer service area and connected to sanitary sewer. Only 454 new residential units were built in the same area with septic systems.

- Therefore, there has been a net reduction of 2209 - 454= 1575 fewer housing units on septic systems in the Missoula valley since 1997. This meets the policy goal to maintain no net growth in the number of septic systems in the Missoula valley for the long-term.

Other new sewer extension projects have been proposed and planned in the Missoula valley during 2002-2005, but several remain controversial. Some neighborhoods are concerned that sewer extension will bring with it unwanted growth or city annexation. One neighborhood, southwest "Target Range" has responded by voluntarily zoning itself at a minimum of 1-acre lots to avoid the push toward sewer extension.

Progress in connecting the Missoula valley to sewer is summarized in **Figure 4** below:




**D) City of Missoula Wastewater Treatment Facility:** The City of Missoula's Wastewater Division has been involved in nutrient reduction efforts since well before the VNRP agreement, and continues to make progress in this area. In 1989-1990, the City wastewater treatment plant staff documented a 30% decrease in the total phosphorus content of raw wastewater after laundry detergents with phosphates were banned. The annual average total phosphorus discharge from the plant dropped from 342 lbs/day in 1988 to 189 lb/day in 1990, due to that local government policy.

In 1995, the City's staff developed a method for further reducing phosphorus in their effluent by altering their treatment process using existing infrastructure. This "experiment" reduced effluent phosphorus concentrations from 4.3 mg/L in 1989 to between 1.5 and 2.1 mg/L, levels that were maintained until recently. The City of Missoula wastewater treatment facility was rapidly approaching its design capacity by the end of the 1990's due to population growth and incorporation of new neighborhoods into the sewer service area. By 2002, a project to expand and upgrade the Missoula treatment facility was well underway. During 2002-2005, the City of Missoula has made the following progress:

- In the period 2002-2004 the City of Missoula constructed an $18 million biological nutrient removal (BNR) treatment system at the existing wastewater treatment plant. This project increased the wastewater treatment capacity from 9 million gallons/day to 12 million gallons/day (average daily flow), and reduced nutrient discharges (phosphorus, nitrogen, and ammonia). The improvements were inaugurated in fall, 2004.

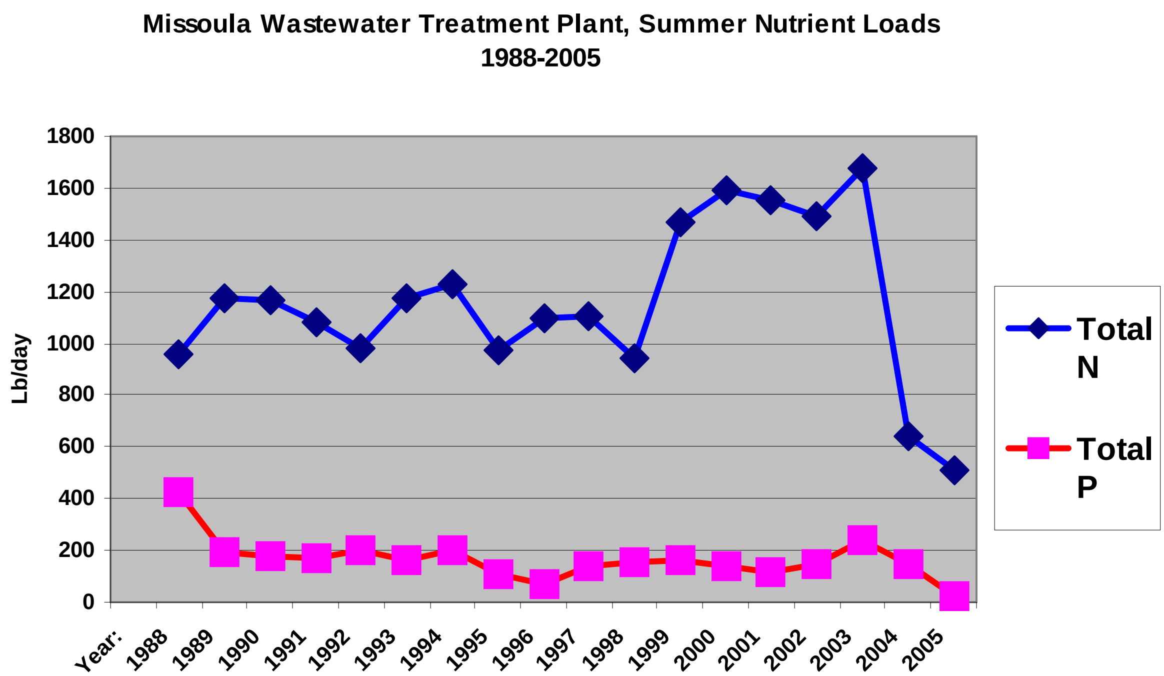
- Since the new biological nutrient removal system has been in full operation and stabilized total phosphorus load discharges have been reduced by more than 80%, total nitrogen load has been reduced more than 65%, and ammonia (toxic to some aquatic life) has been reduced by more than 95%. The performance of the new biological nutrient removal system has exceeded design criteria, and is expected to meet the city's VNRP commitments as well as all State and Federal regulatory requirements for many years. In summer 2005, total N discharge was down to 510 lbs/day, and total P discharge down to 24 lbs/day (10 times lower total P than in the late 1980s). The data can be seen in Figure 6 below.

- The City of Missoula funded a "mini-grant" program during 2002-2003 with $45,000 of City funds in order to find opportunities to reduce nutrient discharges from small point sources and non-point sources in the Clark Fork basin. Details of this program are described below under "VNRP Activities."

- The City of Missoula also provided $35,000 in funding for a nutrient modeling project in 2003 for the Bitterroot River watershed (see details below under "VNRP Activities.")

- In June, 2005, the City was presented with an opportunity to remove an MPDES-permitted point-source discharge to the Clark Fork. This MPDES permit was associated with an industrial food-processing facility, and was a significant source of phosphorus (estimated at 40 lbs. per day). The City wastewater treatment plant is now accepting this waste stream and combining in with the municipal waste stream treatment process.

**Figure 5:**



**D. Activities and Impact at Smurfit-Stone Container Corporation**: The Smurfit-Stone Container Corporation linerboard mill (the Mill) near Frenchtown has been a participant in the Tri-State Water Quality Council since its inception, and an active member of the VNRP Committee since 1994. In the late 1980's and early 1990's the Mill dramatically reduced the amounts of supplemental nitrogen and phosphorus which were added to its wastewater stream, which has in turn reduced the nutrient load of its wastewater. For example, the Mill has accomplished a number of its specific objectives relative to VNRP since 1998, including the following:

- The Mill's bleach plant was shut down in February, 1999, reducing the volume and strength of process wastewater, including its nutrient content, thus eliminating the need for the operation of the Color Removal Plant.

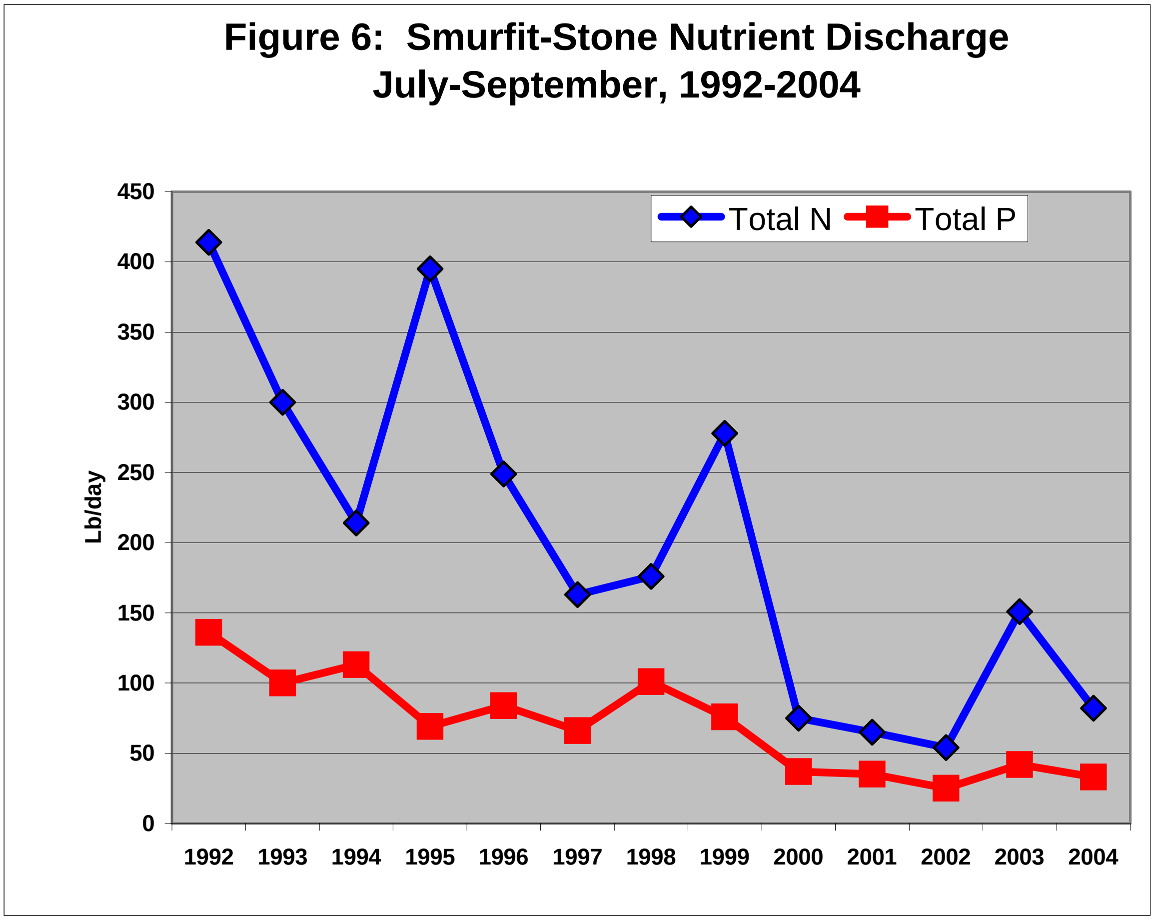
- Long-term efforts were continued to optimize supplemental nutrients added to wastewater. Thus its total nitrogen discharge to the river has declined from over 800 lbs/day in 1986 to 130 lbs/day in 2001; and in total phosphorus the decline has been steady from over 300 lbs/day in 1985 to 57 lbs/day in 2001.

- Research has been conducted on the possible use of artificial wetlands for nutrient removal.

- In-plant process controls further reduced mill process wastewater strength.

- The Mill does extensive in-stream monitoring above and below its Plant site, and has noted that its total nitrogen load to the river varied from about 1% to 3% of the total river load in summers of 1999-2001; while its contribution of total phosphorus to the river in those summers (mostly through seepage) varied from about 9% to 10% of the total river load just upstream at Harper's Bridge.

- The Mill has maintained fairly stable levels of total N and total P for the past five years. Since the Mill does not discharge directly to the Clark Fork at flow levels below 4,000 cfs in July and August, most nutrient discharge is indirect, through groundwater seepage into the river. The long-term changes in summer nutrient discharge from the Smurfit-Stone Mill are shown in Figure 6 below.




**E. Other Point-Source Activities:**

Tri-State Water Quality Council: The Council has been the entity responsible for coordination and facilitation of the VNRP since the early negotiations and studies in 1994. All the VNRP signatories are also members of the Council, and assist in its broader deliberations in addition to their specific responsibilities within the VNRP Committee. Since 1999, the Council has taken on a new role of outreach and project implementation through the VNRP Coordinator, who is a half-time consultant hired specifically to work with other parties in the watershed on nutrient control projects. Specific accomplishments of the Council on point source issues from 1998-2002 include:

- Implementing five mini-grants to small communities for nutrient pollution diagnostic studies, grant-writing, or wastewater project designs (Florence, Drummond, Rocker, Silver Bow County, Deer Lodge Valley Conservation District).
- Developing a new Clark Fork computer model (using QUAL2-E software) to predict nutrient concentrations in the river with the contractor HDR Engineering.
- Working with Montana Dept. of Environmental Quality on the process of developing nutrient standards for the Clark Fork river.
- Performing a case study of the impact of phosphorus in automatic dishwasher detergents on nutrient discharge from Lolo, Montana's wastewater treatment plant. This case study was completed in late 2001, reported in several conferences/newsletters in Montana, and posted on the Council's website. People interested in dishwasher detergent phosphorus bans nationwide have contacted the Council about this research.

In the 2002-2005 period, the Council has continued to work on point-source issues in the Clark Fork. For example, the Council's VNRP Committee:

- Developed a second mini-grant program in 2002-2004, with money donated from the City of Missoula. This program awarded $45,000 in grants to five projects: 1) Gold Creek Water Quality Improvement Plan, a watershed assessment managed by the Watershed Restoration Coalition of the Upper Clark Fork; 2) Land Application Feasibility Study at Alberton, MT, with the City of Alberton; 3) City of Deer Lodge Wastewater Seepage Control project (folded into their on-going Facility Plan); 4) Conservation Easement Project with Five Valleys Land Trust; and 5) Assessment of Groundwater Nutrient Budget in Lost/Dutchman Creeks, with the University of Montana.

### F. Policy Affecting Nutrients/Algae in the Clark Fork

Montana Department of Environmental Quality Water Quality Standards: In 2000 the State of Montana's Department of Environmental Quality (MDEQ), reacting to concerns from the Council about possible increases in non-VNRP nutrient discharge to the Clark Fork, and to a recent national directive from the Environmental Protection Agency on nutrient standards, began the process of developing in-stream water quality standards for algae, nitrogen and phosphorus for the Clark Fork river. In preparation of the proposed standards, Dr. Mike Suplee of MDEQ made an independent review of the targets being used by the VNRP. The MDEQ initially recommended that soluble inorganic nitrogen and phosphorus concentrations would be more appropriate water quality standards.

However, after considerable debate with stakeholders about the advantages of soluble vs. total nutrient criteria, and possible variations in target levels, MDEQ made a decision to use the VNRP total nutrient criteria and "chlorophyll a" algae criteria as water quality standards for the upper and middle Clark Fork. The State did change the point of transition from an upper river total phosphorus target (20 micrograms/Liter) to a lower river target (39 micrograms/Liter) to the confluence of the Blackfoot and Clark Fork rivers. This change was based on Dr. Suplee's analysis of other factors controlling the type of algae in the river, such as water hardness.

The Montana Board of Environmental Review adopted the new nutrient and algae water quality standards for the Clark Fork in August, 2002. Subsequently the MDEQ has continued to research appropriate nutrient and algae standards for other regions of Montana. According to Dr. Suplee, this effort, independent of the VNRP, has resulted in preliminary regional nutrient criteria recommendations for the Clark Fork basin (streams other than the Clark Fork mainstem itself) which are very similar to those originally developed by the Council's VNRP committee. Work on statewide nutrient/algae criteria is ongoing in Montana.

DEQ Pollution Discharge Permits:
A key issue in the implementation of the VNRP is how DEQ will incorporate the new numeric water quality standards for nutrients/algae, into the Montana Pollution Discharge Elimination System (MPDES ) permits in the Clark Fork. A related issue is how waste load allocations (for point sources) and load allocations (for major tributaries) set when the VNRP was approved as a TMDL in 1998 will be applied to MPDES permits once the VNRP expires in 2008. Many MPDES permits in the Clark Fork are currently in the process of being renewed in for five years (2005-2010), making these issues particularly critical for the dischargers.

The VNRP Committee has had a number of discussions with DEQ staff on this issue in the past three years. In July 2005, the Committee met with a group of DEQ staff, and presented them with nine specific questions about how DEQ intends to apply the VNRP-based standards, and the TMDL waste load allocations in the context of MPDES permit renewals. George Mathieus, head of DEQ's Water Quality Planning Bureau, responded in an August 5, 2005 letter that represents the most current and definitive statement from DEQ on these issues.

DEQ intends to incorporate wasteload allocations (WLAs) based on the VNRP targets directly into the permits for Missoula, Deer Lodge, and Butte when the agency renews the permits this year, and into the Stone Container permit when it comes up for renewal. Where it appears a facility's present discharge will not meet its WLA, DEQ intends to impose interim effluent limits and a compliance schedule requiring the facility to take action toward full compliance with the final limits. This is consistent with standard DEQ practice.

The Clark Fork TMDLs: The DEQ is in the process of developing basin-scale nutrient TMDLs for the entire Clark Fork/Bitterroot/ Blackfoot/ Flathead basin, including tributaries, with a current goal of completing the work by 2012. These TMDLs will consider all significant nutrient sources in the basin, both point and non-point, and will allocate loads to each source. These new TMDLs will re-examine the TMDLs, WLAs, and load allocations approved in 1998 (see Table 4). The DEQ is careful to note that the new WLA's for point sources will not necessarily be lower than the existing WLAs. What proportion of the tributaries within the basin will receive formal load allocations in the new TMDLs is unclear.

MDEQ is using a water quality model known as the Soil and Water Assessment Model (SWAT) to help in developing the new TMDLs. The SWAT model estimates non-point nutrient loads based factors including on land use, soils, climate, and topography. In the case of nutrient inputs from septic systems, applying the SWAT model will represent cutting-edge work done with input from Texas A&M and Temple Universities, which developed the model. MDEQ will use the VNRP's QUAL2E modeling work on the Bitterroot River system as input in developing the SWAT model for the Bitterroot basin.

**Table 4: Summer Waste Load Allocations and Load Allocations Approved by EPA in the VNRP TMDL , October, 1998*:**

| Location: | WLA: (kg/day) | LA: (kg/day) | TMDL (kg/day): |
|---|---|---|---|
| Silver Bow Creek abv. Butte | | 75 TN, 2.7 TP | |
| Butte WWTP | 44 TN, 4.4 TP | | |
| Clark Fork abv. Deer Lodge | | 52 TN, 0.84 TP | |
| Deer Lodge WWTP | 0 TN, 0 TP | | |
| Clark Fork above Little Blackfoot | | | 52 TN, 0.84 TP |
| Blackfoot River | | 184 TN, 7.9 TP | |
| Clark Fork abv. Missoula | | 285 TN, 19 TP | |
| Missoula WWTP | 404 TN, 40 TP | | |
| Clark Fork below Missoula | | | 689 TN, 59 TP |
| Bitterroot River | | 414 TN, 28 TP | |
| Clark Fork abv. Smurfit Stone | | 771 TN, 54 TP | |
| Smurfit Stone mill: (seepage):<br>(direct): | 30 TN, 23 TP<br>0 TN, 0 TP | | |
| Clark Fork below Smurfit Stone | | | 801 TN, 77 TP |
| | | | |

*Values of waste load allocation (WLA) and load allocations (LA) are 30-day averages based on a 30 Q10 low flow condition (drought). TN=Total Nitrogen, TP= Total Phosphorus.

Finally, DEQ notes that it is in the process of developing a rule setting forth numeric nutrient standards for *all* waters in Montana. DEQ expects this process to take 1-2 more years.

### G. Summary of Point-Source Impacts on the Clark Fork

The point-source and septic system nutrient impacts on the Clark Fork have been significantly reduced by the nutrient reduction measures of the signatories. A comparison of 1989-91 annual nutrient loads to the Clark Fork with 2004/2005 loads is shown in Table 5 below. The reduction in summer loads was shown in the graphs in each of the preceding sections for each discharger.

The annual loads reflect the reduced load passed to downstream water bodies (lower Clark Fork, Lake Pend Oreille, etc.). Data for annual loads from wastewater plants in 1989-91 is taken from Ingman (1992, "Assessment of Phosphorus and Nitrogen Sources in the Clark Fork River Basin: Final Report, Section 525 of the 1987 Clean Water Act Amendments) based on monitoring done at each facility in 1989-1991. Data for 1990 for Smurfit-Stone Container Corporation is taken from Smurfit-Stone's own records for 1990 (which record a substantially higher value than Ingman's monitoring report—possibly because they include an estimate of the seepage component). The 2004/2005 loads are based on reports from each agency's own monitoring system (Missoula reported daily average data to date for 2005, while Butte, Deer Lodge and Smurfit-Stone use 2004 data.

**Table 5: Annual Average Nutrient Loads Discharged by VNRP Signatories for 1989-91 and 2004/05:**

| Discharger: | 1989-91 TN, TP Load: (lbs/day) | 2004/05 TN, TP Load (lbs/day): | Reduction N Load (%): | Reduction P Load (%): |
|---|---|---|---|---|
| **Butte WWTP:** | 409 N 118 P | **498 N 50 P** | -22% | 57% |
| **Deer Lodge WWTP:** | 88 N 22 P | 59 N 6 P | 33% | 73% |
| **Missoula WWTP:** | 926 N 190 P | 668 N 59 P | 28% | 69% |
| **Smurfit-Stone Mill:** | 553 N 142 P | 184 N 55 P | 67% | 61% |
| **Total Point Source Load:** | **1,976 N 472 P** | **1,409 N 170 P** | **29%** | **64%** |

The data show that the VNRP signatory MPDES point sources have **reduced their annual load of total nitrogen to the river 29% in the last 15 years, and reduced their total phosphorus load 64% to the river.** The much greater reduction in phosphorus load requires explanation.

The change in ratios between nitrogen and phosphorus since 1991 indicate that that Butte and Deer Lodge raw wastewater loads currently include far less phosphorus than in 1989-91. For Butte, this is probably due to a combination of stormwater detention basins reducing stormwater overflow to the sanitary sewers, the laundry detergent phosphate ban and reduction of industrial loads. In Deer Lodge, the laundry detergent ban is the main known effect before 2000. Since that time, Deer Lodge's land application system is removing a large part of the annual volume of wastewater effluent and thus nutrient load (summer wastewater flows are much higher than winter flows in Deer Lodge).

The Missoula wastewater treatment plant's new biological nutrient removal system, which became fully effective in 2005, is more efficient at removing phosphorus than nitrogen, which explains why their phosphorus reduction is more dramatic than the nitrogen reduction (the effect of the phosphate laundry detergent ban in Missoula occurred before 1990 data shown). Note that City of Missoula is decreasing total nutrient loads discharged while increasing population and number of homes connected to sewer.

A further reduction in total nitrogen load discharged in the Missoula valley is due to the connection of septic systems to sewer, and the associated net reduction in the number of septic systems. This load reduction is not shown in the table, and is not easy to measure directly, but is estimated at 0.08 lb/day total N per septic system, or about 126 lbs/day of total nitrogen (mostly nitrate) from the net reduction of 1575 septic systems.

Smurfit-Stone Container has dramatically reduced both nitrogen and phosphorus annual loads discharged to the river—note that their reductions in each nutrient are proportional.

## III) Non-point Source Nutrient Reduction Measures

### A. VNRP Non-point Source Priority Tributaries

Priority Tributaries: In 1999 the VNRP Coordinator proposed a strategy for reducing non-point nutrient loads which focused on priority tributaries in a paper called "VNRP Coordinator's Non-point Source Strategy and Goals." The priorities were set up based on the perceived feasibility of obtaining significant reductions in nutrient discharge from those streams. Assumptions included: a) streams with nutrient concentrations higher than the Clark Fork targets deserved most attention; b) high non-point nutrient concentrations were assumed to be due to land use practices which could be mitigated; c) smaller watersheds were assumed to present more opportunities for nutrient reduction than larger watersheds (where the problems are more difficult to locate or expensive to mitigate).

The criteria chosen for ranking tributaries were:

a) High concentrations of either total nitrogen or total phosphorus (>VNRP targets).
b) High concentrations of both nutrients.
c) Significant nutrient loads (arbitrarily defined as >10 kg/day total P or 40 kg/day total N).
d) Watershed size, assuming smaller watersheds would be easier places to have an impact.
e) Social factors, including the existence of stream restoration projects with other agencies, watershed groups working in area, or prior history with restoration.

The results were based heavily on data collected by Ingman (1992) during source monitoring of tributaries in the upper and middle Clark Fork in 1989-1991. The rankings were as follows (higher numbers indicate higher ranking):

**Table 6: Ranking Clark Fork Tributaries for Nutrient Reduction Priority**

| Tributary: | Score (5 is max. -2 is min.) |
|---|---|
| Lost Creek | 5 |
| Little Blackfoot River | 4 |
| Gold Creek | 4 |
| Flint Creek | 4 |
| Warm Springs Cr.-Garrison | 4 |
| Mill-Willow Creeks | 3 |
| Dempsey Creek | 3 |
| Racetrack Creek | 3 |
| Cottonwood Creek | 2 |
| Warm Springs Creek-Anaconda | 2 |
| Bitterroot River | 2 |
| Ninemile Creek | 1 |
| Trout Creek | 1 |
| Rock Creek | 0 |
| Blackfoot River | 0 |
| Fish Creek | -1 |
| St. Regis River | -1 |

Reference to subsequent tributary nutrient sampling work done by the Council and by Dr. Vicki Watson of the University of Montana, resulted in general confirmation of this ranking system, with some modifications. For example, the Lost Creek, Little Blackfoot, Gold Creek, and Flint Creek have the largest effects on the Clark Fork due to their flows and respective nutrient loads, while the Little Blackfoot frequently has nutrient concentrations much lower than the VNRP targets. We also know that much of the Little Blackfoot, Gold Creek, and Warm Springs Creek-Garrison load is from naturally high phosphorus groundwater, particularly in Gold Creek, with no known point sources.

The Bitterroot River probably merited a higher ranking---it had a total nitrogen average concentration in the 1989-1991 data that was barely below the VNRP target, and it has by far the largest nutrient load of any tributary. More importantly perhaps, the human population in the Bitterroot is growing more rapidly than any other part of the upper/middle Clark Fork, with major land use changes tending toward suburbanization, and concerns about stormwater, additional sewer load, and the tremendous growth of septic system loads. The State of Montana lists the Bitterroot River mainstem and eight of its tributaries—including Rye and North Rye, Threemile and Ambrose, Burnt Fork, Sweathouse and Sleeping Child, as nutrient-impaired.

The Blackfoot River system has a relatively high load of nutrients but only because of its high flow, while its nutrient concentrations tend to be well below VNRP targets. Two Blackfoot river reaches from Nevada Creek to Belmont Creek are nutrient-impaired, as are Nevada Creek, Union Creek, and Elk Creek, according to the DEQ 303(d) list.

### B. Non-point Source Nutrient Reduction Activities and Impacts in the Upper Clark Fork

The VNRP Coordinator has worked with a number of different groups since 1999 to promote watershed conservation or stream restoration activities which can improve the non-point source nutrient issues in the upper Clark Fork. Some projects identified by agencies and landowners as “fisheries improvement” or other types of conservation projects probably have, or will have, significant long-term effects on nutrient discharge from Clark Fork tributaries.

Many projects of this type have been initiated in the upper Clark Fork, particularly in the past 5 years. But watershed-level projects tend to proceed slowly and incrementally as funds become available, and new landowners enter into the process. Few projects of this type have been “completed.” A general accounting of project activity on priority nutrient tributaries follows in Table 7.

**Table 7: Non-point Source Activities in Upper Clark Fork Priority Tributaries**

| Tributary: | Activities Known to VNRP Coordinator: |
|---|---|
| Lost Creek | MFWP restoration project on 20+ miles with >$1 million invested since 1999. Council is monitoring nutrient impact. |
| Little Blackfoot River | Deer Lodge Valley Conservation District stream assessment and restoration planning done. Landowner group active. |
| Gold Creek | Watershed Restoration Coalition of the Upper CF project initiated, assessments done. Council funding in 2003. |
| Flint Creek | No comprehensive project known. Very large watershed. |
| Warm Springs Cr.-Garrison | Council VNRP coordinator did watershed assessment with focus on phosphorus sources in 2003-2004. Also on Brock, Gold (see above) and Dunkleberg Creeks. |
| Mill-Willow Creeks | Some project planning and sampling underway by ARCO-MSU. Metals contamination is primary focus of plans. |
| Dempsey Creek | Council mini-grant to Deer Lodge V. Conservation District improved corrals on upper creek. |
| Racetrack Creek | None known. |
| Cottonwood Creek | Watershed Restoration Coalition watershed assessment done and projects identified. Large flood control project starting in Deer Lodge. |
| Warm Springs Creek-Anaconda | Montana FWP has extensive assessments and restoration plans. ARCO-Butte-TU are supplementing flows (dilutes nutrients). |
| Bitterroot River | Various. See section below. |
| Ninemile Creek | Montana DEQ and watershed group have completed a TMDL for sediments/ other impairments. |
| Trout Creek | None known. |
| Rock Creek | Various fisheries projects, none known to influence nutrients. |
| Blackfoot River | Many fisheries and grazing projects with Blackfoot Challenge/others. Major 319 projects on Nevada Creek drainage addressed nutrients. |
| Fish Creek | None known. |
| St. Regis River | DEQ, County working on TMDLs. |

### C. Non-point Source Nutrient Reduction Actions in the Bitterroot

The VNRP Coordinator has worked extensively in the Bitterroot river valley since 1999 to educate the stakeholders about non-point nutrient issues in the drainage, and to initiate projects to address identified non-point nutrient sources. The VNRP Non-point Strategy highlighted Threemile Creek, Rye Creek, and Sweathouse Creek as Bitterroot River tributaries which were highly ranked as nutrient problem areas, using the same criteria as were applied to the upper Clark Fork. Several of the most important VNRP initiatives in the Bitterroot since 1998 include:

- Supporting the Bitterroot Water Forum, a citizen-based group doing education, fundraising, and project development around watershed and water quality issues in the fastest-growing county in Montana. The VNRP Coordinator has written several successful grant proposals with the Forum, and works closely with several of their committees. The Water Forum is working with the realtors association, Trout Unlimited and MFWP on developing stream setback guidelines for development. They have also been lobbying to have the County consider a Water Quality District. In addition the Water Forum provided coordination and funding to three different tributary watershed projects—Mill Creek, Skalkaho Creek, and Threemile Creek-- in the valley, and is initiating activities in Rye Creek drainage.

- The VNRP Coordinator developed a comprehensive watershed assessment project for the Ambrose-Threemile drainage from 2002-2005. This 71-sq. mile drainage has by far the highest concentration of nutrients of any Bitterroot river tributary. The assessment identified nutrient and sediment source areas (the problems are closely related), and developed specific priority work areas. Several major pilot projects are underway in priority reaches—including new grazing systems, stream channel rehabilitation and roads projects. A local organization (Friends of Lee Metcalf Refuge) is taking on coordination of projects.

- Since 2000, the VNRP Coordinator has been working with the Natural Resources Conservation Service and local dairymen to improve dairy manure management in the Bitterroot Valley. The six largest dairies in the County participated in a dairy waste management assessment project in 2001, and three of those dairies have gone on to invest in improved manure management systems. Two Bitterroot dairies are now selling dairy manure compost, using infrastructure financed in part by Council projects.

- Montana DEQ developed a Bitterroot Headwaters TMDL Planning Area project in 2001-2004, which addressed impairments on 14 upper watershed tributaries, primarily within the Bitterroot National Forest. The Council participated as a Technical Advisory Committee member and coordinator. In 2004, DEQ began the process of preparing TMDLs for the Bitterroot mainstem (from Darby to Missoula) and numerous tributaries. The Council's VNRP coordinator and Trout Unlimited have been involved in water quality sampling for the nutrient-impaired mainstem and eight nutrient-impaired tributaries. The Council is also working with Bitter Root Water Forum on a public participation strategy for that TMDL.

**D. Non-point Source Nutrient Reduction Activities and Impacts in the Blackfoot**

The North Powell Conservation District and NRCS have been working for a number of years on water quality and fisheries projects in the Nevada Creek drainage, which is an important nutrient source for the Blackfoot. The Council is not directly involved in nutrient-reduction projects in the Blackfoot, but collaborated in funding several stream restoration/nutrient reduction projects managed by the Blackfoot Challenge in 2002-2005, including projects in the Nevada Spring Creek, Ward Creek, Warren Creek and Wasson Creek drainages. Various other fisheries related projects coordinated by Blackfoot Challenge and Montana FWP may also have secondary positive impacts on nutrients.

## IV) In-Stream Impacts of Nutrient Reduction Work in the Clark Fork

### A. Summary of Council Nutrient Monitoring Program

The Council has an extensive water quality monitoring program run in coordination with state and local governments and other stakeholders. The program began in 1998 with the signing of the VNRP and the need to monitor the effects of those efforts. The VNRP portion of the monitoring program has three major objectives: 1) detect trends in nutrients in the river; 2) detect trends in attached algae density; and 3) evaluate summer nutrient concentrations relative to the VNRP targets.

The monitoring program established 32 monitoring sites in 1998, including 15 Clark Fork river sites, 11 of them above the Flathead confluence, and 17 tributary sites. The mainstem stations were initially monitored 12 times per year, and the tributaries 4 times per year. Since that time the monitoring program has been modified several times by the Council's Monitoring Committee due to funding constraints and various scientific criteria

However, summer data for nutrients and algae in the upper and middle Clark Fork is consistently collected every summer. Most key sites have data collected 10-12 different times during the June-September period. This data, in combination with earlier intensive data collection by the State of Montana in 1989-91, and work done by the University of Montana and others, allows a good picture to emerge of changes in nutrients and algae since the late 1980s to the present.

### B. Summary of Trend Analysis Published by the Council for 1984-2002

In 2004, the Council's contractor Land and Water Consulting of Missoula, MT, produced a very in-depth trend analysis of nutrient and algae data in the Clark Fork (Land and Water, 2004). This information is summarized in the report "Water Quality Status and Trends in the Clark Fork-Pend Oreille Watershed: Trend Analysis from 1984-2002," available from the Tri-State Council's office in Sandpoint, Idaho.

The trend analysis revealed many interesting situations, for instance:

- There were 13 sites with significant declining trends in total phosphorus in the basin, and only 2 sites with increasing trends.
- There were 15 sites with significant declining trends in total nitrogen in the basin, and none with increasing trends.
- However, total soluble inorganic nitrogen was found to be increasing at 14 sites and decreasing at only two sites. This is in contrast to all other nutrient and metal parameters measured, which were predominantly decreasing in the basin.
- Total nitrogen was decreasing significantly at Clark Fork at Warm Springs and Clark Fork above Little Blackfoot, while total phosphorus was decreasing at these two upper river stations as well as at Clark Fork below Missoula and at Huson.
- Soluble inorganic nitrogen was decreasing at Clark Fork at Warm Springs and below Missoula, but not trending at Clark Fork above Little Blackfoot, and trending upward at Huson. These four stations will be discussed below relative to the 2002-2004 data.

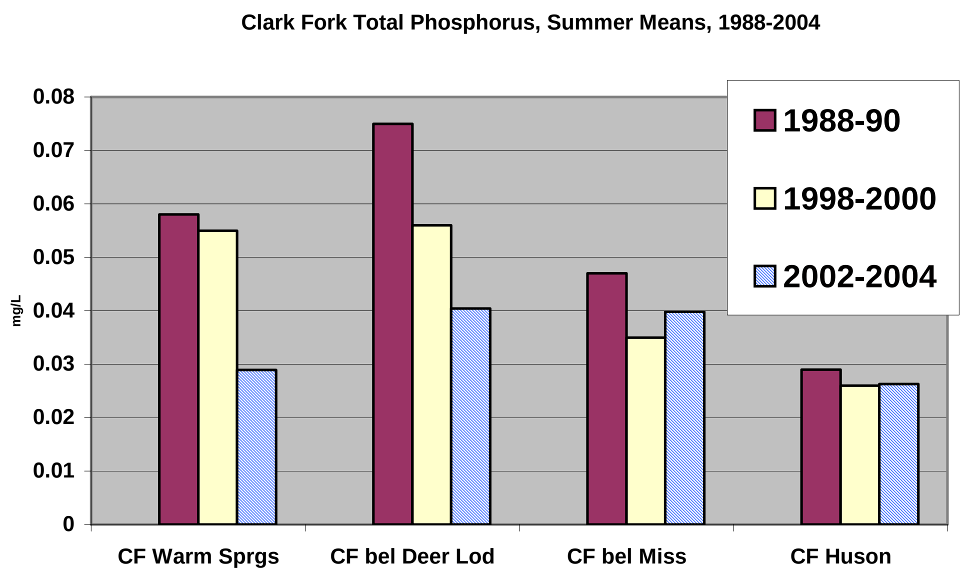
## C. Clark Fork Nutrient Concentrations in 2002-2004

The most recent data pertinent to this three-year status report, the nutrient and algae data for 2002-2004, was mostly not available during the trend analysis. This section will update information from the prior VNRP Three-Year Report (May, 2002), using an "illustrative analysis." This is not a "trend analysis," but simply an attempt to put the most recent monitoring data from the river into historical perspective. The objective is to help us understand how recent improvements in nutrient management by the VNRP signatories might be reflected in the river's water quality.

Nutrient data is notoriously variable from year-to-year. To better understand how nutrient concentrations vary over time, this report compares three-year sets of nutrient data from the Clark Fork from three distinct time periods: 1989-1991, 1998-2000, and 2002-2004. The Council monitoring program has sufficient data that each three-year combined data set has about 30 data points. Comparing these large multi-year data sets tends to minimize the effects of outlier data and annual flow-related fluctuations.

Since many of the signatories started improving their nutrient management during the 1990's, we can use these three time periods to track the effects of major changes in nutrient discharge by the point-source VNRP signatories. All three data sets have some low-flow years, and no exceeding high flow years, with mean summer flows below long-term averages at most points on the river. The general similarity in flow conditions in these three periods makes our comparison more credible.

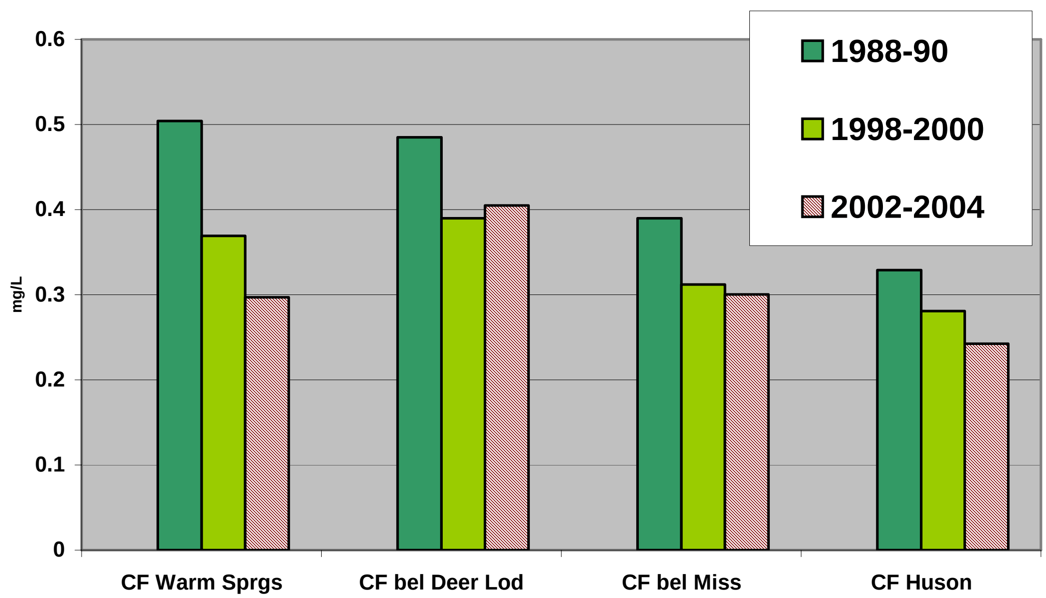
**Figure 7: In-Stream Total Phosphorus Concentrations Compared from Summers 1988-90, 1998-2000 and 2002-2004:**




This illustrative comparison indicates that the trend continues through 2002-2004 for decreasing total phosphorus at the key upper Clark Fork stations (Warm Springs and **above Little Blackfoot—also known here as "below Deer Lodge").** The long-term reductions in total phosphorus at Clark Fork below Missoula and Huson do not appear to be continuing in the 2002-2004 data set. Note that summer means for total phosphorus the 2002-2004 data in the upper river are no longer higher than the summer means for total P in the lower river below Missoula, as has been the case for a long time. This indicates very significant changes in the nutrient dynamics of the upper river.

Long-term changes in total nitrogen concentrations in the Clark Fork can be visualized using the following data (more upstream stations are to the left):

**Figure 8: Clark Fork Total Nitrogen, Summer Means 1988-2004**




Although total nitrogen seems to be continuing to decrease at the Clark Fork Warm Springs station in the upper river, a similar continuation of long-term decreases is not apparent above Little Blackfoot. There are long-term decreases in mean total nitrogen at both lower river stations (Missoula and Huson) but these were not determined to be statistically significant in the Trend Analysis Report in 2002. It will be interesting to see if the apparent decreases at Huson become more significant as the more recent data is incorporated into the next analysis.

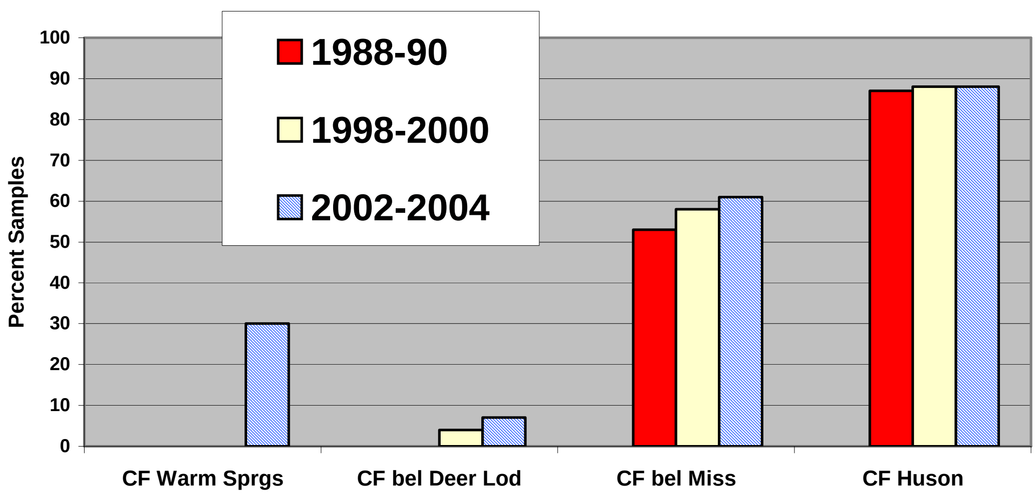
**In general, the major decreases in total phosphorus and total nitrogen discharge by the VNRP signatories from 1989 to the present (64% decrease in annual total phosphorus load and 29% decrease in annual total nitrogen load) appear to be reflected in the water quality of the river**. This can be seen in the results of the Trend Analysis, and in this illustrative analysis of data from 2002-2004. These positive impacts appear to be greater in the upper river, and are not as notable in recent years below Missoula. This may be because Missoula's WWTP has been absorbing an ever-greater wastewater load in recent years as new sewer districts hook up to the system. The major improvements in Missoula's wastewater effluent quality noted during 2005 as the new biological nutrient removal system came on-line are not yet captured by the river data. These improvements are expected to be seen in the river water quality data starting in summer, 2005.

Meanwhile, it is of concern that **the Trends Analysis found increasing trends for soluble inorganic nitrogen in many parts of the river, including the station at Huson**. This general increase in soluble nitrogen also may be affecting the relative lack of recent improvement in total nitrogen in the lower river. The source of additional soluble nitrogen is not known. It may be related to the drought, since low flows often reflect a higher relative hydrologic influence from ground water. Soluble inorganic nitrogen, distinct from the other nutrient species, is discharged to surface water quite readily through shallow ground water. The original source may be septic systems (which have increased dramatically in the Bitterroot sub-basin), fertilizer or perhaps other sources.

### D. Meeting the VNRP Nutrient Targets:

The following data expresses the frequency that water samples at various points in the river meet the VNRP's total phosphorus targets (0.020 mg/L in the upper river, 0.039 mg/L in the lower river).

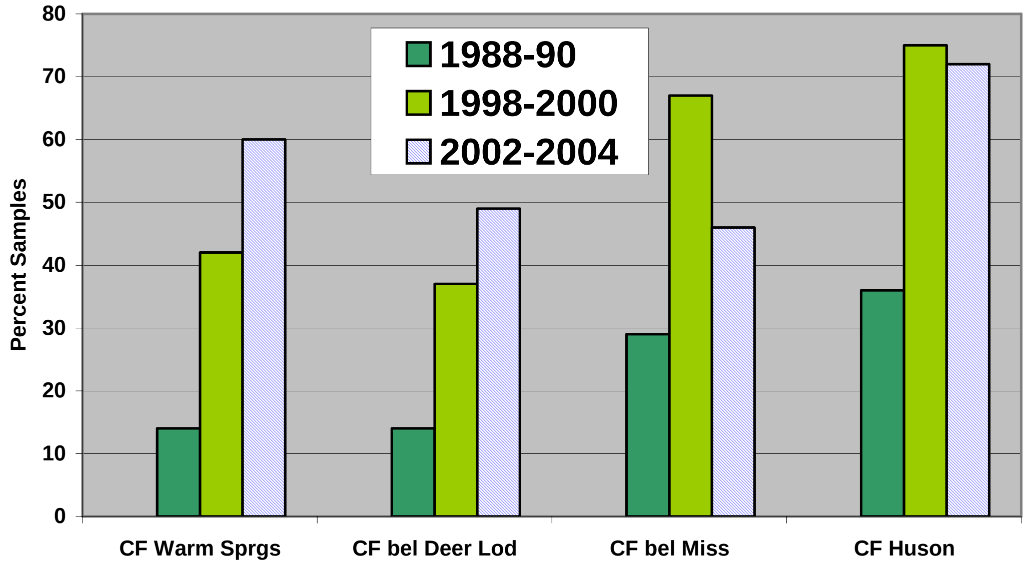
**Figure 9: Clark Fork Sites Meeting VNRP Phosphorus Targets (%)**




The upper river stations (CF Warm Springs and CF Deer Lodge) met the VNRP targets relatively few times in 2002-2004, but more frequently than in the past. In fact, it is the first time that CF Warm Springs data have ever met the VNRP total P targets. This is another indicator of the progress being made to reduce total P concentrations in the upper river. In the lower river the percentage of samples meeting targets appears to be slightly increasing (below Missoula) or remaining steady (Huson).

The frequency of meeting total nitrogen targets at different periods since the late 1980s is expressed in the following graph:

**Figure 10: Clark Fork Sites Meeting VNRP Nitrogen Targets (%)**



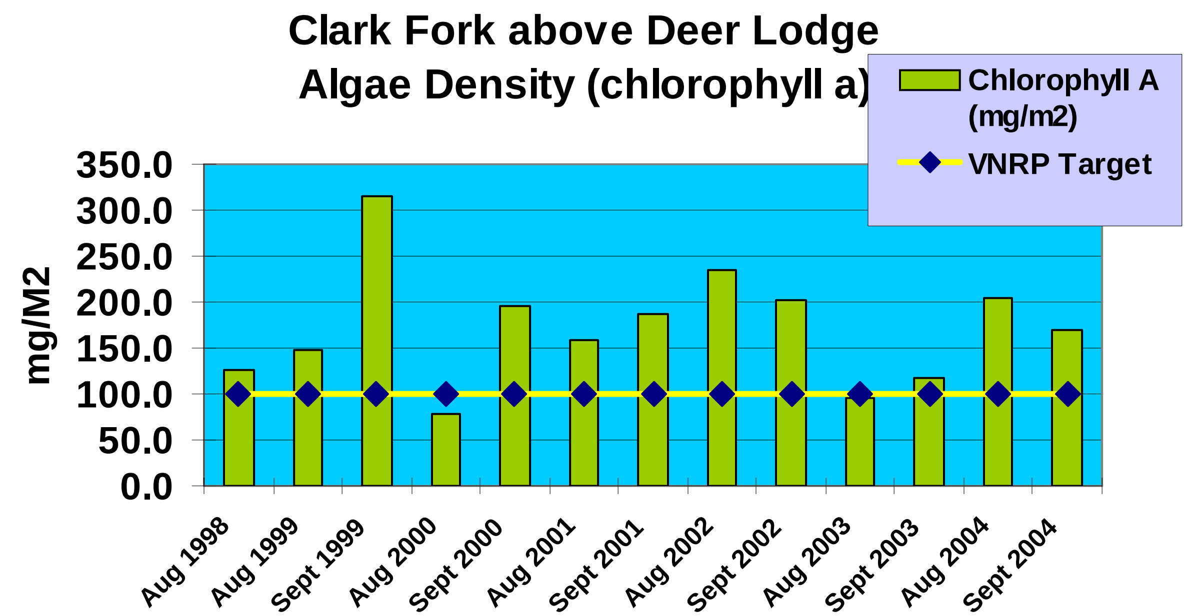

The improvements in meeting total nitrogen targets are quite marked in the upper river. This is interesting, because consideration of the mean total nitrogen levels did not show improvement at CF above Little Blackfoot. It appears likely that a negative trend in total nitrogen concentration continues in the upper river, which is logical given the efforts of the VNRP signatories in Butte and Deer Lodge to remove or dilute nutrient concentrations in the river.

The lack of improvement since 2000 in meeting total nitrogen targets in the Clark Fork below Missoula comes as no real surprise. This is because the Missoula Wastewater Treatment Plant was operating from 2000-2004 at its highest ever volume, really at design capacity, before the plant expansion was inaugurated in fall, 2004. The nitrogen discharge data from Missoula previously discussed, show that total nitrogen load discharge from the plant peaked in 2003, and just started to decline in late 2004, and in 2005 due to the new biological nutrient removal facility.

**E. Attached Algae Density in the Clark Fork:**

The VNRP Committee had access to relatively little attached algae data prior to the initiation of the VNRP monitoring program in 1998. The sporadic data from the 1980s indicates that attached algae was more abundant at that time, but effective annual monitoring of algae levels has only been done consistently from 1998 to 2004. This data is displayed for two problematic stations in the following graphs:

**FIGURE 11:**


Clark Fork above Deer Lodge
Algae Density (chlorophyll a)
Chlorophyll A (mg/m2)
VNRP Target
mg/M2
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Aug 1998
Aug 1999
Sept 1999
Aug 2000
Sept 2000
Aug 2001
Sept 2001
Aug 2002
Sept 2002
Aug 2003
Sept 2003
Aug 2004
Sept 2004

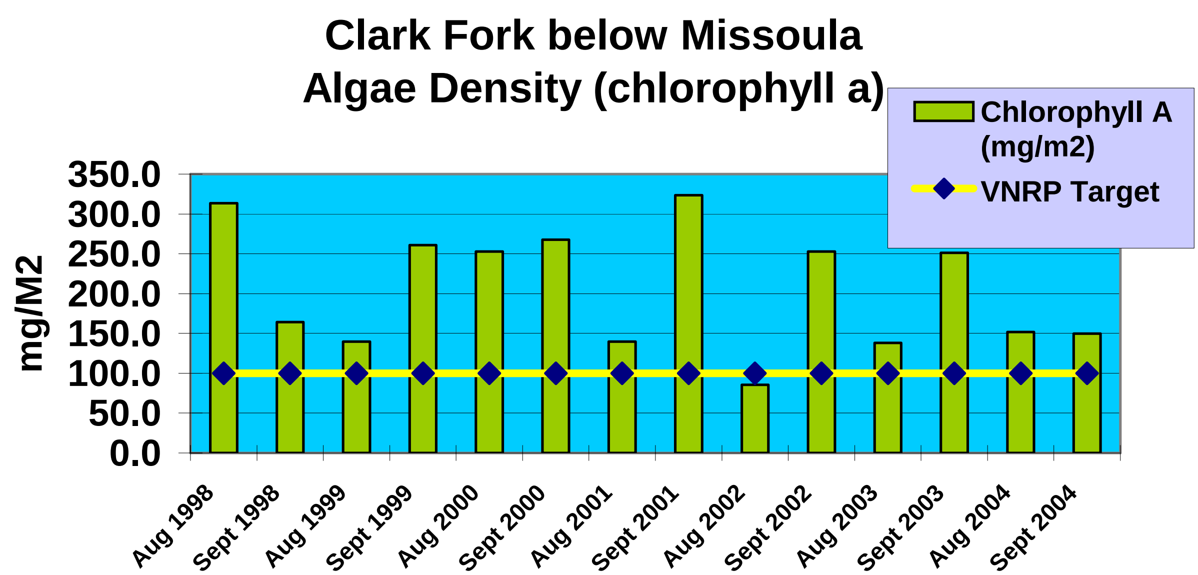
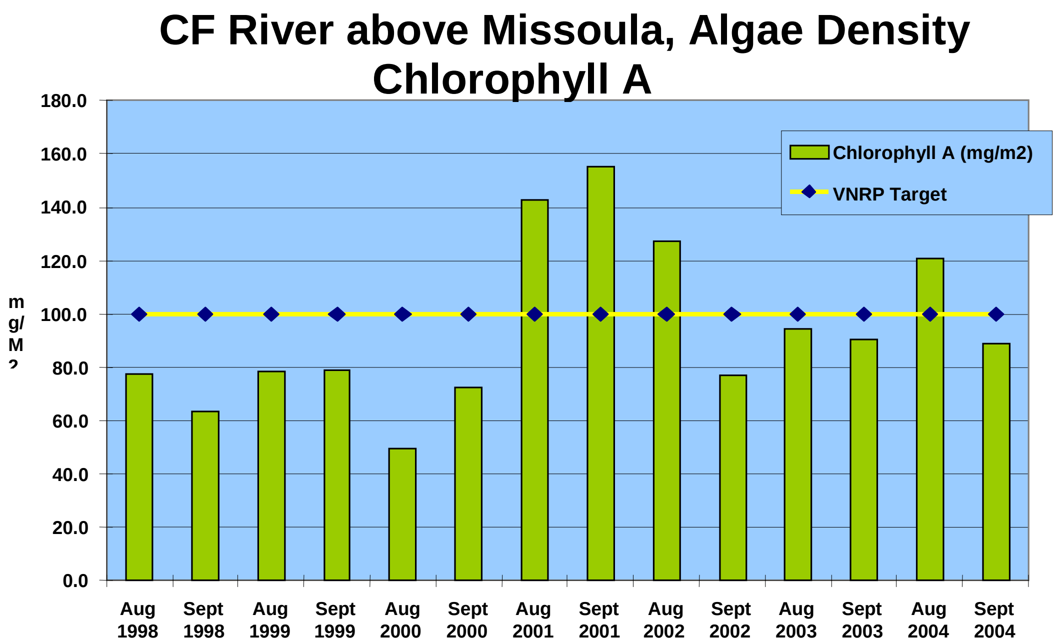

Clark Fork below Missoula
Algae Density (chlorophyll a)
Chlorophyll A (mg/m2)
VNRP Target
mg/M2
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Aug 1998
Sept 1998
Aug 1999
Sept 1999
Aug 2000
Sept 2000
Aug 2001
Sept 2001
Aug 2002
Sept 2002
Aug 2003
Sept 2003
Aug 2004
Sept 2004

**FIGURE 12:**




Although the attached algae data show considerable annual variation, it is clear that the monitoring sites above Deer Lodge and below Missoula, show algae densities in excess of the targets most years (13 out of 14 sampling events). Below Missoula, the algae density is more than double the target in at least half the sampling events. Meanwhile, in the monitoring site above Missoula, where nutrient concentrations are consistently lower, the algae density only exceeded targets in four events out of 14 (29%). This data is shown in the table below:

**Table 8: Frequency of Exceedance of Mean Algae Density Target, 1998-2004:**

| Site: | Means Exceeding the VNRP Mean Target (100 mg/M2): | Percent Means Exceeding the Target (100 mg/M2): |
|---|---|---|
| Clark Fork above Deer Lodge | 13/14 | 93% |
| Clark Fork above Little Blackfoot | 7/14 | 50% |
| Clark Fork above Missoula | 4/14 | 29% |
| Clark Fork below Missoula | 13/14 | 93% |
| Clark Fork at Huson | 3/14 | 21% |

The Council's Trend Analysis analyzed algae data from 1998 to 2002, and from 1987-2002. The chlorophyll A data from 1998 to 2002 showed no statistically significant trends in the data from the upper river-- Clark Fork at Deer Lodge and Clark Fork above Little Blackfoot. But stations at Bonita, above Missoula, below Missoula, and at Huson showed increasing trends for chlorophyll A in these recent years.

A trend analysis for attached algae was also conducted with data from 1987 to 2002. The results showed no significant trends in chlorophyll A when each year's replicates are averaged, but small sample size (only 6 or 7 years of data) limits the power of this analysis. Using raw data (over 150 data points per station) shows statistically significant decreasing trends for algae density at Clark Fork at Deer Lodge, Clark Fork above Little Blackfoot, Clark Fork at Bonita, and Clark Fork above the Flathead. However, all these analyses must be viewed with caution due to lack of independence of the data (i.e., algae growth one year affects the algae the next year) and other statistical limitations (Land and Water Consulting, 2004, p. 27-29).

Several problems limit our ability to link nutrient reductions with declines in algae. First, our algae data is much more limited than our nutrient data. Second, annual algae density is only loosely correlated to annual nutrient concentrations in river systems. Many other factors including timing and duration of streamflows, scouring flood flows, abundance of grazers, toxic metals (e.g. copper) concentrations, temperatures, etc. are involved in determining attached algae density in any given year. Among these factors, only nutrient concentrations can be controlled by society's decisions. It is expected that the major decreases in nutrient concentrations will have an impact on algae density in the medium-term. Further algae monitoring will be done by the Council in the coming years.

### F. Prospects for Meeting the VNRP's Goals and Targets by 2008

Based on the Trend Analysis and recent data, it is clear that the VNRP is on the right track to meet its ambitious nutrient targets in the Clark Fork in the next few years. This will require signatories to meet difficult challenges to put in place the remaining alternative effluent disposal systems now being planned. And it will require strong efforts by DEQ in revising the Clark Fork TMDL and the existing MPDES permits in the Clark Fork. Reaching the algae targets in the short term will be more challenging still, because algae respond to many different ecological cues besides nutrients.

## V. Challenges Remaining for the VNRP

### A. General Challenges:

The VNRP Committee is encouraged by the progress made by signatories in reducing nutrient discharges in both the upper and lower river. These measures taken by municipalities and industries, working together, have made a difference in the river's water quality. Both nutrient concentration and algae levels have gone down in the last decade, and more improvement in the river is expected as measures such as Missoula's new biological nutrient removal system and Butte's expanded land application are implemented and show effects.

However, challenges are surfacing in the effort to curb nutrient pollution. Some of the general basin-wide challenges are listed below:

1) Population growth continues to be strong in Ravalli, Missoula, and Mineral counties. Thousands of new septic permits have been granted in recent years in Ravalli county, and development there also may affect the integrity of some riparian areas and watersheds, both of which could affect nutrient levels in the Bitterroot River, a key tributary.

2) The increasing trend in soluble nitrogen concentrations in the basin, especially in the lower river, is of great concern. This may be related to septic systems or other human-related sources in the basin at large. This problem requires more study and perhaps, a much greater effort on non-point soluble nitrogen sources. Policy-makers may have to consider more stringent methods to control nutrients from growth and urbanization.

3) New industries are locating in the upper basin, often in Clark Fork tributaries, and some of these industries can have have significant phosphorus discharges. For example, the Tax Increment Financing Industrial District (TIFID) near Butte is attracting new industries, and is considering various wastewater treatment options. It is unclear if TMDLs and MPDES permits on tributaries to an impaired water body like the Clark Fork will be sufficient to avoid increases in nutrient loads to the river. This is a challenge for the MDEQ permits division and the municipalities where these new industries locate.

4) Non-point pollution in general continues to contribute a large proportion of the total nutrient load to the Clark Fork. Important sources for these non-point loads are difficult to locate, and therefore to manage. Outreach to landowners in the vast rural areas of the basin is always challenging. Watershed groups in the Blackfoot, Upper Clark Fork, and Bitterroot are key partners for the Council in any non-point efforts. These groups often have problems finding funding, and the funding environment for conservation and restoration is extremely competitive. Comprehensive planning for tributary watershed conservation is complex, and not usually attempted by smaller watershed groups. It may be worthwhile for groups partnering with the Council to attempt a coordinated prioritization exercise for tributaries with different restoration goals.

5) Meeting the goals for expansion of sewer systems into the neighborhoods around Missoula continues to be a major political challenge for local government. Stronger

efforts to assist these neighborhoods to do planning/zoning are required, because their concerns are usually not focused on water quality issues at all. Other communities may have similar issues with

6) Finally, the municipal signatories have more large capital investments still ahead of them, and political issues about costs and revenue are a challenge for local government.

## B. Specific Tributaries: Non-point and Policy Issues

### *Upper Clark Fork:

The nutrient issues in the upper Clark Fork are imbedded in a complex array of other water quality issues related to metals contamination in the same area. Some particular concerns for VNRP are:

- Solutions for metals contamination problems developed through the SuperFund (CERCLA) process should consider the impact of their activities on nutrient issues. Many times the solutions will be very compatible, such as any measures to minimize the sediment input to the system, and measures to increase flows to dilute contaminants.
- Silver Bow Creek's nutrient concentration is still extremely high, and includes many non-point source nutrients (N and P) from the urban area of Butte, even above the wastewater treatment plant. All efforts to improve Silver Bow creek biologically and aesthetically must consider the creek's potential to grow noxious algae. Continuing efforts to reduce non-point nutrient inputs are required.
- Mill-Willow Creek has had high nutrient concentrations in the past, and may still have these problems. The relationship of the creek to the diffuse septic system discharge from the town of Opportunity needs to be better understood.
- The impact of the Anaconda wastewater treatment system ponds on nitrate levels in Dutchman and Lost Creek is still unclear. A Council project to investigate the groundwater-surface water nutrient dynamics in this system was postponed because Anaconda did not give approval.
- In the Little Blackfoot, Warm Springs-Garrison, and Gold Creek drainages, the potential for non-point source sediment/nutrient/fisheries habitat improvement projects needs to be pursued.
- The Flint Creek drainage has potential nutrient issues related to development pressures in Georgetown Lake and Philipsburg areas, as well as historical land use.

### *Bitterroot River drainage:

The nutrient issues in the Bitterroot river and its tributaries are related to both historical land use and to current development pressures. Some of the most important problems and opportunities are:

- Land use planning decisions in the urbanizing areas of Ravalli County are very controversial. Sanitary sewer and stormwater issues need to be carefully planned to protect water quality in the areas around Stevensville and Hamilton and the highway 93 /Bitterroot river corridor. But contestants in conflicts over growth tend to use water quality issues as a “weapon” to fight growth, rather than to face the need for land use planning..

- Rural land development continues to add septic system nutrient loads to the shallow groundwater throughout the Bitterroot Valley. Planning must take into account the capacity of the river to absorb the increased wasteloads. New septic systems with greater nutrient removal capacity may be needed in the future.
- Watersheds on the east side of the valley—Threemile, Burnt Fork, Rye, etc.--with higher nutrient loads need help developing watershed management and stream restoration plans, and obtaining funding.
- Small-scale farms and ranches need to be educated about the water quality issues related to livestock and agriculture.
- Policies related to setbacks from streams are urgently needed—some good initiatives currently exist and deserve support.

## VI) REFERENCES:

Ingman, Gary, 1992, “Assessment of Phosphorus and Nitrogen Sources in the Clark Fork River Basin, 1988-1991: Final Report,” State of Montana Dept. of Health and Environmental Sciences, Water Quality Bureau, Cogswell Building, Helena, MT.

Land and Water Consulting, 2004, ““Water Quality Status and Trends in the Clark Fork-Pend Oreille Watershed: Trend Analysis from 1984-2002,” Missoula, MT (for Tri-State Water Quality Council, Sandpoint, ID).

Tri-State Water Quality Council, 1998, “Clark Fork River Voluntary Nutrient Reduction Program,” submitted to MT Dept. of Environmental Quality, Helena, MT; and U.S. Environmental Protection Agency, Regional Office, Denver, CO.

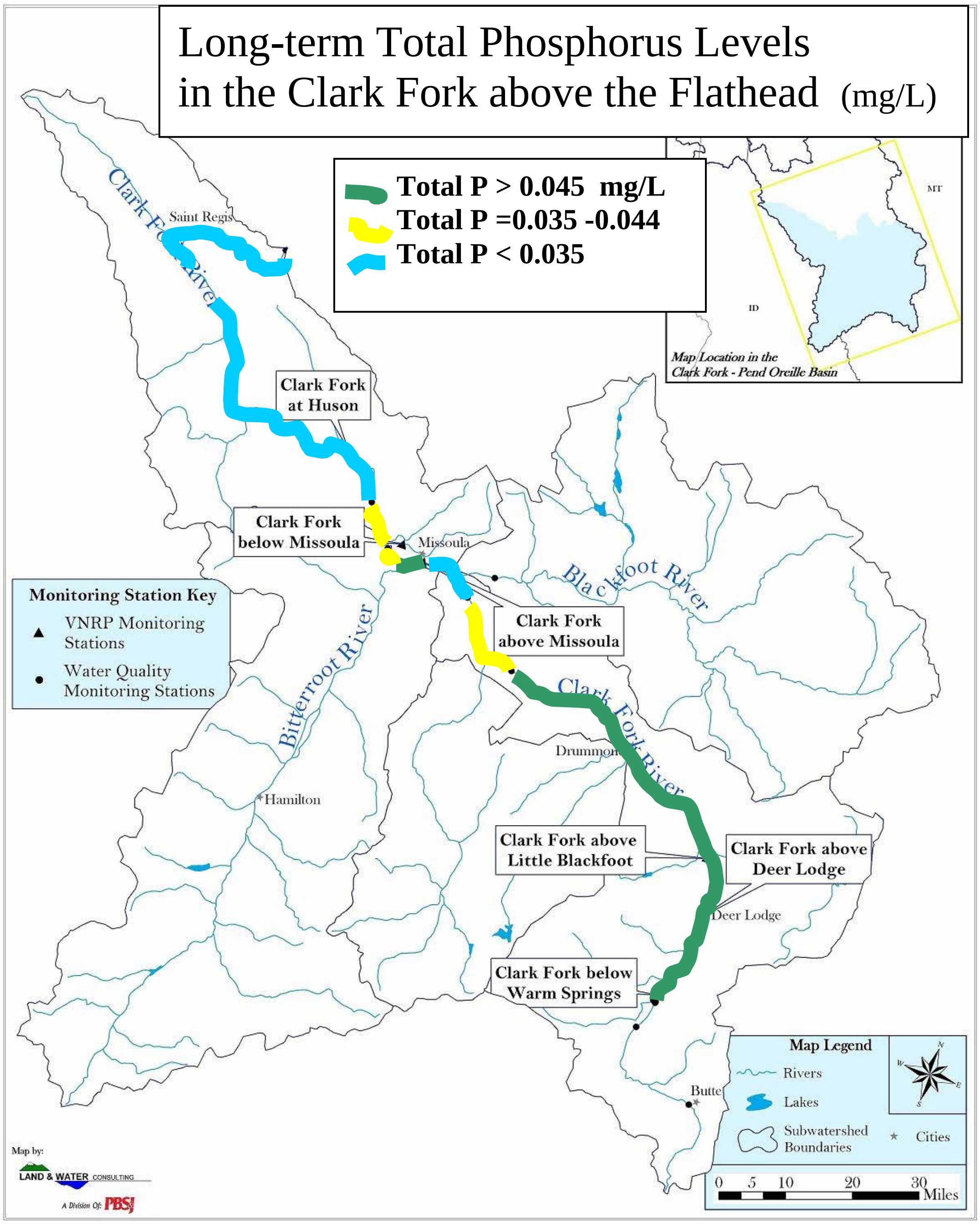
## APPENDICES:

**MAP 1: Mean Long-term (1984-2002) Total Phosphorus Concentrations in the Clark Fork**

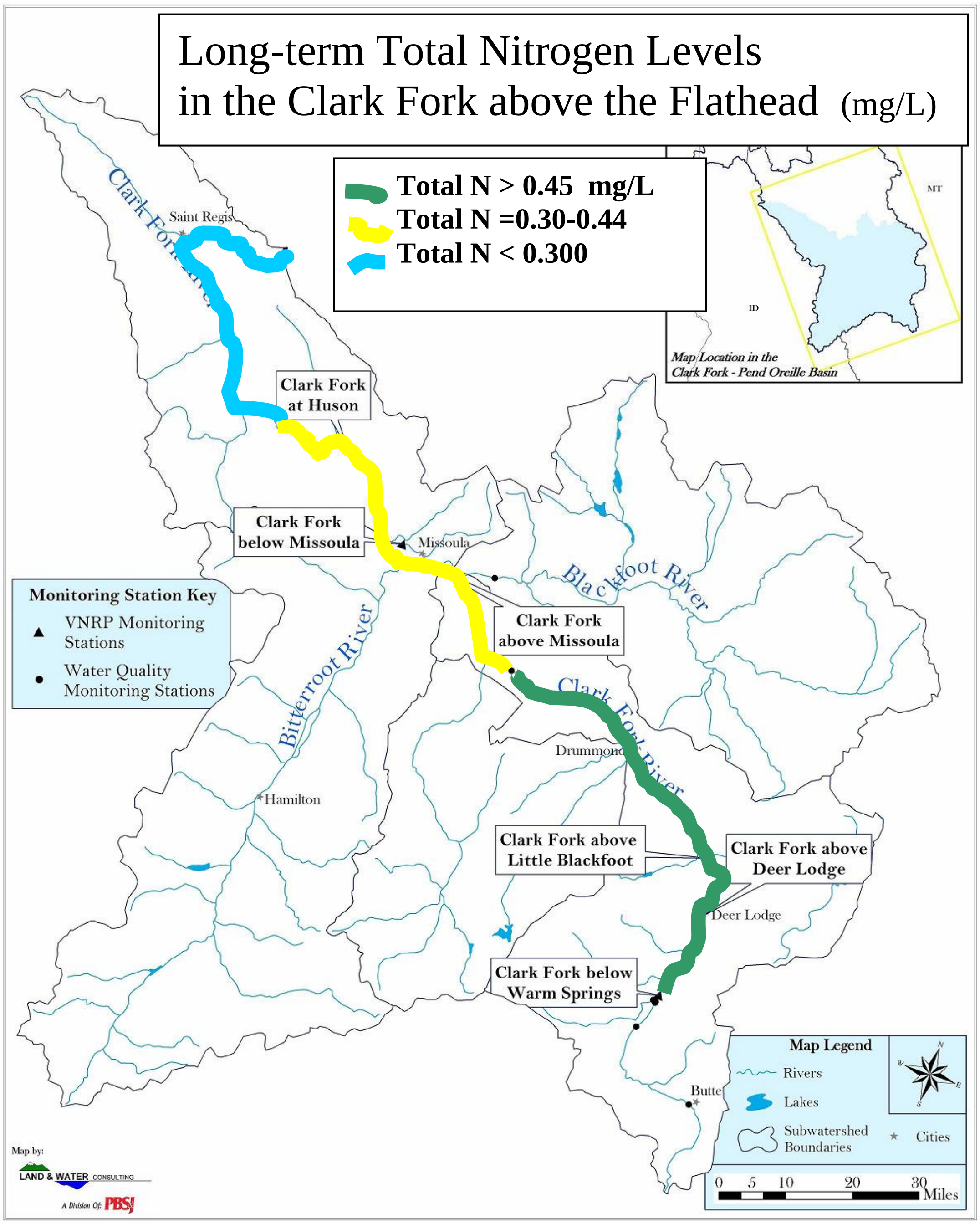
**MAP 2: Mean Long-term (1984-2002) Total Nitrogen Concentrations in the Clark Fork**

**TABLES: Mean Annual and Mean Summer Nutrient Discharge to the Clark Fork From Butte WWTP, Deer Lodge WWTP, Missoula WWTP, and Smurfit-Stone**

**MAP 1: Mean Long-term (1984-2002) Total Phosphorus Concentrations in the Clark Fork:**



**MAP 2: Mean Long-term (1984-2002) Total Nitrogen Concentrations in the Clark Fork:**



## NUTRIENT DISCHARGE DATA FROM VNRP SIGNATORIES:

**Butte Summer Average Nutrient Load Discharge, June-Sept 1997-2004**

| | Total N lb/day | Total P lb/day | Flows mgd |
|---|---|---|---|
| 1997 | 549.90 | 31.90 | 6.17 |
| 1998 | 525.10 | 40.30 | 6.12 |
| 1999 | 459.60 | 56.40 | 4.84 |
| 2000 | 441.90 | 50.60 | 4.05 |
| 2001 | 496.20 | 63.20 | 4.08 |
| 2002 | 395.10 | 41.60 | 3.54 |
| 2003 | 529.60 | 70.80 | 3.40 |
| 2004 | 479.30 | 42.50 | 3.11 |

| NUTRIENT LOAD REDUCTION TO THE CLARK FORK RIVER, MONTANA | | | | | | |
|---|---|---|---|---|---|---|
| **FROM 1986 to 2005** | | **DEER LODGE, MT** | | | | |
| | | Annual Average | | | Summer Average* | |
| YEAR: | | Total N | Total P | | Total N | Total P |
| | | (lb/day) | (lb/day) | | (lb/day) | (lb/day) |
| 1986 | | na | na | | na | na |
| 1987 | | na | na | | na | na |
| 1988 | | na | na | | na | na |
| 1989 | | 116.5 | 11.8 | | 41.8 | 7 |
| 1990 | | 95.7 | 9.8 | | 38.9 | 6.3 |
| 1991 | | 94.4 | 10.4 | | 40 | 6.9 |
| 1992 | | 87.7 | 9.5 | | 35.1 | 6.1 |
| 1993 | | 126.3 | 13.1 | | 51.8 | 8.9 |
| 1994 | | 88.4 | 9.3 | | 36.3 | 6.1 |
| 1995 | | 68.1 | 8 | | 34.2 | 5.8 |
| 1996 | | 74.9 | 7.8 | | 28.2 | 4.7 |
| 1997 | | 78.3 | 8.4 | | 31.5 | 5.4 |
| 1998 | | 69.3 | 7.5 | | 27.7 | 4.8 |
| 1999 | | 52.9 | 5.7 | | 22.2 | 3.7 |
| 2000 | | 40.7 | 4.2 | | 10.1 | 1.7 |
| 2001 | | 67.4 | 6.6 | | 24.4 | 3.8 |
| 2002 | | 55.3 | 5.1 | | 13.4 | 2.3 |
| 2003 | | 82 | 6.8 | | 21.6 | 3.3 |
| 2004 | | 59.5 | 5.7 | | 17.8 | 2.7 |
| 2005 | | | | | 17 | 2.7 |

***Averages are estimates based on flows and 1994-1995 nutrient data.**

| NUTRIENT LOAD REDUCTION TO THE CLARK FORK RIVER, MONTANA | | | | | | |
|---|---|---|---|---|---|---|
| **FROM 1986 to 2005** | | **MISSOULA WWTP** | | | | |
| | | Annual Average | | | Summer Average* | |
| YEAR: | | Total N | Total P | | Total N | Total P |
| | | (lb/day) | (lb/day) | | (lb/day) | (lb/day) |
| 1986 | | NA | 299 | | NA | 279 |
| *1987 | | NA | 297 | | NA | 304 |
| **1988 | | 1,121 | 342 | | 961 | 425 |
| 1989 | | 1,386 | 228 | | 1,177 | 192 |
| 1990 | | 1,335 | 189 | | 1,164 | 180 |
| 1991 | | 1,200 | 183 | | 1,083 | 167 |
| 1992 | | 1,230 | 198 | | 979 | 201 |
| 1993 | | 1,177 | 180 | | 1,176 | 159 |
| 1994 | | 1,283 | 186 | | 1,227 | 204 |
| 1995 | | 1,025 | 91 | | 973 | 112 |
| 1996 | | 1,144 | 95 | | 1,095 | 73 |
| 1997 | | 1,207 | 119 | | 1,107 | 137 |
| 1998 | | 1,218 | 143 | | 940 | 155 |
| 1999 | | 1,482 | 134 | | 1,471 | 164 |
| 2000 | | 1,679 | 144 | | 1593 | 137 |
| 2001 | | 1,862 | 146 | | 1549 | 119 |
| 2002 | | 1,860 | 165 | | 1491 | 144 |
| 2003 | | 1,745 | 214 | | 1678 | 243 |
| 2004 | | 799 | 163 | | 644 | 148 |
| ***2005 | | 668 | 59 | | 510 | 24 |

***1987-Summer average total phosphorus for does not include June.**
****1988- Annual and summer average total nitrogen includes only July-Dec.**
*****2005 data include only January-August.**

**NUTRIENT LOAD REDUCTION TO THE CLARK FORK RIVER, MONTANA**
**FROM 1986 to 2005 SMURFIT-STONE CONTAINER**

| YEAR: | | Annual Average Total N (lb/day) | Total P (lb/day) | | Summer Average* Total N (lb/day) | Total P (lb/day) |
|---|---|---|---|---|---|---|
| 1986 | | 702 | 195 | | No Data | No Data |
| 1987 | | 646 | 217 | | No Data | No Data |
| 1988 | | 562 | 136 | | No Data | No Data |
| 1989 | | 552 | 125 | | No Data | No Data |
| 1990 | | 553 | 142 | | No Data | No Data |
| 1991 | | 487 | 107 | | No Data | No Data |
| 1992 | | 378 | 129 | | 414 | 136 |
| 1993 | | 387 | 102 | | 300 | 100 |
| 1994 | | 416 | 109 | | 214 | 113 |
| 1995 | | 405 | 98 | | 395 | 69 |
| 1996 | | 314 | 78 | | 249 | 84 |
| 1997 | | 272 | 113 | | 163 | 66 |
| 1998 | | 291 | 96 | | 176 | 101 |
| 1999 | | 232 | 58 | | 278 | 76 |
| 2000 | | 232 | 58 | | 75 | 37 |
| 2001 | | 131 | 57 | | 65 | 35 |
| 2002 | | 157 | 44 | | 54 | 25 |
| 2003 | | 259 | 53 | | 151 | 42 |
| 2004 | | 184 | 55 | | 82 | 33 |
| 2005 | | | | | | |

*** Summer average data include July, August, September.**